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## ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA

Cultural Event for Disabled Persons in the ESCWA Region: An Event to Mark the End of the United Nations Decade of Disabled Persons (1983-1992) in the ESCWA Region
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Amman

### A BACKGROUND PAPER FOR DISCUSSION ON THE IMPLEMENTATION OF THE WORLD PROGRAMME OF ACTION CONCERNING DISABLED PERSONS IN COUNTRIES OF THE ESCWA REGION AND PREPARATION OF THE REGIONAL LONG-TERM STRATEGY TOWARDS THE YEAR 2010

### INTRODUCTION, ADAPTATION AND TRANSFER OF NEW AND APPROPRIATE TECHNOLOGIES FOR DISABLED PERSONS IN THE ESCWA REGION

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## INTRODUCTION

The transfer of technology from industrial countries to non-industrial countries, as envisaged within the framework of the new international economic order, as well as other provisions for strengthening the economies of non-industrial countries, would be of benefit to all people in these countries, including disabled persons.

For able-bodied people, technology makes things easier. For disabled persons, technology makes things possible. For instance, the personal computer (PC) lets all of us do things faster and more efficiently than we otherwise could. Thanks to interactive TV, we are not only able to do banking, reserve seats on flights and purchase tickets through computer networks, but we are now able to purchase goods seen on the TV screen by simply pressing a few keys on the remote control. Very soon, electronic mail will become something available to everyone. This marriage of the telephone and the computer will make it possible for employees to work at home.

But for disabled persons, the PC has a more profound significance. For the blind person, the quadriplegic, and the victim of severe cerebral palsy, the PC gives an access to personal accomplishment and economic independence as well as freedom from the isolation which is often the result of disability. Physically disabled persons can purchase goods seen on the TV screen by merely pressing a few keys through special frequencies assigned for this purpose.

Computer and electronics applications have special advantages in vocational preparation and subsequent rehabilitation, and facilitate the integration of disabled persons into productive life. Various PC devices and software, mostly from small companies,[1/] are helping disabled PC users overcome physical handicaps. Computers talk to the blind and listen to the commands of those who cannot otherwise manipulate keyboards. Head-mounted switches enable severely paralysed persons to use Morse code to communicate with the PC. And the PC, in turn, will introduce disabled persons to people, activities, and opportunities that they could not otherwise reach.

Employment opportunities are of particular concern for disabled persons. Employment gives disabled persons independence and productivity in their lives, thus allowing them to maintain their human dignity. Fortunately, owing to the advancement of new technologies (particularly computer-based technologies), projections on the employment of disabled persons seems to be quite optimistic, mainly for the following reasons:

1. The shift from work requiring physical strength and manual dexterity to work requiring more intellectual skills removes major barriers for even severely disabled persons. Although new technologies may pose a threat to some disabled persons, such as mentally retarded persons, others will have new opportunities.

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1/ A list of companies producing technical aids for disabled persons is provided in the annex.

2. The nature of computer and telecommunications technologies and of informatics permits greater flexibility regarding where, when and how much people produce. Freedom from the work-place and rigid schedules is a benefit to people with disabilities.

3. New technical aids are continually being developed which reduce the impact of disabilities dramatically, to the extent that in some cases workers are virtually non-handicapped in the work environment.

The transfer of new technology among nations, within the context of the World Programme of Action concerning Disabled Persons,[2/] should concentrate on methods that are functional and related to prevailing conditions in a particular country or region. Although new technology for preventive and remedial control of most disabilities has been strengthened by recent progress in bio-medical and bio-engineering research, it is still a fact that many countries, including countries in the ESCWA region, lack the technology to produce the technical aids required by disabled persons. New technologies developed in industrial countries should therefore be adapted to meet the local needs and then be transferred to the region through the training of trainers. This process includes two levels of customization: one is usually performed at the laboratory or the factory and requires technological innovations to adapt the technology to meet local needs, and the other is applied by the training personnel and requires some adaptation for each individual case with regard to specific aids.

For instance, in Egypt, various agencies and institutions (both governmental and non-governmental) are involved in the extensive task of rehabilitation of diversified categories of disabled persons. No doubt, new technologies and advanced technical aids for disabled persons were made available to the institutions and agencies through international technical cooperation programmes. However, a formal organization specifically working on adaptation and transfer of such technologies was first established in 1974, in close collaboration with five centres in the United States and one centre in Yugoslavia. The purpose of this centre -- the Cairo Engineering Centre -- is to introduce, adapt and transfer new technologies to the local needs and assist disabled persons to integrate into society.[3/]

The acquisition of technological devices and the appropriate training required for using them does not suffice in itself. Motivation should be provided and special attention should be given at the outset in terms of maximizing the use of these technologies regardless of various obstacles. The

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2/ United Nations, World Programme of Action concerning Disabled Persons (New York, Division for Economic and Social Information for the Centre for Social Development and Humanitarian Affairs, DIESA, 1983).

3/ This section draws heavily on an unpublished paper prepared by Mohamed Hashish, "Adaptation and transfer of new and appropriate technologies for the disabled in Egypt", IBM Cairo Scientific Centre, 1990.

educational, industrial and business sectors also play an important role in establishing internal programmes to assist disabled persons in benefiting to the greatest extent possible from the services which are rendered to able-bodied persons. For instance, the banking community should set up voice-controlled cash machines, or at least display the instructions for using such a machine in embossed characters (Braille). These financial institutions could allocate a small portion of their profits for acquiring devices that would assist disabled persons in performing small tasks that are nevertheless useful and productive.

There already exists a substantial number of technologies and technical aids, including simple adaptations to existing equipment, which could benefit disabled individuals of all ages in all major life activities. These technical aids are readily available in industrial countries. The transfer of both "low" and "high" (thus "appropriate") technologies into the ESCWA region must therefore be promoted.

The 1981 "Arab Declaration on Action for Disabled Persons"[4/] estimated that there were 15 million disabled persons in the Arab world, an estimate that may be well below the actual figure. Although regionally the group of disabled persons is not negligible, their attractiveness as a consumer group is fragmented, both by the number of countries of the region and by the variety of their needs. Also, countries' capacity to introduce and adapt sophisticated technologies varies from one country to another in the region, because of differences in gross national product (GNP), social welfare programmes and legislation. In some countries of the region plagued by prolonged wars and armed conflicts, considerations of "national security" absorb much of their concern and the greater part of their resources. And, unfortunately, where resources are limited, support for disabled persons is usually not given a high priority. Therefore, the application of low or indigenous technologies is an alternative solution and is sometimes much more appropriate to local needs than imported technologies. High technologies are costly and spare parts are not readily available. And besides these disadvantages, such aids may not be easy to maintain and may be inappropriate for the environment. Increasing attention is now being given to the design of simpler, less expensive devices, using local methods of production or simple adaptation of existing technical aids. The local use of appropriate technologies, therefore, should take into account the technical, socio-economic and cultural conditions in the particular society.

One of the aims of this paper is to provide a brief overview of the latest technologies for various categories of disabled persons which have been recently developed and are available in the market. These technologies are described in an easy-to-understand, non-technical language, with particular emphasis on the following two major points:

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4/ Economic and Social Commission for Western Asia, Developmental Social Welfare Issues: Inter-Regional Consultation on Developmental Social Welfare Policies and Programmes, (E/ESCWA/14/7).

1. The current status of new technologies designed for particular subgroups of disabled persons as well as major trends of new developments of such technologies in industrial countries.

2. The progress that has been achieved in these technologies in the region and/or action that needs to be taken in the near future in order to transfer such technologies to the ESCWA region.

A few practical examples of technical innovations will be selected and presented for each category of disabled persons (i.e. visually disabled persons, persons with aural disabilities, and physically disabled persons). Although the systems and devices explored here are only a small part of what is proving to be an expanding field of achievements and technological advances, this paper attempts to review the present, overall picture of future projections in the field as well.

This paper also presents a few model strategies to cover the high cost of introducing and maintaining these sophisticated devices.

In addition to considering the importance of using simplified "low technologies", a few examples of "low-tech" communication aids and other low-cost technical aids are presented. These low technologies can be introduced in countries of the region with little or no adaptation.

In conclusion, the report sums up the lessons learned from various examples and makes several action-oriented recommendations on how "appropriate technologies" can best be introduced in countries of the ESCWA region in the near future.

## I. NEW TECHNOLOGIES FOR VISUALLY DISABLED PERSONS

Visually disabled persons can be divided into two broad sub-categories, totally blind persons (including both Braille readers and non-Braille readers), and partially visually impaired persons (large-print readers). A variety of innovative technical aids, computer applications, and informatics are available for both categories of visually disabled persons. Major technical developments currently taking place in industrial countries can be categorized as follows:

1. Computer applications and other informatics.

2. Hand-held reading-from-paper devices and other portable communication aids.

3. Mobility aids.

4. Magnifiers, closed-circuit TV and overhead projectors for partially blind persons.

## A. Computer applications for the blind

In order to communicate with computers and other information-processing systems, a blind person must rely on his/her other senses. Braille printing and tactile displays use the sense of touch and synthesized speech devices utilize the sense of hearing.

Micro-computers with enhanced peripherals such as tactile displays, Braille printers, Braille input keyboards and speech synthesizer output devices are providing visually disabled persons with newly acquired independence.

Blind individuals, including those who have no problem with data entry and use a standard keyboard and those who use a tactile input keyboard, may require alternative means of access to the output information that is normally displayed on a monitor screen or in printed text format. The most common alternative means of output system are Braille display/printing and synthesized speech output. For example, a totally blind programmer may input data by Braille or another tactile keyboard (a peripheral keyboard adapted for data input) and generate the output with a speech synthesizer, a tactile screen, or a Braille printer (Braille embosser). Tactile output devices have enrolled blind persons into the PC community. There are many software programs for Braille translation on the market. These convert texts processed on word-processing systems or other packaged software programs into various standard Braille texts. The user may select from various Braille printers available in the commercial market.

For example, the "VersaBraille" system, developed by Telesensory Systems, Inc. in Mountain View, California, is a powerful touch-oriented terminal for blind persons. Using a specialized set of keys, the VersaBraille user can build a new text file which is stored either on a cassette tape (VersaBraille) or on a diskette (VersaBraille II), position himself or herself within an existing file, and receive or transmit information over a serial data-bank link. The VersaBraille touch-pad output device connects to a PC to convert screen letters into Braille characters. A maximum of 20 characters pop up and down at one time on a small window surface located on the desk top VersaBraille machine as the blind user navigates the screen using the standard arrow-keys.[5/]

Its latest model, "VersaBraille II Plus" is a handy dual-function board. The keyboard and Braille display on VersaBraille II Plus Model L1D simultaneously register, process, and generate information in two modes. In the VersaBraille mode, the L1D is a stand-alone Braille information processing system. By merely flipping a switch, the L1D becomes a peripheral, i.e. a keyboard and "Braille screen" for the IBM PC and compatibles. With the Braille keyboard and display, the user can work in Braille with popular PC software programs. The data can then be generated as output in regular print and/or standard Braille print.[6/]

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5/ "VersaBraille" brochure, Telesensory Systems, Inc., Mountain View, California, 1988.

6/ VersaBraille II Plus Systems brochure, Telesensory Systems, Inc., Mountain View, California, 1988.

"Visio Braille" is another example of a comprehensive system which enables blind persons to operate an IBM-PC (or compatible) running on an MS-DOS system, with a non-permanent display and a Braille terminal connected to the PC through an RS 232 interface and a standard Braille printer.7/

The aforementioned Braille processing systems can be used with various embossers. Many similar systems are available to convert texts processed on word-processing and other PC software programs into various standard Braille prints. The blind user may select a printer from among the compatible Braille printer machines available in the commercial market. In printing and publishing task operations, the use of these up-to-date computer-based Braille embossers is revolutionary and relieves a common frustration. For example, while a conventional Braille typewriter requires one to two hours to print one page, centres for blind persons in both England and the United States produce about 200 pages of Braille per hour, using these Braille processing computer systems.8/

However, for non-English speaking countries, particularly those whose languages are not totally phonetic,9/ the applications of Braille printing technology are not easy. For example, in Japan whose language is not totally phonetic, the development of a completely automated Braille processing PC system was a long-term struggle. The Welfare System Research Association (WESRA) says that it has recently developed a comprehensive and completely automated Braille processing system "Hachijutten" (meaning "80 per cent"). With application of its editing function, any texts processed on a standard word processor or scanned by an optical character reader (OCR) can be converted into the standard Japanese Braille format with an 80 per cent accuracy rate.

As useful as these Braille output applications are, they are not a panacea for the entire blind population: only a very small portion of the blind population (estimated 12.5 per cent in the United States) can read Braille.

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7/ Balin Philippe, "Visio Braille: The Black Light", presented at the International Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, May 1987 (E/ESCWA/ID/87/WG.2/15).

8/ This section draws heavily on the paper by Nazeh Al-Qadamani, "The disabled: the blind and prospects of modern technology" at the Conference on the Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1989 (E/ESCWA/SD/89/WG.1/19).

9/ The Japanese language, for example, is composed of hiragana and katakana (both phonetic codes) and kanji (Chinese characters which are symbolic in nature).

Access has been somewhat expanded by some of the latest Optacons,10/ which provide access via a raised-character system, not only to the printed text, but also to PC-stored information via its RS-232 interface.

Access has been expanded much more by the integration of speech synthesizers into PCs to output information in an aural form and their application in text-reading (character-recognition) devices. The latter are passed over the printed text and feed the data into the computer system. The output is transmitted in the form of either pronounced words, if they are recognized, or spelt-words, if they are not recognized. Most programs can also recite punctuation, though experienced users can turn off the punctuation feature if it is not required to resolve ambiguity. This technology is a powerful application for blind persons who lost their eyesight during adulthood and who have difficulty in learning Braille.

An example of a PC-based speech synthesizer -- the development of an operating system (OS) for a speech synthesizer -- is the "Verbal Operating System (VOS)" from Computer Conversations in Alexandria, Ohio, which allows users to operate most of the basic software programs such as word processing, database, Lotus 1-2-3 and simulation programs. "Vert Systems" from Telesensory Systems, Inc., is a full-featured software program which works with the IBM PC and IBM-compatibles, in conjunction with a speech-synthesizer peripheral. Most software programs work with this system and its enhanced version "Vert Plus" allows the blind user to select a speech synthesizer from various options, including the most widely accepted "Detalk" from Digital Equipment Corporation.11/ Similar developments of OS are found in non-English speaking environments. For example, in Japan, Fujitsu Company has developed, in collaboration with WESRA, the special OS enhancement "OS Talk", which is a speech-synthesized Japanese version of MS-DOS. This enables the blind user to operate basic Japanese software programs under MS-DOS version 3.1. However, "OS Talk" requires the Fujitsu OS enhancement "Otojiro". The overall quality of these Japanese PC-based speech synthesized outputs is relatively high.12/

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10/ The Optacon was introduced in the early 1970s by Telesensory Systems, Inc., as a print-reading device for blind persons. It allows the blind user to move a small scanner over a document with one hand while the index finger of the other hand "feels" the letters as its control unit recreates the image of the computer screen. The control unit consists of 100 vibrating rods, which are closely packed to form a continuously alternating surface. The Optacon's control unit does not produce Braille. It merely transforms identical features from the PC screen into readable form.

11/ This section draws heavily on an article by Herb Brody, "The great equalizer: PCs empower the disabled", PC/Computing, (July 1989) pp. 83-93.

12/ "Electronics for disabled people", Progress Report of WESRA (Welfare System Research Association) Tokyo, April 1990.

Some of the stand-alone text-reading machines (character-recognition machines) such as the "Arkenstone Reader" from Arkenstone, in Santa Clara, California, are also sold as a complete PC peripheral for PC speech output. However, speech-synthesizing technology is still limited by its inability to vocalize graphic images. In fact, almost all PC-based adaptive equipment for blind persons operates in the character-based DOS environment. When integrated into a PC, it can only process information stored in the ASCII character format.13/ When used in conjunction with a text-reading device, it is limited by a scanner that only recognizes standard Latin characters. For instance, as the Mackintosh uses a graphical interface, it is basically inaccessible to blind persons. If DOS and OS/2 emulate the Mackintosh's graphical interface to the fullest extent, there is a fear that blind persons might soon be shut out of the PC community as well.14/

However, for partially blind persons, this development has no negative implication. Several PC applications can assist users who can see the screen but cannot visualize normal-sized text. For example, software such as Large Print DOS from Optelec of Harvard, Massachusetts enlarges the text on a PC screen, similar to the print in large-print books.15/

Other devices for partially sighted users allow access to graphical interfaces. Magnification lenses, such as the Compu-Lenz from Able Tech Connection in Kettering, Ohio, simply fit over the screen and magnify whatever is on it -- graphics windows, icons, texts, etc.16/

As blind persons usually retain good speech command, this can be a powerful residual mechanism left to them as a means to input information. One of the most innovative alternatives to a Braille keyboard of a standard keyboard input system is a voice recognition system -- a system which can understand and distinguish between a number of words in the user's voice pattern and then either print the text or act on spoken commands to control external devices.

However, at this stage, a normal microcomputer-based system can only discriminate between 150 and 200 words. Special systems which can discriminate up to 10,000 words have been developed by Kurzweil Company, Cambridge, Massachusetts, but they are only available at very high cost. In order to

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13/ In Japan, however, very sophisticated OCR machines, which are used in offices for the purpose of developing databases, make it possible for the blind user to scan not only printed characters but also the user's own handwritten characters, upon registering the pattern of his/her writing (matching method). The information scanned is stored in the automated electronic character format for speech-synthesized output.

14/ H. Brody, op. cit.

15/ H. Brody, op. cit., p. 87.

16/ H. Brody, op. cit., p. 86.

produce all possible text from a limited vocabulary, individual letters, numbers and punctuation must be assigned representative words, such as "Alpha" for A, "Beta" for B, etc. The machine can identify the required character or word, as long as the operator can say them consistently using system-recognizable pronunciation. If a series of representative words which the user can easily utter in a consistent manner are developed, its performance level will be maximized.17/

In summary, the ongoing development of software and PC peripherals for the adaptation of the PC for blind persons would include the following major steps:

1. Development of hardware devices such as:

   (a) Speech-recognition device for input;

   (b) Braille keyboard for input;

   (c) Speech synthesizer for output;

   (d) Braille/tactile display for output;

   (e) PC magnifier output device for partially blind users;

   (f) High quality OCR for both standard and non-standard characters.

2. Development of an interface that drives the specialized hardware peripherals to work with the rest of the computer.

3. Development of software (OS enhancement) to interface between the general-purpose standard packaged software and special peripheral devices.

4. Development of "layering", which is the inclusion of additional levels of software between the blind end user and the OS or other standard, general-purpose software. This layering method might provide immediate necessary functional solutions for blind users today, but in the future it may adversely impact the ease of maintaining software currency at the operating-system level, and reduce the ability of blind users to utilize equipment at different sites.

### B. Reading-from-paper devices and other portable communication aids

Access to the computer screen and on-line networks is only part of the overall solution for enhanced communication for blind persons. As long as information is presented in a printed format, blind people need to use an assisting device (preferably portable and handy) to be able to read the print

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17/ This section draws heavily on a paper by Bob Allen, "Current and future trends in computer technology for the physically disabled", presented at the International Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, May 1987 (E/ESCWA/ID/87/WG.2/13).

like any sighted reader. The use of these portable communication aids in everyday situations is also very important in order to perform the daily activities in the manner or within the range considered normal for the able-bodied population.

Since it was first introduced in the early 1970s, Optacon has been used by many blind persons in over 70 countries. The control unit of Optacon processes information received by the tiny scanner (camera) and drives the tactile array, consisting of 100 vibrating rods. As the user runs the scanner across the page, the pins spell out the words, character by character. It has several advantages; it is portable, handy and less expensive. However, as Optacon does not translate into Braille, learning to distinguish one letter from another by touch takes practice, and even experienced blind users find "reading" in such a manner to be a time-consuming process.

More than a decade ago, Kurzweil Company brought a revolution to the blind community with a text-reading machine. It could read printed text and convert it into synthetic speech. At $US 50,000 at the time, however, the Kurzweil reading machine found a market limited to institutions or libraries. After a decade of continuing efforts, in 1988, Kurzweil introduced a much smaller (portable) and less expensive text-into-speech machine, "Personal Reader". A system with a hand-held scanner is sold for less than $US 8,000. Like the earlier Kurzweil, Personal Reader can be upgraded to eventually recognize any typeface. It can be used with one of the most widely recognized speech synthesizers, "Detalk", which guarantees reasonably high quality voice output.[18/] This type of speech-output device has been developed to replicate the natural human voice, avoiding the robot-like monotonous vocal output, it includes functions such as a dropping pitch when the blind user pauses after punctuation marks or a slightly rising pitch to indicate a question at the end of a statement.

A Japanese version of Personal Reader, named "Personal Reader 7315", is available. However, the current price of $US 12,000 has limited its market.[19/] In principle, Kurzweil markets its system as a handy stand-alone package, while other companies sell similar products as PC peripherals. The technical details of these products were mentioned in the previous section.

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18/ This section draws heavily on the article by Herb Brody, "The great equalizer: PCs empower the disabled", PC/Computing, July 1989.

19/ "Electronics for disabled people", Progress Report of WESRA (Welfare System Research Association) Tokyo, April 1990.

The "DELTA" developed by SYSTELEC Company in France, is one of these very handy, portable text-reading machines which can be used as a computer peripheral as well. It translates instantaneously into Braille any document printed in standard Latin characters read by its micro-camera unit. Its built-in processor analyses the image received by the micro-camera and displays it on the Braille tactile display board. The AV 24 (RS 232C) interface allows DELTA to be connected with peripheral equipment such as a micro-computer Braille printer or a speech synthesizer. A buffer memory with an 8,000-character capacity allows the PC to store and display characters previously read.[20/]

The inexpensive and handy talking calculator with synthesized speech output provides more independence for numerical recognition and numeration-related daily activities, and thus increases employment opportunities, particularly self-employment possibilities. For daily social activities of blind persons such as shopping, it is advisable that these portable assisting devices be provided. In this category, a synthesized version of the fashionable, portable data memo is also available for blind persons. In Japan, a portable data memo, "Yurika A4", with 16 data memo functions (including mini word-processing, database, telephone directory and schedule memo) is available in the market. It can be operated with the Braille keyboard, and the input information can be confirmed by the built-in speech synthesizer before being stored in the floppy disk.[21/]

Another category of people associated with visual impairment are deaf-blind persons -- persons who perceive neither light nor sound. They need technical applications in order to communicate with able-bodied persons as well as disabled persons with visual impairment, with hearing impairment or with both. Among the aforementioned VersaBraille series, the "VersaBraille MODEL P2" can be used as a Braille telephone for deaf-blind persons if it is connected to a modem. A conventional telephone can be used when the user calls another party who has a compatible telephone set. It consists of a portable electronic Braille terminal with the standard six Braille key controls and a space bar with a display that has space for a maximum of 20 Braille characters (at one time, popping up and down). Deaf-blind persons can use the Braille keyboard to input the outgoing information and touch the Braille display to receive the incoming information. If the incoming information is transmitted at a higher speed than it is received, the information can be stored on the cassette tape and later will be retrieved onto the Braille display.[22/]

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20/ Catalogue about DELTA, SYSTELEC Company in France.

21/ "Electronics for disabled people", Progress Report of WESRA (Welfare System Research Association) Tokyo, April 1990.

22/ International Commission on Technical Aids (ICTA) Information Centre, Aids for the Deaf-Blind, Bromma, Sweden, April 1985.

"Telebraille" from Synskadades Centralforbund of Finland is a similar type of Braille telephone consisting of a Braille keyboard, a space-bar and a Braille display presenting one Braille character at a time (the standard six vibrating Braille reading pins). It is connected to a telephone network parallel with the conventional telephone set. It can be used for telephone calls directly to other subscribers who have the same "Telebraille" set. The Brailled text is transmitted and presented character by character. Therefore, the caller must take into consideration the receiver's reading speed and capacity. Also, it can be used as a conversation aid for direct communication as well as for entering or reading Braille-coded text for use with a tape-recorder.23/

Deaf-blind persons also need to communicate with able-bodied persons for daily communication. "Tella-Touch" from the American Foundation for the Blind (New York) is a portable device for translating regular alphabet letters into Braille. It makes communication possible between a deaf-blind person who can read Braille and an able-bodied person who does not know Braille characters. The machine has a standard keyboard with alphabet letters; therefore, knowledge of Braille is not required. As each key for a letter of the alphabet is depressed, the corresponding Braille symbol is raised on the display plate on the back of the device. The deaf-blind person can hold a finger on the display and read one Braille character at a time.24/

## C. Mobility aids

During the last few decades, approximately 30 models of mobility aids for blind persons have been developed (see table 1).

Sonic-Torch, Sonospect, Pathsounder, Mowat Sensor, Nottingham Obstacle Detector and Laser Cane are all obstacle detectors which let the user know whether or not there is an obstacle in his/her course. Sonicguide is an environment sensor which can search for obstacles in many directions at the same time. The disadvantage of this device is that spatial resolution is not high and distorted images are perceived when several obstacles are displayed at the same time. The Mowat Sensor is portable (small enough to be carried in a pocket) and has a hand-held battery-operated orientation and navigation aid with tactile indication. It is suitable for detecting and avoiding obstacles on a footpath or locating specific landmarks such as gaps in a hedge or a doorway.25/

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23/ *Ibid*., p. 15.

24/ *Ibid*., p. 26.

25/ This section draws heavily on a paper by Ifukube Thoru, "A design of blind mobility aided modelled after echo location of bat" [*sic*], presented at the International Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, May 1987 (E/ESCWA/ID/87/WG.2/7). The Symposium was held under the auspices of: ESCWA; UNESCO's Regional Office for Science and Technology for the Arab States; the War Handicapped Welfare Council; and the Electronics and Computers Research Centre/Scientific Research Council.

The transmitter in the cane generates a high-frequency sound to detect objects. When an ultrasonic beam hits an object, it is reflected to the aid and received by the microphone. The sensor responds only to a close object within the beam and the vibration rate increases as the blind user approaches the object. The sensor has two detection range settings controlled by a sliding thumb switch. On the short-range setting, which is for indoor use, the sensor responds only to objects within a range of 1.5 metres. On the long-range setting, it will respond to any object up to 3 metres away. These updated sensory devices, however, must be use as a supplement to an ordinary long cane or guide dog, as the scope of the sensor is very limited.26/

### D. Magnifiers, closed-circuit television (CCTV), overhead projectors for partially sighted persons, and other devices

People with partial vision can maximize their residual vision with various assisting devices. The partially blind who can read text might choose one of the following types of magnifiers: a magnifier attached to eyeglass frames; a stand magnifier; a hand-held magnifier; telescopic aids or a television viewer which magnifies print and projects it on to a TV screen. As a conventional hand-held magnifier (which magnifies over 30 times) reduces field vision tremendously, CCTV, which provides a wide range of magnification levels (normally 3 to 45 times) and flexibility for the field of vision accordingly, has become frequently used. There have been many enhancements of the features of the latest models of CCTV. They have larger screens, without increasing the overall size of the CCTV. Some CCTVs can be used as a monitor for an image-enlarging system for PCs. Also, some models can be used with typewriters. The typing mirror allows the blind user to view the text when it is in the typewriter. A magnetic switch automatically engages to compensate for the mirror's reversed image.

Better appearance is also a very important consideration, because social stigmas can cause real psychological sufferings for disabled persons. In California, artificial eyeballs that move like real eyes have been implanted in 4000 people who lost their eye(s), freeing them of embarrassment from the odd movements of traditional artificial eyes. The newest type of implant, made of sea coral treated with chemicals, has 90 per cent of the movement of real eyes, compared with an average of 25 per cent normal movement for older types.27/

### E. Adaptation and transfer of new technologies for blind persons in the ESCWA region

The aforementioned new technologies and technical aids designed for blind persons have promoted greater equality between blind persons and sighted persons in industrial countries. In particular, these devices allow blind persons to have greater equality in regard to education and employment in tasks requiring access to written information. No doubt countries of the ESCWA region have benefited or will easily benefit from new technologies such as mobility aids or magnifiers, as these devices require very little adaptation or modification for local use.

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26/ *Ibid.*, p. 2.

27/ *Jordan Times*, 7 November 1991.

However, in the field of information and computer adaptations, the aided systems for the blind will face many difficulties in the region (and in other Arabic-speaking countries). First of all, Arabic processing of textual and spoken language has to overcome many technical problems including oral, spoken and other forms of processing of the language. In addition, basic software program must be arabized. It would be necessary to arabize the software programs (OS enhancements) which interface the arabized software and specialized peripheral devices. Finally, arabization of additional levels of software between the end user and the standard OS/other general-purpose software should be concurrently promoted.

To ensure the development of efficient printing devices, the terminology and symbols used in Arabic Braille, including the numerical symbols, should be continuously reviewed with a view to achieving regional standardization.

In this section, a few pilot projects on such computer applications in the ESCWA region will be briefly illustrated. As blindness is the major category of disabled persons in the countries of the ESCWA region,28/ intensive efforts have been made in those countries to develop computer applications in order to help blind persons become fully integrated into income-generating and educational activities.

1. Projects at the IBM Cairo Scientific Centre

At the IBM Cairo Scientific Centre, a rehabilitation engineering programme was started to help Arabic-speaking blind persons through the application of the latest computer Braille processing systems. Two Braille production systems, one semi-automated and the other fully automated, have been developed.

(a) Semi-automated Braille text production system: This system allows the users to input information into the computer in a normal manner through the standard Arabic keyboard and the regular screen. However, for blind users, the system converts the text into the Arabic version of the Braille codes and allows for manual data entry through the standardized Arabic keyboard. The translation process is either one-to-one character pattern mapping (full spelling) or many-to-one mapping (alphabet abbreviations). Table 2 shows the standard Arabic characters and their corresponding Braille codes;

(b) Automated Braille production systems: Another and more dynamic form of data entry, which solves the problem of feeding the huge backlog of data already printed, is through a computer interface of the printed text. The Braille production process can be fully automated through the utilization of the Optical Arabic Reading Machine (OARM). OARM is an Arabic text-reading machine which has a high recognition rate for various fonts used in the production of printed texts of standardized characters. Currently at the IBM Cairo Scientific Centre, the latest development of the Arabic printed text-recognition project has reached the recognition level of 99 per cent on the

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28/ For example, 46 per cent of the total disabled population in Egypt is visually impaired, including those with the use of only one eye, according to the Population and Housing Census, 1976, Volume I, Central Agency for Public Mobilization and Statistics, Cairo, 1980.

standard character level, with the font of the IBM "Quietwriter Arabic Font" (Yasmina). The spell-checking and assistance software (which was also developed at the Centre) is an application that can be used in order to enhance recognition before actually transcribing the recognized Arabic words into Arabic Braille codes. The automated Braille system basically follows the same production process in the semi-automated Braille production system as mentioned above. However, the automated data entry system makes it possible to input the large quantity of the printed texts already available.29/

2. Projects at the Regional Bureau of the Middle East Committee for the Affairs of the Blind, Riyadh

The Regional Bureau of the Middle East Committee for the Affairs of the Blind, located in Riyadh, Saudi Arabia has a Braille printing unit which produces all material pertaining to educational curricula in Bahrain and the United Arab Emirates, prints the entire Holy Quran in six volumes and publishes periodicals for blind persons. The Bureau has also started additional advanced research programmes within the affiliated computer centre in order to get acquainted with new developments in the world of Braille and to acquire appropriate state-of-the-art computer units.

Recently, the Bureau successfully introduced the Arabic version of the Braille system, mobilizing Arabic characters. As a result, it is reported that during the five years from 1984 to 1989, the production of the Bureau increased 100 times over its production during the preceding five years. The technical applications of Braille production are as follows: A sighted operator inputs the data into the computer through the standardized Arabic keyboard and the screen. The computer system translates the ordinary files into Braille files, unabridged at the first level and abridged at the second level. Braille typewriters (LED) attached to this system emboss the text from the Braille files onto cardboard for later revision. Braille typewriters (PED) connected to the same system emboss the text from Braille files onto zinc plates for use in regular printing workshops. The experiment proved to be very difficult at first. However, the Bureau continued to overcome difficulties until it finally succeeded in implementing this Braille system for use with Arabic.

3. Arabization projects by Telesensory Systems, Inc., Saudi Arabia

Telesensory Systems, Inc., in collaboration with the National Groups for Computers, Saudi Arabia, has started working to arabize their "VersaBraille" system so that Arabic-speaking blind users can have access to the synthesized speech output generated from a text on the screen.30/

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29/ This section draws heavily on the paper by H. Abdelazem and M. Hashish, "Automated recognition of bilingual typewritten text", presented at the "CompEuro '89", Hamburg, May 1989.

30/ This section draws heavily on the paper by Nazeh Al-Qadamani, "The disabled: the blind and prospects of modern technology", presented at the ESCWA Conference on Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1989 (E/ESCWA/SD/89/WG.1/19).

4. Other ongoing pilot projects

Efforts have been made to arabize or transfer several other computer-based technologies for the blind, among them "Mini Braille" from Petersman Company in Germany, which is a micro-computerized Braille translation system. The translation process is based on input of new data by a sighted operator who can select the operation mode in more than one language (Arabic, English, German or French). The advantage of this system is that the text file can be translated into the languages included. For instance, if an English line intervenes in an Arabic text, the program translates the English line using the Braille method and continues translating the major Arabic text. Although the operation of this system is slightly complicated, the expedient transfer of this machine should be promoted, considering its multi-language advantage.31/

Regardless of these developments in the field of computer adaptations, the aided-system technologies for blind persons in the region (and in other Arabic-speaking countries) still face many difficulties. First of all, Arabic processing of textual and spoken languages must overcome many technical problems. In addition, basic software should be arabized. It is also necessary to arabize the specialized OS enhancement programs that drive the specific hardware peripherals to interface with the Arabic software.

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31/ *Ibid*., p. 3.

## II. NEW TECHNOLOGIES FOR PERSONS WITH HEARING/SPEECH IMPAIRMENTS

The technologies for this category of disabled persons are classified into two areas based on the type of function: diagnostic,[32/] and therapeutic and/or rehabilitative. In this section, several modern technologies for therapeutic and rehabilitative purposes will be reviewed. Diagnostic devices will not be treated in this paper.

### A. Therapeutic and rehabilitative devices

In the field of rehabilitative devices, there are many new technologies, such as tape recorders with the facility for speech compression and speech expansion, various types of calibration equipment, and artificial electronic larynges, canal-type hearing aids, cochlea implants and wearable vibro-tactile aids and speech synthesizers.

One of the most significant developments so far in this field is the telefax machine, which allows deaf and mute persons to communicate through telephone modems. In some industrial countries, the law mandates all major public agencies (e.g. police stations, hospitals and fire stations) to be equipped with a telefax machine. Although telefax machines were originally developed for general use, they consequently benefited deaf and mute persons significantly. In the United States, the system of Telecommunication Devices for the Deaf (TDD) has been available since the 1960s. TDD is a portable technical device with a small keyboard and a display of one line, to be connected to telephone sets. The information processed through the keyboard is transmitted to the party called and displayed on his/her screen. All major public agencies in the United States have TDD numbers.[33/]

Various speech synthesizers, which can be operated through the standard alphabet keyboard, have been developed. One type has a limited output of vocabulary but a clear and distinguishable vocalization while the other has unlimited vocabulary devices. Portable communication aids which have speech aids with speech output, such as "Light Talker" or "Touch Talker" (both manufactured by Prentke Romich, and are used in conjunction with a software package "Minispeak") are available in the market. Touch Talker has a guarded keypad finger operation, and Light Talker can be used in association with an optical head pointer or switches for multiply-disabled persons. Both of these devices have practical applications. Minispeak is the symbolic language the mute person uses to tell Touch Talker or Light Talker what to say. The combination of Touch Talker or Light Talker hardware with Minispeak software makes the system powerful, because the image-type symbols of Minispeak have

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32/ The available diagnostic technologies in industrial countries include microprocessor audiometers with cathode-ray tube console (with video monitor and printout), ERA (Evoke Response Audiometer), VRA (Visual Reinforcement Audiometer) and various forms of sound-level metres.

33/ Asano Shiro, Takamatsu Tsurukichi & Shigeru Ohota, Shyogaisha no Konausei wo Hirogeru Computer. April, 1990, Tokyo.

many meanings which change according to the context in which they are used. The symbols themselves have no fixed meaning, but only the user and the programmer (in most cases, the same persons) need to know the meaning of the symbols because pressing them makes the machine vocalize. As some deaf and mute persons have multiple disabilities, Light Talker has a host of switches which are attached to provide the fastest means of talking for those who cannot press buttons.34/

Franklin Electronic Publishers of Mt. Holly, New Jersey markets a hand-held talking dictionary, the thesaurus and a spelling corrector designed to help speech- and visually-impaired persons. The "speaker" pronounces every letter as it is typed, as well as every word and definition that appears on the screen. In addition, for speech-impaired persons, a message key allows up to 26 messages to be entered, stored and "spoken" at any time.

The speech synthesizer units available in the market range from an easy pressure-sensitive voice synthesizer to a more sophisticated type which works on phonetics typed through a keyboard for sound production. Other sophisticated models include:

1. One which can be operated through the keyboard, equipped with visual display and a small printer.

2. One with a keyboard, visual display, print-out and memory function.

3. The latest speech synthesizer, which can be operated through the concept keyboard denoting symbols or expressions rather than standard character keys.

In Japan, the most sophisticated portable speech synthesizer allows the user to programme the most commonly used words and expressions in accordance with his/her needs, thus ensuring a reasonably high speed of speech.

Sometimes, deaf and mute persons may wish to communicate with others confidentially, just as voiced persons whisper when they communicate with others. "Canon Communicator" which was invented by Canon Corporation is a portable ultra-mini electronic typewriter incorporating a full alphanumeric keyboard, plus mathematical signs and punctuation marks. The user depresses keys to create a message on a thin paper tape. The new model has a message storage capacity of 19 characters and can be interfaced with compatible equipment via an RS 232 interface unit. The advantage of this communication aid is its portability, which enables the mute user to mix with the community knowing that, despite an absence of speech, communication can be readily effected.35/

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34/ Exhibition product review of "Naidex '88", an international exhibition of equipment and services for the disabled and elderly, London, 11-13 October 1988.

35/ *Ibid*., Circle Reader Service No. 35.

One of the most significant problems in oral communication between deaf persons and hearing persons is due to the fact that it is not easy for deaf persons to lip-read every sound of speech. Many vowels and consonants such as e, i, ur, m, b, p, k, g and ng are ambiguous when lip-reading. "Cued Speech", which was invented at Gallauded College, Washington, D.C. (the only university in the world for deaf persons) gives all this information clearly in face-to-face communication.36/

The development of computer applications also has had a great impact on rehabilitation technologies for deaf and mute persons. One recent application is the data processing and analysis of speech signals for the training of hearing-impaired and mute persons. Hearing-impaired persons, particularly those who were deaf at birth, may not speak properly because they cannot hear their own voice. The IBM Centre in France has developed a system that visualizes the user's voice with a PC. Voice parameters such as intensity and pitch are extracted from the speech signal and displayed in graphics and plots. This voice-training system gives feedback to pronunciation trials.

### B. Adaptation and transfer of new technologies for the deaf in the ESCWA region

The above-mentioned IBM PC-based voice-training system has been already tested for adaptation in Arabic. The pilot project was conducted by the Kuwait Institute for the Handicapped, in collaboration with the Kuwait Special Institute for the Handicapped and the Kuwait Institute for Scientific Research, with financial assistance from the Kuwait Federation for the Advancement of Science. The adaptation schemes are arabization and development of new software applications for training purposes. The project team worked on a special scheme in arabizing the software's English text. The first scheme included arabizing the software's English text, by using "Basic" editor along with IBM Arabic utility software and the "Enhanced Graphic Adapter Card". In addition, a few voice-controlled games have been developed. Messages and information were written in Arabic through the Basic editor and were stored in Basic files. At the later stage, these files were modified by a professional editor and again stored in data in a format usable by the system software applications. Copies of the Arabic version of the software applications were distributed to all users (the educators of the Kuwait Special Institute for the Handicapped). Upon consultation with the educators, a special application of the voice-controlled game was initiated. The game was developed using the same voice pitch parameters, but has a different style of character mobilization than the originally supplied voice-control games. The pitch information of the user's voice patterns is obtained through a microphone on the IBM-supplied speech analysis base. The voice pitch is processed by a special software program which moves the object on the screen in accordance with the varied levels of voice pitch. In order to direct the object on a pre-designed path, the user has to exercise some control of his voice modulation. Students develop a reasonable understanding about using the system as a training tool for control over voice pitch and intensity and differentiating between sustained voiced and voiceless Arabic sounds.

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36/ *Ibid*., Circle Reader Service No. 78.

During the second phase of the project, voice-pitch training was demonstrated. Three major training exercises were initiated. The first was the distinction between the short vowels and the long ones, such as تَ and بِي. The next exercise involved distinguishing between the definiteness or indefiniteness of nouns, reflected by the ending, for example لُ and لٌ. The last was the distinction between words that have the same point of articulation but differ as to voicing, such as ذَ and دَثَ. It was discovered that this voice-training system was a useful device, which to some degree could show the user his/her voice characteristics and give a sense of the spoken word. Also, it would provide the user with some feedback for attempts made at pronunciation. The key success of this project is the arabization of the software's English text, as most trainers in the Institute were more comfortable with and competent in receiving information displayed on the screen in Arabic. Another important factor is that the trainers were given sufficient training in advance so as to transfer this technology to their students efficiently.37/

Also, other computer-based therapeutic devices were adopted in the region. In 1989, IBM in the United States introduced the "Speech Viewer", which helps speech therapists to train speech-disordered persons. By translating sounds into visual images, it allows persons with speech disorders to watch the images of the sounds they produce on the computer screen and compare them with those of the speech therapists. A preliminary Arabic version of the "Speech Viewer" has been developed and is being tested at the IBM Cairo Scientific Centre.

A joint project of the Cairo Rehabilitation Engineering Centre, the National Project for Rehabilitation of the Deaf and the USA-Yugoslav Institution, was launched exclusively for rehabilitating deaf children. International and local experts in the fields of medicine, phonetic linguistics, speech therapy, social work and other related areas were involved in the preparation and development of this programme. A child is admitted at the age of three, when he is assigned to the appropriate group in accordance with the degree of deafness, IQ and acquired language skill. The child spends four hours per day in group and individual training on speech skills through the utilization of sound and tactile instrument techniques. In addition, vocal, movement, drawing and music sessions are used in order to enhance the speech skill acquisition process of the child. The project currently provides its services to approximately 150 cases, within an age range of three to seven years. The project administration is keen on upgrading the capabilities and knowledge of specialists in charge of training the deaf and extending such services to new centres in Al-Wafaa Wa Al-Amal City in Alexandria and Port Said.38/

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37/ This section draws heavily on Hansi Qasem and others, "Computer application for the training of deaf children in Kuwait", International Symposium on Computers and Electronics for the Service of the Handicapped, ESCWA, Baghdad, May 1987 (E/ESCWA/ID/87/WG.2/2).

38/ This section draws heavily on an unpublished paper by Mohamed Hashish, "Adaptation and transfer of new and appropriate technologies for the disabled in Egypt," IBM Cairo Scientific Centre, Cairo, 1990.

A significant breakthrough was witnessed in Egypt, when a computer software program was first introduced and adopted as a means of rehabilitating deaf and mute persons on speech in Arabic language. The new project was launched jointly by the Ministry of Social Affairs and the IBM Cairo Scientific Centre and aimed at introducing PC applications for speech training for deaf children. This effort has proven a great success. Not only has the application of special computer software helped deaf children pronounce words and develop their own speech patterns, it has also provided a tremendous motivation to overcome their impairment or to improve the quality of speech (for the cases that are already trained).

Motaz Osma Talat was three years old when he was admitted to the aforementioned joint rehabilitation project for deaf children (ordinary programme on adaptation of new technologies, but not PC-based scheme). His hearing intensity was 50 decibels and his IQ was diagnosed at 120. After a series of speech-training sessions, he had still not acquired the skill of producing words. After three years of training, he was able to converse, yet he still suffered from several distinct speech defects. He could not pronounce s, sh, k, and r, and frequently confused m with n. He was then transferred to the joint PC-based training course of the Ministry and the IBM Cairo Scientific Centre. His speech defects were rehabilitated through upgraded training involving computer application.[39/]

Most diagnostic aids and bio-medical therapeutic aids for deaf and mute persons -- such as hearing aids, cochlea implants and calibration equipment -- can be used without adaptation in the region. However, good customer service is needed to effectively transfer these technologies. For example, in Saudi Arabia, Rajab and Silsilah (representative of Philips in Saudi Arabia) has marketed the world's smallest in-the-ear-hearing aid. The single-touch cordless remote control (FAROI) hearing-aid Model M30 uses inflated technology for the first time in a hearing aid, making adjustments for sound quality and volume convenient and less embarrassing. The M30 earpiece is filtered with a custom-made mould prepared at Rajab & Silsilah Hearing Aid Centres in Jeddah and Riyadh by specially trained technicians to suit the precise shape of the user's ear.[40/]

On the other hand, all computer applications for deaf and mute persons have to go through a similar type of adaptation process including arabization. A good-quality speech synthesizer in an Arabic version is urgently needed. The development of various speech synthesizers in Arabic should include a sophisticated unlimited-vocabulary type, as well as a portable touch-talk type of device.

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39/ Ibid.

40/ Arab News, Riyadh, 24 May 1991.

## III. NEW TECHNOLOGIES FOR PHYSICALLY DISABLED PERSONS

In the overview of the progress made in the field of new technologies which help the integration of people with physical disabilities, both the orthopaedically and the neurologically disabled are categorized in the same group, namely physically disabled persons. This disabled group benefits most from these new technologies. Among the most important new technological developments for this group are: computer applications, orthotic devices, prosthetic devices (artificial substitutes for a malfunctioning or missing body part), and conventional and computerized wheelchairs, and various types of voice-controlled robots.

### A. Computer applications

The adaptation of the computer for physically disabled persons involves hardware alterations, at the input and output levels, as well as software applications. The physically disabled can use the computer, if special input and/or output peripheral devices are attached for user-machine communication. The appropriate software programs are required to filter the incoming coded information or to generate the outgoing stream of information. This must be adapted for each particular output device. The difference between visually impaired persons and this group is that adaptation of hardware at the input level is much more important than at the output level for the latter, as they are most likely able to read normal printed texts. Therefore, this section will focus on recent innovations at the input level.

Many physically disabled users are capable of using the normal keyboard if it can be modified slightly. In the United States, Congress re-authorized the Rehabilitation Act of 1973 (Public Law 99-506), as amended, adding Section 508 on "electronic equipment accessibility" to ensure that all disabled individuals may use electronic office equipment with or without special peripherals. Following the enactment of this law, the Department of Education and the General Services Administration developed government agency procurement guidelines to ensure access to electronic office equipment by disabled employees. In the relevant guidelines, minor adaptations for input by disabled employees include: a serial multiple keystroke control option; extension of the keyboard tolerances and a feature to turn off the repeat function options; emulation of the mouse using the keyboard and/or other suitable peripheral input devices (e.g. joy stick track ball, voice input and touch pad).41/

In Japan in 1989, the Japanese Electronic Equipment Accessibility Guidelines were drafted by the Humanity Electronics Research Committee of JIDEA, and the Draft Guidelines were issued by the Ministry of Trade and Industry. The Guidelines include similar provisions such as sequential input function, auto-repeat condition-setting function and key input finalizing function.

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41/ United States Department of Education and General Services Administration, Access to Information Technology by Users with Disabilities: Initial Guidelines, October 1987.

For those with residual muscular control, less expensive lower-tech solutions are recommended. Physically disabled people with good control of their neck and head muscles, for instance, can use a mouthstick, which is a piece of wood or plastic that the user can grip in his teeth to manipulate the keyboard. Mouthsticks are inexpensive, and an experienced mouthstick user can become almost as efficient as a one-finger typist.

Some physically disabled persons, particularly quadriplegics or victims of cerebral palsy, lack the neck-muscle control required by the mouthstick device. Keyboard macroprograms permit the user to modify the keyboard to combine common commands in a single keystroke. For able-bodied users, such macros may represent enhanced tools, but for disabled persons, they are fundamental. Keyguard is another simple device for assisting disabled persons. It allows people with poor arm control to rest their hands on the keyboard without making accidental keystrokes. To push a key, the users must poke a finger or stick through a hole in the protective shield. Special keyboards also compensate for specific disabilities. Physically disabled persons such as victims of cerebral palsy, who can make large movements but lack fine motor skills, can use an oversized keyboard. The "King Keyboard" from Technical Aids and Systems for the Handicapped, in Markham, Ontario, is an example of an oversized keyboard. The company also provides mini-keyboard devices for users with good manual dexterity but who have a limited range of motion, such as victims of muscular dystrophy. They also produce highly innovative keyboard in the form of a flat panel with a membrane surface. The surface is flexible so that it can be configured to have between 2 and 128 keys (expanded keyboard). If the user has better motor control, the keys can be more closely spaced and more numerously configured.[42/] Though this type of expanded keyboard cannot communicate directly with the computer terminal, it can be configured by using an additional interface box.

In the field of "high tech" computer applications, a head-mounted light-pointer system is the most innovative of input devices, though relatively slow. This device is a powerful tool for those who have no motor control from the neck down, such as victims of Amyotrophic Lateral Sclerosis (ALS) and for whom faster interfaces, such as voice recognition systems, would not work. The user of a head-mounted pointing system attaches a camera to his/her head and looks at the emulator screen, which displays a keyboard. The display sequentially highlights letters of the alphabet. When the user holds a gaze at a particular highlighted letter, the computer then selects that character. After the user enters the first character, the screen offers a list of common words that start with that letter. Some keyboard emulator systems such as the "Words Plus Software Keyboard Emulator" can adapt its word list to the user's style. Words which are never used will disappear from the list and words frequently entered will be added. "Freewheel" from Pointer Systems in Burlington, Vermont is a similar system.[43/]

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42/ Herb Brody, "The great equalizer: PCs empower the disabled", PC/Computing, July 1989.

43/ Ibid.

The latest computer applications designed for severely physically disabled persons is a brain-wave interface system. The Smith-Kettlewell Eye Research Institute, in San Francisco, is developing an interface to monitor electrical brain waves to find out where on the screen the user is staring. The secret is to create a checkerboard on the screen, with each square flashing on and off, at different intervals. The interface is able to determine which section of the screen is being gazed at by reading the user's brain waves, which will vibrate rhythmically with the particular section of the screen being viewed. Researchers are also developing the brain-scanning idea one step further. Although, this project is in the development stage, the basic premise is that brain-wave patterns are homogeneous as they react to words and ideas. These patterns can be studied and analysed and possibly be used as a method of communication in the future.44/

## B. Prostheses and orthoses

While an amputee requires a prosthesis, a physically disabled person with an orthopaedic impairment most likely needs an orthosis in order to fully function in society. Advanced components and fabrication techniques have been developed in most industrial countries. Today, rehabilitation is no longer interpreted as merely the successful return to and full integration into the work-place; it is measured, rather, by the resumption of activities in one's personal life. Prostheses are no more purely functional substitutes for missing extremities but they are an integral part of the overall humanization process of disabled persons, including better appearance. Several companies who manufacture rehabilitation aids, such as Otto Bock in Germany, have mass-produced a wide range of high-quality prosthetic and orthotic devices.45/

Myoelectric prostheses are very sophisticated devices for the upper-limb amputee. The technologies of myoelectric prostheses have been developed since the Second World War, particularly in those countries which had substantial numbers of wounded soldiers/victims. Myoelectric devices operate on the basis that the muscle is a biological actuator which converts energy stored in chemical substances within the body into mechanical output. Normally an amputee who has lost his/her hand below the elbow still has the muscles which control the functions of the hand.46/ Such persons can continue to maintain the feelings of these muscles.

The basic principle of myoelectric control is very simple. It involves the use of an electrical signal generated by the muscles and is similar to the flow of energy from a battery to a motor. In a myoelectric prosthesis, the control signal is subject to voluntary control. A below-elbow myoelectric device needs five essential elements to operate: the signal source (muscle), electrical connection to the signal source (electro-code), electronic intervention which translates the control signal into the action (controller),

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44/ *Ibid*.

45/ Otto Bock catalogue, Duderstadt, Germany 1989.

46/ Information obtained from the Otto Bock Myoelectric Prosthesis Manual.

a function to store energy (battery) and a prosthesis appliance (electric hand). Advantages of this type of prosthesis are that the movement of the artificial legs/hands can be controlled by extensor and flexor muscles and that no auxiliary suspension device is necessary. Also they are cosmetically very well designed, and the grip power can be controlled by varying the muscle contraction. However, it is necessary to ensure that the user is well trained on the operation of the system. Adequate training can be achieved by teaching the user how to control signal strength.[47/]

## C. Wheelchairs and voice-controlled robots

A great variety of powered wheelchairs are available in industrial countries. Also, numerous compact and light-weight drive motor attachments which can be fitted to the side of a standard wheelchair are now available. Although most powered wheelchairs are built for general outdoor use, new features such as multi-stage gear transmissions or wide-range driving speed make them well suited for indoor operation as well.

The currently available computerized wheelchairs are activated by either voice control or manual controls. Speech-recognition technologies have made some progress over the past few decades, but most of these devices have limited capabilities. They are able to understand only a limited set of vocabulary or simple grammatical structures. However, early models of recognition systems with an upgraded function to discriminate a number of words are very costly. Several speech-recognition devices have been developed which are very effective (if the vocabulary set of the special environment is well defined) and relatively economical. Special software applications which increase the computer's ability to recognize patterns of human speech have recently been introduced. The latest computerized wheelchairs actuated by voice control can be moved, steered and raised. They also stop automatically when the attached microcomputer senses obstacles ahead. It is therefore necessary to revitalize research activities in the field of voice analysis and speech recognition. Specifically, further research is required in the field of artificial intelligence, the understanding of natural languages, and the linguistic structure of limited-grammar languages.

The potentially most far-reaching innovation for disabled persons, which is still under experimentation, is the voice-controlled robot. It is equipped with a voice-recognition device which receives oral commands and translates them into electronic commands to the robot's arms to lift and/or to transport small objects. Such robots may eventually be able to serve physically disabled persons with ALS, muscular dystrophy, cerebral palsy or other physical impairments. This type of robot is being developed by a joint project of the New England Medical Centre and Tufts University.[48/] Also, PRAB Command in Kalamazoo, Michigan has adapted one of its robot systems to perform simple

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47/ This section draws heavily on the paper by M. Huwaish, "The use of myoelectric prosthesis for the upper limb", presented at the International Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, May 1987 (E/ESCWA/ID/87/WG.2/6).

48/ New York Times, 10 August 1986.

office functions. The robot is designed to be fully voice-controlled, recognizing oral commands such as "Get the computer manual" or "Bring me coffee". Furthermore, a research unit at Carnegie Mellon University has created a "pizzabot" which will make pizzas following the voice commands of paraplegics, who will thus be able to operate pizza parlors.49/

### D. Adaptation and transfer of new technologies for physically disabled persons

There is no need to adapt some of the new technologies available, such as some prosthetic devices and/or other medical aids developed for physically disabled persons. However, technologies still need to be expediently transferred to the ESCWA region, and their applications (e.g. customization, maintenance, affordable prices for disabled persons) are to be promoted further to truly meet disabled persons' needs.

The agreement for the establishment of the aforementioned Cairo Rehabilitation Engineering Centre was concluded in collaboration with the Rehabilitation Service Administration, Washington, D.C. The principle upon which this centre was established was the linkage of bio-medical engineering applications for impaired persons and rehabilitation efforts. This special attention was motivated by the presence of a large population of victims from the 1973 Middle East war.50/ Case-studies and research have been conducted concerning the paraplegics and quadriplegics. Areas of research include:

(a) Environmental control studies;

(b) Architectural barriers elimination;

(c) Use of functional electric stimulation;

(d) Utilization of bio-feedback techniques;

(e) Lower limb prosthesis development.

Most of the above-listed projects were successfully applied in the service of various categories of physically disabled persons, although some are still confined to the experimental phase. However, several factors such as overly sophisticated design and overly complicated operation and maintenance of the adopted devices have limited to a certain extent the wider application of such technologies.

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49/ Giancarlo Masini, "Un telefono tuttofare", Arrivederci, vol. II, No. 23 (June 1992), pp. 79-84.

50/ This section draws heavily on an unpublished paper by Mohamed Hashish, "Adaptation and transfer of new and appropriate technology for the disabled in Egypt", IBM Cairo Scientific Centre, Cairo, 1990.

Although very little or almost no adaptation is required for some physical aids, nevertheless the issues of customization, cost, and maintenance are important considerations. In Egypt, El-Gomhoria Factory in Ramadan City has transferred from companies in Europe the technology to locally produce wheelchairs, walking aids, medical beds, crutches, artificial limbs, hand trappers and medical shoes. The factory procures 90 per cent of its raw materials from the local market and keeps its price range from 30-50 per cent of equivalent products manufactured in Europe. Their strategy is labour-intensive and involves utilizing local manpower and avoiding sub-contracts. The company has already expanded its market of selected products to Saudi Arabia and other Gulf countries.51/

In regard to computer applications, arabization is crucial, as Arabic is the official and only widely understood language in the ESCWA region. The introduction of a peripheral input device, such as a foot-operated shift control or speech recognizer, requires specialized software with the computer. Arabic processing must go through complete analysis in terms of oral commands, text processing, and other forms of processing Arabic. Furthermore, for the development of a speech recognizer, artificial-intelligence research and linguistic research on limited-grammar language should continue to be developed simultaneously in both industrial countries and in the ESCWA region (in different language environments).

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51/ Catalogue of El-Gomhoria Factory, Ramadan City, Egypt, and interview with representatives from the factory.

## IV. STRATEGIES TO TACKLE THE HIGH COST OF TECHNOLOGIES FOR THE BENEFIT OF DISABLED PERSONS

There is no doubt that scientific and technical progress can help disabled persons in their education and training, and enable them to be more productive members of society. In the most advanced countries, not only has legislation been enacted to ensure equal accessibility of disabled employees to all public buildings, but new laws have guaranteed their access to computer equipment. Science and technology have opened up tremendous possibilities for rehabilitating disabled persons and for integrating them fully into productive activities. However, the question covering the high cost of these sophisticated devices is often raised.

Although the number of disabled persons in the Arab region (10-15 million) is substantial, it is not considered large enough (since their needs are too individualistic) for this group to be considered an attractive consumer market in any one single country of the region. Furthermore, the countries' capacity to purchase and transfer technologies varies greatly from one country to another, because of differences in gross national product, social services, available human resources and legislation. However, all Arab States share the same language and some of them have quite similar conditions in the fields of social services and manpower development. Regional cooperation should be promoted, with a view to widening markets and thus reducing unit costs. Such regional collaboration might make the disabled consumer group a more interesting target for this new technology industry. Presumably, a collective Arab or regional approach would also help avoid the duplication of efforts and would maximize the market potential for these technologies. Examples of similar cooperative ventures are the ongoing work in Western Europe of the Group/European Cooperation within the Field of Scientific and Technical Research (COST 219) on tele-informatics facilities for disabled persons and the TIDE programme of the European Community.52/

Transfer of technologies for disabled persons should be an integral part of all technical solutions for problems faced by the general public. Benefits to disabled persons may also be of assistance to the general public. Furthermore, additional enhancements are less costly if they are already included in basic design criteria and are not added afterwards. An example in the computer applications field are keyboard macro-programs which enable the user to modify the keyboard to combine common commands in a single keystroke. For able-bodied users, the macros may be merely enhanced functions, but for physically disabled persons, they are fundamental devices.

Strategies to tackle the high cost of these new technologies can be summarized in the following manner:

(a) To develop general-purpose technologies which also meet the special and individual needs of disabled persons;

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52/ TIDE -- Technology for the Integration of Disabled People in Europe -- is a programme based on the proposal by the European Community Research and Development Programme on the application of informatics and telecommunications.

(b) To provide specially adapted interfaces to existing general purpose technologies to meet the special needs of disabled users;

(c) To arabize already available software programs;

(d) To widen markets and reduce unit costs through either international or regional cooperation;

(e) To adopt alternative low-cost technologies, utilizing indigenous materials and manpower resources.

## V. APPLICATION OF SIMPLIFIED LOW-COST TECHNOLOGIES FOR DISABLED PERSONS

So far this paper has identified high technologies designed for disabled persons and discussed measures for their adaptation and transfer to the ESCWA region. As these sophisticated high technologies are mostly imported from industrialized countries, they are costly to purchase, require complex maintenance, lack readily available spare parts, and depend on appropriate infrastructure. Also, adequate training for their use and maintenance is a prerequisite for their expedient transfer. Taking into account the fact that the majority of disabled persons in the ESCWA region do not have equal access to education and training programmes, it is important to be aware of the economic and technical possibilities of the countries to which the high-tech communications technologies are transferred. Increasing attention is now being given to the production and application of low-cost but high-quality devices and technologies, using locally available materials and human resources. This section will highlight a few examples of low-cost, simplified technologies which could be easily applied or which have been applied in the region.

For example, communication aids for disabled persons are usually highly sophisticated electronic devices, frequently based on microcomputers, such as speech recognition devices or speech synthesizers. Although the range of their prices and enhanced functions is becoming wider, the costs for acquisition and maintenance are still excessive.

By contrast, in the Alternative and Augmentative Communication (ACC) system, low-tech symbolic communication systems are developed for less educated or illiterate individuals with communication disabilities. The Blisssymbolics System, commonly known as the Bliss System is a simple but effective symbolic ACC system, invented by Charles Bliss. The Bliss System is based on a semantic system, and most components have either direct or indirect meaning. Due to its symbolic nature, it was originally invented to facilitate effective communication between persons with different language backgrounds. The Bliss System is composed of pictographic and ideographic components which are organized in different combinations. The symbols are developed from several basic geometric shapes (such as circles, triangles, hearts and squares), and each symbol is used as a basic component for all related meanings. For example, the basic symbol "heart" is used as a component for all symbols regarding human feelings. The system, which was originally based on an English-speaking environment, has been slightly modified in many countries, and subsequently different versions, reflecting various cultural and linguistic backgrounds, have been developed. Applications of this ACC system range from low tech solutions, such as utilization of boards and a set of pictographic cards, to more high-tech solutions such as development of electronic scanners or computer software programmes.53/

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53/ This section draws heavily on a paper by M.F. Luis Azavedo, "From old to new technologies: technical aids and the integration of disabled people", presented at the Conference on Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman 20-28 November, 1989 (E/ESCWA/SD/89/WG.1/37).

Pictogram Ideogram Communication (PIC) is another ACC system, which originated in Canada. Different versions of this system -- with adaptation to various cultural and socio-economic patterns -- have been developed in many countries through international collaboration.

The system is composed of 400 pictographic symbols drawn over a black background. The description of each symbol is presented on the top corner of the symbol in order to facilitate communication with persons who are not familiar with the system. Like any other ACC system, the applications of the PIC system were first limited to low-tech aids such as boards of easily available materials. However, some computer-based applications of the PIC system are being developed in some industrial countries.54/

In order to meet the socio-economic and climate conditions in lower-income countries in the ESCWA region, those countries need to reduce to the minimum level the supplies of both raw materials and finished products of technical aids from developed countries. The major prerequisites of such low-tech aids are low price, high durability of material, simplicity of manufacture, low weight and improved appearance.

The technical appliances most frequently required by physically disabled persons include braces, lower limb prostheses, corsets and other functional aids. The World Health Organization (WHO) has promoted, within the framework of its CBR programme, the manufacturing of low-cost orthopaedic appliances of thermoplastic materials. According to WHO, almost all components of prostheses or orthopaedic appliances can be made of thermoplastics such as polpropylene, polyethylene and polyvinyl chloride (PVC). The manufacturing procedures are very simple; only an oven and some basic tools are required. The study undertaken by WHO shows that there are numerous advantages in using thermoplastics in both prosthetics and orthotics. Such advantages include the ease of handling and fabricating the appliances, the use of flexible sockets, low weight and low cost.

Hearing-impaired adults who have not had speech training frequently do not have equal opportunities for education and employment. A low-technology solution, a system of generating left-hand finger moves that represent Arabic characters (finger spelling) has been developed at the IBM Cairo Scientific Centre. The system can be used as a means to communication between deaf and hearing individuals. It also has a significant educational role to play; it can be used at the early educational stage to teach Arabic characters and word spellings. It is believed that the use of manual systems of signs and finger spellings in conjunction with speech will enhance communication for deaf persons.55/

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54/ Ibid.

55/ This section draws heavily on the paper by Mohamed Hashish, "Computer-based Assistance systems for the handicapped", presented at the Conference on the Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1989 (E/ESCWA/SD/1992/2, pp. 199-204).

The two communications systems presented in this section are good examples of low-tech solutions which allow the fuller integration of disabled persons into daily activities. These systems can be introduced and transferred with little or no adaptation into the ESCWA region at affordable cost. However, applications of such communications systems also range from high-tech to low-tech solutions -- such as from pictogram cards to computer system applications. These systems can be adopted in accordance with the economic and technical capabilities of a given country. Increasing attention is currently being given to the development of simpler and less expensive devices utilizing local methods of production which are more easily adaptable to any particular country. Local production is very important, using locally available materials and human resources.

To facilitate the expedient transfer of these simplified technologies, emphasis must be given to the role of informal education and the "learning by doing" approach. Such schemes may include the teaching of skills to rural health workers by physiotherapists, orthopaedic specialists, technicians, etc. It is also important to develop informal local back-up facilities.

## VI. CONCLUSIONS AND RECOMMENDATIONS

The evolution of various new technologies is laying the foundation for devices which reduce the negative effect of sensory, motor and psychological impairments. Today, humanity is reclaiming the capabilities which have been limited by disabilities in the past. Those people with multiple disabilities can now use computers not only to work, but also to communicate with their friends and families.

It is important to keep in mind that although technology offers great opportunities, it could also threaten disabled persons. Many simple repetitive jobs, ideally suited to some categories of disabled persons, such as the mentally retarded, have been eliminated through automation and robotization. For instance, PCs give most users some sense of liberation, by automating the tedious chores of information processing and management. An effort should be made to find out whether those with cognitive limitations such as mentally retarded persons, can enter the new-technology work environment.

Another important issue is that technologies are progressing and changing with such speed that what is applicable today may be out of date in the immediate future. In introducing, adapting and transferring of new technologies into the region, it is important to exert great efforts towards seeking long-term and flexible (upgradable) approaches rather than short-range solutions.

The technologies covered in this paper represent only a small portion of the achievements currently being expanded. Research, development and production of new technologies should be based on humanitarian needs and values, in terms of social progress, to which the disabled could contribute and from which they could benefit.

In the context of the United Nations Decade of Disabled Persons (1983-1992) and the implementation of the World Programme of Action, the United Nations Economic and Social Commission for Western Asia (ESCWA) organized the Conference on the Capabilities and Needs of Disabled Persons in the ESCWA Region, in collaboration with the Ministry of Social Development of Jordan, the Regional Bureau of the Middle East Committee for the Welfare of the Blind and the United Nations Centre for Social Development and Humanitarian Affairs (CSDHA), and with additional financial assistance from the Arab Gulf Programme for the United Nations Development Organizations (AGFUND), the Organization of Petroleum Exporting Countries (OPEC) fund and the Government of the Netherlands. The Conference was held at Amman from 20 to 28 November 1989.

The Conference was attended by some 200 Arab and international experts -- some 40 of whom were themselves disabled -- including experts participating in their personal capacity, representatives of Governments, representatives of Arab organizations, mass media experts and eminent personalities from the region, in addition to representatives of members of the ESCWA Inter-Organizational Task Force on Disability and other United Nations agencies.

The situation regarding technologies for the benefit of disabled persons has not changed significantly since the Conference was held in 1989. Therefore, it is useful to cite the recommendations of the Conference56/ on the adaptation and transfer of new technologies in the region, most of which still need to be implemented:

(a) Advanced technologies developed in industrial countries should be adapted to meet local needs and transferred to the region through staff training;

(b) The use of computers should be promoted to assist the integration of disabled persons into the community. The process may involve the adaptation of hardware to make it accessible to various categories of disabled persons and the development of appropriate software packages;

(c) Local production of appropriate and simplified technologies should be encouraged for items such as wheelchairs, prosthetic devices and mobility aids, taking into account technical, socio-economic and cultural conditions in the society in question. Governments are urged to undertake pilot projects to establish suitable rehabilitation industries and to set up a national delivery system of rehabilitation aids;

(d) Urgent efforts should be made to further develop artificial intelligence, other computer-aided systems and an Arabic speech-recognition system. In view of the absence of Arabic language in current computer technology and the difficulty involved, research should be undertaken to arabize computer systems to make them compatible with programs for disabled persons;

(e) The problem of the high cost of new technologies cannot be separated from the cost of maintenance and service. Whenever possible, Governments should subsidize the acquisition of these technologies. In this regard, international and regional cooperation should be an important means for widening markets and thus reducing the unit cost;

(f) To keep abreast of innovations, Arab experts, particularly disabled experts, should participate in seminars, exhibits and events at both regional and international levels.

The major guidelines on the adaptation and transfer of new technologies summed up from the examples presented in this paper are included in the above Conference recommendations. It is also very important to note that already-existing indigenous technologies and their simple adaptation can significantly promote the independence of all categories of disabled persons in all major productive activities of life.

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56/ Final Report of the Conference on the Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1992 (E/ESCWA/SD/89/WG.1/38)

Furthermore, it is very important to develop practical guidelines at the regional level for acquisition planning and procurement to ensure the accessibility of disabled employees to electronic office equipment, by government agencies and private companies. The models in the United States and Japan (the Guidelines for Implementation of Section 508 of PL 99-506 and Japanese Electronic Equipment Accessibity Guidelines) may be used as references. The most important is that documentation should be made available in an electronic format (e.g. ASCII format) suitable for computer-based outputs. The disabled user may choose the most appropriate form of output (e.g. speech synthesizer, Braille, large print and tactile output) in accordance with his/her need if the documentation is available in an electronic format. The United Nations reports on disability-related issues should be available for wide distribution on floppy disk or cassette tape. The development and standardization of specialized OS and disclosing of the connection interface of the alternative input/output devices are essential in this regard.

Ultimately, the investment in technologies for the benefit of all citizens, including disabled citizens, could reduce society's burden associated with disability. Such an effort would lead to diminishing expenditures for treatment, education, rehabilitation, transportation and other services required by disabled persons. After solid regional cooperation is achieved in the ESCWA region as well as in other regional blocks, international cooperation going beyond cultural and socio-economic boundaries might draw due attention.

Table 1. Mobility aids in use

| Name | Developed in | Developed by | Obstacle detection method | Display method |
|---|---|---|---|---|
| Sonic Torch | 1965 | Lasley Kay (England) and detects beat sound between emitted and reflected sounds | Transmits FM-ultrasonic bursts and detects beat sounds between emitted and reflected sounds | Displays beat sound, frequency of which is proportional to the distance of obstacle |
| Sonosoec | 1965 | Toshin Electric Co. (Japan) | Transmits ultrasonic pulse and detects time delay of reflected sound | Displays sound, frequency of which is proportional to time delay |
| Pathsounder | 1966 | Lindsay Russel (USA) | Transmits ultrasonic pulse and detects time delay of reflected sound | Displays sound and vibration, frequency of which changes at two levels according to time delay |
| Sonicguide | 1969 | Lasley Kay (New Zealand) | Transmits FM-ultrasonic bursts and detects sound by using two receivers with different directivity | Displays two beat sounds binaurally |
| Mowat Sensor | 1972 | Geoff Mowat (New Zealand) | Transmits ultrasonic pulse and detects time delay of reflected sound | Displays sound or vibration, frequency of which is proportional to time delay |
| Nottingham | 1974 | J. Armstrong (USA) | Transmits ultrasonic pulse and detects time delay of reflected sound | Displays sound, frequency of which changes at 8 levels corresponding to time delay |

Source: "A design of blind mobility aid modelled after echo location of bat", by Tohru Ifukube, Research Institute of Applied Electricity, Hokkaido University, Sapporo, Japan.

Table 2. Arabic Braille Key

| | | | | | |
|---|---|---|---|---|---|
| ا | ⠁ | ز | ⠵ | ق | ⠟ |
| ب | ⠃ | س | ⠎ | ل | ⠇ |
| ت | ⠞ | ش | ⠩ | ك | ⠅ |
| ث | ⠹ | ص | ⠯ | م | ⠍ |
| ج | ⠚ | ض | ⠫ | ن | ⠝ |
| ح | ⠱ | ط | ⠾ | ه | ⠷ |
| خ | ⠭ | ظ | ⠿ | و | ⠺ |
| د | ⠙ | ع | ⠷ | ي | ⠈ |
| ذ | ⠮ | غ | ⠣ | | |
| ر | ⠗ | ف | ⠋ | | |

Source: "Computer-based assistant-system for the handicapped", by M.A. Hashish and O.S. Emam, IBM Cairo-Scientific Centre.

**ANNEX**

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Ab Viktor Begat-Medifa | Spanga Kyrkvag 438/ Box 8135/ 16308 Spanga | Phone: 08-7617270 | Sweden | |
| Able Tech Connection | Kettering, Ohio | | USA* | PC-based information systems for the blind |
| Actuator A/S | 2834 Nygard | Phone: 061-80006 | Norway | Mobile, electric lifts |
| Acuna y Fombona SA | Uria 39/ 33202 Gijon (Auturias) | 87379 | Spain | |
| Ahlbergs | Anderstavagen 33/ Box 25/ 19070 Fjardhundra | 76147 | Sweden | |
| Akern | Via Panciatichi 56-13/ 50127 Firenze | | Italy | Electronic prostheses |
| Alvema AB | Finspangatan 44, Box 8344/ 16300 Spanga | 11509 KHSS | Sweden | |
| American Foundation for the Blind | 15 West 16th St., New York, NY 10011 | | USA* | Devices for the blind |
| American Hospital Supply | 1450 Wauteegan Rd./ McGaw Park/ IL 60085 | Phone: 312-4730400 | USA* | Rehabilitation and physiotherapy |
| American Stair-Glide Corp. | 4001-T E. 138 St. / Gerardview/ MO 64030 | 510-6011056 AMER STRGLD | USA* | |
| Arkenstone | Santa Clara, California | | USA* | PC-based information systems for the blind |
| AR MET | Ghiando V. Monte Santo 44-44a/ 42021 Bibbiano (RE) | | Italy | Wheelchairs |
| Arjo Mecannaids | St Catherine St. / Gloucester / GL1 2SL | 43451 ARMEC | UK** | Physiotherapy and rehabilitation |
| A. Pamirani Di Roncaglia Rino | Via San Mamolo 15/ 40136 Bologna | | Italy | Wheelchairs |
| Berto Vassilli | Via Irpinia 3/ 35020 Sannara (PD) | 430817 | Italy | Wheelchairs |
| Bettne Mobility Systems Ltd. | PO Box 7044/ Christchurch | | New Zealand | Mobility Aids |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Bimeda Rehabilitationshilfen | Heim-und Spitalbedarf AG/ Budentalstrasse 7/ 8394 Wallisellen | Phone: 01-8303052 | Switzer-land | Rehabilitation |
| Boden Rehab AB | Industrivagen 12/ 96138 Boden | Phone: 0921-18769 | Sweden | |
| Boras Electrotekn. Verkstad AB | Industrigatan 28/ Box 19066/ 50009 Boras | Phone: 033-128120 | Sweden | |
| Braillo Norway A/S | Box 647/ 3101 Tonsberg | Phone: 033-28990 | Norway | Braille printers for blind persons |
| Buehmann Nederland | PO Box 1068/ 4700 BB Roosendaal | Phone: 1650-51721 | Nether-lands | Aids for visually impaired |
| Calley & Currier Co. | Old Bristol Road/ Bristol/ NH 03222 | Phone: 603-7445151 | USA* | |
| Canon Corporation | Tokyo, Japan | | Japan | Communication aids and other informatics |
| Capodareo Elettr. Coop | Via Silicella 57-a/ 00169 Roma | | Italy | Wheelchairs |
| Carters (J & A) Ltd | Alfred St./ Westbury/ Wiltshire BA13 3DZ | 444159 REHAB | UK** | Wheelchairs, rehabilitation & Physiotherapy |
| Casco | 37 Rue des Sarcelles/ 67100 Strasbourg | | France | Lift and other elevating systems |
| Centro Elettromedical | Via Falloppio 33/ 35121 Padova | 430817 UPAPD | Italy | Wheelchairs |
| Citieffe | Via Fratelli Roselli 3/ 40012 Lippo di Caldera di Reno/ Bologna | 226325 AZBVCH | Italy | |
| Colson Company, the Equipment Div. | PO Box 1000, Fair Blvd./ Caruthersville/ MO 38131 | Phone: 314-3332070 | USA* | |
| Computer Conversations | Alexandria, Ohio | | USA* | Computer-based information system for blind persons |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Constella Verken AB | Byggmastargatan 4/ Box 10024/ 78110 Borlange | Phone: 0243-83140 | Sweden | |
| Cooper and Sons Ltd | Wormley/ Godalming/ Surrey GU8 5SY | 858476 COOPER | UK** | Crutches and walking aids |
| Cooperative d'Electronique pour Sourds | 8636 Wald | Phone: 055-952888 | Switzer-land | Hearing aids |
| Cormed Inc. | 591 Mahar St./ PO Box 470/ Medina/ NY 14103 | 501783 | USA* | |
| C. ITOH & Co. Ltd. | Ralambsv. 7/ 11259 Stockholm | 19100 CITOH | Sweden | Speech aids |
| C.G.D.B. | Via Garibaldi 69/ 20071 Casapusterlengo (MI) | | Italy | Prostheses |
| Days Medical Aids | Litchard Industrial Estate/ Bridgend/ Mid-Glamorgan | 498087 DMALTD | UK** | Wheelchairs and rehabilitation |
| Digital Equipment Corporation | | | USA* | Speech synthesizers & other PC devices |
| DIPOR SA | Marques de San Esteban 21/ 33206 Gijon (Asturias) | Phone: 85-353983 | Spain | |
| ECICO Electronics Ltd | 37-8 Eastcastle St./ London W1N 7PE | 262714 ECICO | UK** | Wheelchairs, rehabilitation & computer aids |
| Einar Egnell AB | Industrigatan 2/ 46137 Trollhattan | Phone: 0520-30240 | Sweden | |
| EK Orthopaedic Bandages BV | Eerste Middellandstraat 26d/ 3014 BE Rotterdam | Phone: 01043-53408 | Nether-lands | Rehabilitation |
| Electronics & Computers Research Centre | Jadriya/ Baghdad | 212187 BAHITHILMI | Iraq | Computer software |
| Enraf Nonius | PO Box 483/ 2600 AL DELFT | 38083Z NRAF | Nether-lands | Physiotherapy and rehabilitation |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Ergomedic AB | Fristadstorget 4/ Box 551/ 63107 Elskiltuna | Phone: 016-123404 | Sweden | |
| ETAC AB | Langgatan 12/ Box 203/ 33400 Anderstorp | Phone: 0371-17780 | Sweden | |
| Ethicon | Pratica di Mare- Via del Mare 56/ 00040 Roma | 611693 ETILCON | Italy | Prostheses |
| Euro Dealers | Via Caffaro 2-1/ 16124 Genova | 272019 EUROD | Italy | Prostheses |
| Everest & Jennings | C.O Ortopedia GmbH/ Salzreder 30/ 2300 Kiel 14 | 292773 A/ORTK | FRG | Wheelchairs and orthopedics |
| F L Antonio Betere SA | Flabesa/ Rafael de Riego 245/ 28045 Madrid | Phone: 1-2302607 | Spain | |
| Fabrica Lucia del Norte | Falunorsa/ Ctra. Zorroza Catrejana 42/ 48013 Bilbao | Phone: 4-4423600 | Spain | |
| Falck Produkter A/S | Box 123/ 4951 Risor | Phone: 041-51866 | Norway | Communication and telecommunication aids |
| Farina A. & Figli | Via G. D'Annuzio 4/ 20053 Muggio (MI) | 332688 AFEF | Italy | Wheelchairs |
| FME-VFNR | PO Box 190/ 2700 AD Zoetermeer | | Nether-lands | Groups of manufacturers of rehab. tech |
| France Revalidation | Rue de Quebec/ ZI Chef de Baie/ 17000 La Rochelle | 791483 | France | Special bathtubs and lifts |
| FST | 32, Cret-Taconnet/ 2002 Neuchatel | Phone: 038-246757 | Switzer-land | Electronic appliances, communication aids |
| Gallauded College | Washington, DC. | | USA* | Communication aids for deaf & mute persons |
| Geoff Mowat | | | New Zealand | Mobility aids |
| Gendron Inc. | 870-T Lugbil Td/ Archbold/ OH 43502 | Phone: 419-4456060 | USA* | |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| GN Danavox Nederland BV | PO Box 5/ 6955 ZG Ellecom | 36652 | Nether-lands | Hearing aids |
| Graf Carello | 8262 Nestelbach Bei 11z/ Nestelberg 8 | Fax: 3118/8289 | Austria | Electrovehciles |
| Granberg Interior Mobile AB | Finspangsvagen 63/ Box 4030/ 60004 Norrkoping | Phone: 011-121224 | Sweden | |
| Guardian Products Co. | 80 Easy Street/ Simi Valley/ CA 93062 | Phone: 805-5813802 | USA* | |
| Harting Bank BV | PO Box 8297/ 3503 RG Utrecht | 40773 | Nether-lands | Rehabilitation |
| Hea Rehab | Box 55077/ 40053 Goteborg | | Sweden | |
| Heisteel | PO Box 22/ 6920 Videbaek | 60215 HELST | Denmark | Electrovehicles |
| HOBI | Hauptplatz 1/ 2542 Kottingbrunn | 111871 BUKA | Austria | Orthopaedics and Wheelchairs |
| Hoegg AG Masehinen u. Apparatebau | Wiler Strasse 137/ 9260 Lichtensteig | Phone: 074-71511 | Switzer-land | Stair Climbers |
| Homecraft Supplies Ltd | 27 Trinity Road/ London SW17 7 SF | 896691 TLXIRG | UK** | Rehabilitation and daily care |
| Hugh Steeper Limited | Unit 7/ Hunslet Trading Estate/ Savern Road/ Leeds LS101BL | 557120 ABMSLS | UK** | Physiotherapy, rehab. environ. control systems |
| Huka Development | Postbus 194/ 7570 AD Oldenzaal/ Ainsworthstraat 21 | 72129 | Nether-lands | Wheelchairs and daily care |
| Iben Sina Medical Service Centre | PO Box 10111/ Amman | 24118 ARABEX | Jordan | Orthopaedics and rehabilitation |

**ANNEX (continued)**

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| IBM Cairo Scientific Centre | | 22158 | Egypt | Computer software and hardware |
| Ima Comfort | Box 8/ 23400 Lomma | | Sweden | |
| INEX-Cooperative Foreign Trade | 00-953 Warsaw/ Galszynskiego 4 | 813292 ZSI | Poland | Various technical aids |
| Infovox AB | Box 2503/ 17102 Solna | 8126164 | Sweden | Text to speech system (Communication aids) |
| Ingenierie et Techniques Industrielles | Tour Essor BP 74/ 14-16 rue Scandicci/ 93502 Pant in Cedex | 233661 SGASTA | France | Environmental Control Systems |
| Intersan | Industria 333/ 08027 Barcelona | 81059 TRSAN | Spain | Orthopaedics |
| Int'l Diffusion Consommateur | BP 1 Montperou/ Chatuzange le Goubet/ 26300 Bourg de Peage | CC IVAL 345715 | France | Walking aids |
| Invacare Corp. | 399-T Develand St./ Elyria/ OH 44036 | 422316 | USA* | |
| ITOS | Via Belfiore 52/ 10125 Torino | | Italy | Electronic prostheses |
| Jafaco | PO Box 113/ 10321 Karjaa | | Finland | Physiotherapy |
| James Hunter Engineering Ltd | 46 Neil Park Drive/ East Tamaki | Fax: 09-274 9313 | New-Zealand | Walking aids |
| Janssen | Turnhoutseweg 30/ 2340 Beerse | 32540 | Belgium | |
| Jedcom Medical Products Ltd | 1 The Avenue/ Barnet/ Hertfordshire EN5 4EN | 298951 BILWAY | UK** | Speech and communication aids |
| J. Armstrong | | | USA* | |
| J.E. Hanger & Co. Ltd | Rochampton Lane/ Rochampton/ London SW15 5PL | 896983 LIMROE | UK** | Orthopaedics |

ANNEX (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Kanor | 385 Warburton Ave./ Hastings/ NY 10706 | | USA* | Toys and adaptative equipment for children |
| Keeler Ltd | Clewer Hill Road/ Windsor/ Berkshire SL4 4AA | 847565 KEELER | UK** | Low-vision systems for partially sighted |
| Kurzweil Computer Products | Cambridge, Massachusetts | | USA* systems | Speech recognizers and other PC-based |
| Kuwait Special Institute for the Handicapped | | | Kuwait | Communication aids in the Arabic language |
| Lacoste | 14, rue de Belgique/ BP 0132/ 37001 Tours Cedex | 754133 | France | Wheelchairs |
| Lafoucriere | 52 Bld Ornano/ 93207 Saint Denis Cedex 1 | 210311 | France | Elevating systems for public buildings |
| Lamico Inc. | 474 Marion Road/ Oshkosh/ WI 54901 | 350707 | USA* | |
| Larkotex Co. | 1002 Olvie Street/ Texarkana/ TX 75501 | Phone: 214-7934647 | USA* | |
| Lasley Kay | | | New Zealand | Mobility aids for the blind |
| Leichle-Matia | 1 Chemin du Baron/ 54480 Cerey s-Veyrouse | 960762 | France | Special bathtubs and lifts |
| LIC | Svetsarvagen 20/ 17183 Solna | 10528 LIC | Sweden | |
| LIKO AB | Tunbyvagen 40 c/ 72223 Vasteras | Phone: 021-120910 | Sweden | |
| Lindsay Russel | | | USA* | Mobility aids |
| Linfante-Vehiculos | Abundancia 7-9-11/ 08980 Hospitalet de Llobregat (Barcelona) | 52495 | Spain | |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Lit Dupont | 25 rue du General Leclerc/ 94270 Kremlin Bicetre | 204870 | France | Wheelchairs |
| Low Vision International | Systratospsvagen 14/ 35246 Vaxjo | 52147 EOSWED | Sweden | Aids for the visually impaired |
| Lumex Inc. | 100-T Spence/ Bayshore/ NY 11706 | 221213 | USA* | |
| Luxilon Industries | Industriepark-Vosveld 11/ 2110 Wijnegem/ Antwerpen | 31832 | Belgium | Orthopaedics |
| L.I.M.A. Ltd | Casiacco Zona Industriale/ 33090 Vito D'Asio (PN) | 450328 LIMA | Italy | Prostheses |
| L.S. Raap Import-Export BV | PO Box 28050/ 3828 ZH Hoogland | Phone: 033-726782 | Nether-lands | Various products |
| Matifas | 626 rue de Rouen/ 80008 Amiens Cedex | 150451 | France | Wheelchairs |
| MECO | Via delle Industrie 5/ 45100 Rovigo (RO) | 410303 RORIZ | Italy | Wheelchairs |
| Medische Revalidatie Technick "Tamo" | Courtine 19/ 4207 AD Gorinchem | Phone: 01830-32121 | Nether-lands | Rehabilitation |
| Mediscus | 10 Westminster Road/ Wareham/ Dorset BH2 04SP | 418496 MEDISC | UK** | |
| Melville Industries Ltd | PO Box 10-230/ 163 Ferry Road/ Christchurch | NZ 4586 CANTY COM | New Zealand | Environmental control systems and wheelchairs |
| Mercado Rehab AB | Valhallavagen 102/ Box 16348/ 10326 Stockholm | Phone: 08-670135 | Sweden | |
| Merivaara-Rehab | Instrumentarium Corp./ 15150 Lahti | 16257 MERVA | Finland | Rehabilitation and mobility equipment |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Mertens International BV | Deurnestraat 208/ 2510 Mortsel | 31933 | Belgium | |
| Mitco Ltd | 5608 Malvey/ Suite 300-4/ Forth Worth/ TX 76107 | 7385299 | USA* | |
| MLW-Intermed Export-Import | Schicklerstr. 5-7/ PO Box 17/ Berlin 1020 | | Germany | All rehabilitation products |
| Modulmed | Rue Papenkasteel 10/ 1180 Bruxelles | 61344 | Belgium | |
| Molnlycke Mobility AB | Fagerstagatan 9/ Box 66/ 16391 Spanga | Phone: 08-7617090 | Sweden | |
| Moore & Moore Inc. | 1202 S. 17th Ave./ Maywood/ IL 60153 | Phone: 312-3438710 | USA* | |
| Nemectron | | 7826458 | FRG | |
| Nottingham Rehab | 17 Ludlow Hill Road/ West Bridgford/ Nottingham NG2 6HD | 377082 | UK** | Physiotherapy and rehabilitation |
| Officine Ortopediche Rizzoli | Via SS Annunziata 13/ 40136 Bologna | 583336 OORB | Italy | Orthopaedics |
| Optelec | Harvard, Massachusetts | | USA* | PC-based information systems for the blind |
| Orona Sdad. Coop. | Olgo. Lastaola s-n/ Ctra. de Goizueta/ 20120 Hernani (Cuipuzeoa) | 36089 | Spain | |
| Orthepaedia Van Lierop BV | Nieuwe Rijn 55-56/ 2312 JA Leiden | 39232 | Nether-lands | Orthopaedics |
| Orthopedic System Inc. | 1897 National Ave./ Hayward/ CA 94545 | 790471 | USA* | Orthopaedics |
| Oticon | 9 Klaedemaalet/ 2100 Copenhagen 0 | 19370 Oticon | Denmark | Hearing aids |
| Otto Bock | IndustrestraBe/ Postfach 1260/ Duderstadt 3408 | 965912 | Germany | Orthopaedics |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| O.M.S.A. | Via Romeo 24-a/ 42020 Atbinea (RE) | 530246 OMSA | Italy | Wheelchairs |
| Paramedi BV | Wilheminapark 28/ 2012 KG Haarlem | Phone: 023-317250 | Nether-lands | Walking aids and rehabilitation |
| Paratec | Ringstrasse 15/ 4123 Allschwill | Fax: 061535240 | Switzer-land | Wheelchairs |
| Prentke Romich | | | UK** | Communication aids |
| Permobil AB | Verkstasvagen 2/ Box 120/ 861 00 Timra | 89 845 5107 PERMOBI | Sweden | Power wheelchairs for children |
| Philips, Hearing Instr. Div | Groenewoudseweg 1/ 5621 BA Eindhoven | 296641 PIRLY | Nether-lands | Hearing aids |
| Phonic ear | Torvet 1/ 3400 Hillerod | Fax: 45-42 266125 | Denmark | Hearing aids |
| Piai Giovanni EC | Via A. Meuci 32/ 31020 S. Giacomo di Veglia (TV) | | Italy | Crutches |
| Pikolin SA | Ctra. Logrono Km 6,5/ 50011 Zaragoza | 58317 | Spain | |
| Pointer Systems | Burlington, Vermont | | USA* | PC-based communication aids |
| Poirier | Les Roches Fondettes/ 37230 Lyunes | 75198 POIRFON | France | Wheelchairs and electrovehicles |
| PRAB Command | Kalamazoo, Michigan | | USA* | Office robots |
| Premis Revalidatie en Verpleegartikelen vof | PO Box 188/ 3970 AD Driebergen | 40132 | Nether-lands | Rehabilitation equipment |
| Preston | 60 Page Road/ Clifton/ NJ 07012 | 4754139 PRESTON | USA* | Physiotherapy and rehabilitation |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Prim S.A. | Polig. Ind. no-1/ Calle C, no-20/ 28938 Mostoles (Madrid) | 43003 PRIM | Spain | |
| Promoplastique | 15 Cite Voltaire/ 75011 Paris | 214483 | France | Orthopaedics, artificial limbs |
| Proteor Service | 11 rue des Buttes/ 21100 Dijon | 350232 | France | Orthopaedics, artificial limbs |
| PAMPUS AB | Ugglevagen 23/ Box 622/ 13121 Nacka | Phone: 08-7181020 | Sweden | |
| Rastronics Aps. | Femstykket 6/ 3540 Lynge | 42191 | Denmark | Hearing aids |
| Regional Bureau of the Middle East Committee for the Affairs of the Blind | P.O. Box 3465, Riyadh, Saudi Arabia | | Saudi Arabia | Braille printing and other information systems for the blind |
| Rehabmodul AB | Vintervagen 41/ 17135 Solna | Phone: 08-7305125 | Sweden | |
| Remploy Ltd | 415 Edgware Road/ Cricklewood/ London NW2 6LR | 23178 | UK** | Orthopaedics, rehabilitation |
| Resus BV | PO Box 140/ 3340 AC Hendrik-Ido-Ambacht | 29453 | Nether-lands | Aids for the visually impaired (Braille) |
| Rexton Danplex | Dronningens Tvaegade 46/ 1302 Copenhagen | Fax: 1-148462 | Denmark | Hearing aids |
| Rigert Maschinenbau AG | Eichlihalde/ 6405 Immensee | 868670 | Switzerland | |
| Ropox Aps. | Ringstedgade 221/ 4700 Naestved | 46226 | Denmark | Rehabilitation equipment |
| RSFU Rehab | Rosenlundsgatan 13/ Box 17006/ 10462 Stockholm | Phone: 08-680940 | Sweden | |
| Samhall-Pile | Stormgatan 14/ Box 506/ 20125 Malmo | Phone: 040-71800 | Sweden | |
| Setma International | BP 16/ 37701 Blagnac | 520607 | France | Physiotherapy and wheelchairs |
| Shatzmann Carlos | Tomas Redondo 1/ 28033 Madrid | 42184 | Spain | |
| Siemens | 39-49 Bd Ornano/ BP 109/ 93203 St-Denis Cedex 1 | 620853 | France | Environment control systems |

ANNEX (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| SKS | Wyden Postfach 25/ 8762 Schwanden | 876259 SKS | Switzer-land | Wheelchairs and rehabilitation |
| Sliema Medical Supplies | 1 Boreham Road/ Warminster/ Wilts. BA12 9JP | 449 861 | UK** | |
| Smith-Kettlewell Eye Research Institute | San Francisco, CA | | USA* | PC-based aids for blind persons |
| Speech Plus Inc. | 461 North Bernardo Avenue/ Mountain View/ CA 94043 | | USA* | Speech and communication aids |
| Spes-Produkt A/S | Freivn. 62/ 6500 Kristiansund | Phone: 073-77277 | Norway | Computer software for the disabled |
| Spoco Power Push AG | Stanserstrasse 107/ 6064 Kerns | Phone: 041-666176 | Switzer-land | Wheelchairs |
| SRF Produkter AB | Sandsborgavagen 50/ 12233 Enskede | | Sweden | Accessories for blind people |
| Stannah Lifts | Watt Close/ East Portway/ Andover/ Hampshire SP10 3SD | 47471 STALIFT | UK** | Disabled access systems |
| Ste Herdegen | 35 rue du Tapis Vert/ 93260 Les Lillas | Phone: 448459720 | France | Walking aids |
| Street Electronics Corporation | 1140 Mark Avenue/ Carpenteia/ CA 93013 | | USA* | |
| Svithun Produkter A/S | Box 3079 Mariero/ 4001 Stavanger | Phone: 04-883000 | Norway | Mobility aids |
| Swereco Rehab AB | Skolvagen 16/ Box 6014/ 19106 Sollentuna | Phone: 08-7540120 | Sweden | Wheelchairs, walking aids, home care and rehabilitation |
| S.A.D.A.M. | 15 Bld St Germain/ 75005 Paris | Phone: 43263098 | France | Wheelchairs |
| S.L.O | Via della Bastia 23/ 40033 Casalecchio Reno (PO) | | Italy | Crutches |
| Synskadades Centralforbund | Finlands Dovblinda Backdagatan 50, SF-00510 51 | | Finland | |
| SYSTELEC Company | | | France | Information systems for the blind |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Tagarno | Hattingvej 5/ 8700 Horsens | Fax: 05-629697 | Denmark | Aids for visually impaired |
| Technical Aids and Systems for the Handicapped | Markham, Ontario | | Canada | Computer communication aids |
| Telesensory Systems, Inc. | 455 North Bernardo Avenue/ PO Box 7455/ Mountain View/ CA 94030 | 278838 TSI UR | USA* | Computer/sensory aids for the blind |
| Texas Instruments | PO Box 10508/ Lubbock/ Texas 79408-3508 | 73324 | USA* | Computer aids |
| Theradyne Corp. | 21730-T Hanover Ave./ Lakeville/ MN 55044 | Phone: 612-4694404 | USA* | |
| Thompson Products Ltd | Division of Smith Biolab Ltd/ PO Box 61005/ Aackland | | New Zealand | Wheelchairs |
| Thune-Maskiner A/S | Box 385/ 2301 Hamar | Phone: 065-22070 | Norway | Lifts for bathtubs |
| Tieman | Moolheek 5, 3235 XK Rockanje | 29764 TIMAN | Nether-lands | Aids for the visually impaired |
| Toshin Electric Corporation | | | Japan | Mobility aids |
| Tufts University | | | USA* | PC-based advanced technologies |
| Uribarri | Talleres Uribarri/ Plgo. Bakiola, 9/ 48498 Arrancudiaga-Vizcaya | | Spain | Orthopaedics |
| Uzri Zavod Rehabilitacjo | Ljubjana | 32260 ZRILJU | Slovenia | |
| U.B.-LET Aps. | Jens Grons Vej 16/ 7100 Vejle | Fax: 05-859551 | Denmark | Electrovehicles |
| Valutec AG | Bleicheweg/ 5605 Dottikon | 827981 | Switzer-land | Wheelchairs |
| Van Hool | Van Hoolstraat 58/ 2578 Lier/ Koningshooikt | 31709 | Belgium | Special vehicles, buses |
| Variolo | Via Prodenone 58/ 33100 Udine | | Italy | Prostheses |

**ANNEX** (continued)

| Company name | Address | Telex, fax or phone | Country | Type of product |
|---|---|---|---|---|
| Vermeiren N.V. | Vermeirenplein 1-15/ 2180 Kalmthout | 71296 | Belgium | Wheelchairs |
| Vermund Larsen | Goteborgvej 10-12/ 9200 Aalborg SV | Phone: 8-181766 | Denmark | Special chairs |
| Vessa Ltd. | Paper Mill Lane/ Alton/ Hampshire GU34 2PY | 858316 | UK** | Wheelchairs and artificial limbs |
| Viennatone | Frobelgasse 26-32/ 1164 Wien XVI | 132865 VITON | Austria | Hearing aids |
| Villard | BP 284/ 72006 Le Mans Cedex | 722912 | France | Wheelchairs |
| Vita New Zealand Ltd. | 670 Rosebank Road/ Avondale/ Auckland | 21406 VITAF | New Zealand | |
| Voice Connection | 17835 Skypark Circlr/ Suite G/ Irvine/ CA 92714 | | USA* | Speech and communication aids |
| Votrax International Inc. | 1394 Rankin Drive/ Troy/ MI 48083 | | USA* | Speech and communication aids |
| Wassermann Marketing | PO Box 1509/ 7060 Schorndorf | Phone: 0 71 81-77331 | FRG | Computer aids for the blind |
| Wesseling B.V. | PO Box 80/ 1160 AB Zwanenburg | Phone: 02907-5183 | Nether-lands | Rehabilitation |
| Wessex Medical Equipment Company Ltd | Budds Lane/ Romsey/ Hampshire SO51 OHA | Phone: 0794-522022 | UK** | Mobility aids, lifts |
| Widex Aps | Ny Vestergardsvej 25/ 3500 Vaerlose | 37588 WIDEX | Denmark | Hearing aids |
| World Health Organization | CH-1211, Geneva | | Switzer-land | Community-based low technologies |
| Wormald International Sensory Aids Ltd | PO Box 19-670 Christchurch | | New Zealand | Electronic orientation aids |
| Zimmer S.A. | 68-70 Rue Gen. M. Joinville/ B.P 104/ 94401 Vitry Sur Seine | 204855 | France | Orthopaedics and physiotherapy |

* United States of America.
** United Kingdom.

## Bibliography


Abdelazem, H. and M.A. Hashish. Automated recognition of bilingual typewritten text. Proceedings of CompEuro '89, Hamburg, May 1989.

Al-Banna, Linah H. and S. Al-Banna. Some computer-associated technologies for the handicapped in the USA. Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, 4-6 May 1987 (E/ESCWA/ID/87/WG.2/10).

Arab News. Riyadh, Saudi Arabia, 24 May 1991.

Asano Shiro, Takamatsu Tsurukichi and Shigeru Ohota. Syogaisha no Konausei wo Hirogeru Computer, Tokyo, April 1990.

Brody, Herb. The great equalizer: PCs empower the disabled. PC/Computing. July 1989, pp. 83-93.

Busby, G. Computer and electronics for the service of the handicapped, Symposium on Computers and Electronics for the Service of the Handicapped. Baghdad, 4-6 May 1987, (E/ESCWA/ID/87/WG.2/12).

Chitore, D.C., S.F. Rahmatallah and K.S. Albakry. An electronic controller for artificial leg prosthesis. Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, 4-6 May 1987 (E/ESCWA/ID/87/WG.2/4).

EEC. Technology for the integration of disabled people in Europe. EEC document (DGXIII/D.1/282/89), 1989.

Egypt. Central Agency for Public Mobilization and Statistics. Population and housing census, 1976. Volume I. Cairo, 1980.

El-Gomhoria Factory. Catalogue of El-Gomhoria Factory, Ramadan City, Egypt.

Hashish, M. Adaptation and transfer of new and appropriate technologies for the disabled in Egypt. Unpublished manuscript, IBM Cairo Scientific Centre, Cairo, 1990.

International Commission on Technical Aids (ICTA) Information Centre. Aids for the deaf-blind. Bromma, Sweden, April 1985.

Jordan Times. Amman, Jordan, 7 November 1991.

Leard, William. The changing work-place; The educator's view. Symposium on Computers and Electronics for the Services of the Handicapped, Baghdad, 4-6 May 1987, (E/ESCWA/ID/87/WG.2/12).

Masini, Giancarlo. Un telefono tuttofore. Arrivederci (Roma) II:23, Gennaio 1992.

Naidex Conventions Limited. Naidex' 88: An international exhibition of equipment and services for the disabled and elderly, London, 11-13 October 1988.

New York Times. 10 August 1986.

Niwa, Samuel Isamu. New technology and employment of disabled persons. European Congress on New Technology and Disabled Persons, Liege, 16-18 March 1988.

Otto Bock. Myoelectric prosthesis manual, The Federal Republic of Germany.

_________. Manual Duderstadt, Germany, 1989.

SYSTELEC. Brochure about DELTA. Palaiseau, France.

Telesensory Systems, Inc. Brochures for VersaBraille, VersaBraille II Plus Systems, Optacon accessories, Advantage and VISTA. Mountain View, California, 1988.

United Nations. Economic and Social Commission for Western Asia. A design of blind mobility aid modelled after echo location of bats. Paper presented by Ifukube Thoru at the International Symposium of Computers and Electronics for the Service of the Handicapped, Baghdad, May 1987, (E/ESCWA/ID/87/WG.2/7).

___________. Economic and Social Commission for Western Asia. Adaptation and transfer of new technologies designed for the disabled in the ESCWA Region. Conference on the Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1989 (E/ESCWA/SD/WG.1/44).

___________. Economic and Social Commission for Western Asia. Computer application for the training of deaf children in Kuwait. Paper presented by Hansi Qasem and others at the International Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, May 1987, (E/ESCWA/ID/87/WG.2/2).

___________. Economic and Social Commission for Western Asia. Computer-based assistance systems for the handicapped. Proceedings of the Conference on the Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1989, (E/ESCWA/SD/1992/2, pp. 199-204).

___________. Economic and Social Commission for Western Asia. Current and future trends in computer technology for the physically disabled. Paper presented by Allen Bob at the International Symposium on Computers and Electronics for the Service of the Hanidcapped, Baghdad, May 1987, (E/ESCWA/ID/87/WG.2/13).

___________. Economic and Social Commission for Western Asia. Developmental social welfare issues: inter-regional consultation on developmental social welfare policies and programmes. Note by the Executive Secretary, fourteenth session of ESCWA, Baghdad, 4-5 April 1987, (E/ESCWA/14/7).

__________. Economic and Social Commission for Western Asia. Final Report of the Conference on the Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1989, (E/ESCWA/SD/89/WG.1/38).

__________. Economic and Social Commission for Western Asia. From old to new technologies: technical aids and the integration of disabled people. Paper presented by Luis M.F. Azaved at the Conference on Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1989, (E/ESCWA/SD/89/WG.1/37).

__________. Economic and Social Commission for Western Asia. Iraqi Electronics and Computer Research Centre, Iraqi War Handicapped Welfare Council and UNESCO Regional Office for Science and Technology for the Arab States. Final report and documents of the International Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, 20 May 1987, (E/ESCWA/ID/WG.2/16).

__________. Economic and Social Commission for Western Asia. The disabled: the blind and prospects of modern technology. Paper presented by Nazeh Al-Qadamani at the Conference on the Capabilities and Needs of Disabled Persons in the ESCWA Region, Amman, 20-28 November 1989, (E/ESCWA/SD/89/WG.1/19).

__________. Economic and Social Commission for Western Asia. The use of myoelectric prosthesis for the upper limb. Paper presented by M.H. Huwaish at the International Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, May 1987, (E/ESCWA/ID/87/WG.2/6).

__________. Economic and Social Commission for Western Asia. Visio Braille: the black light. Paper presented by Balin Philippe at the International Symposium on Computers and Electronics for the Service of the Handicapped, Baghdad, May 1987, (E/ESCWA/ID/87/WG.2/15).

__________. United Nations Educational, Scientific and Cultural Organization. New information technology in special education. A study prepared for UNESCO by Jorgen Hansen, Denmark.

__________. World Programme of Action concerning Disabled Persons. Division for Economic and Social Information for the Centre for Social Development and Humanitarian Affairs, DIESA. New York, 1983.

United States. Department of Education and General Service Administration. Access to information technology by users with disabilities: initial guidelines, October 1987.

VISIOBRAILLE. Description of a workstation for the Blind, Zygote, France.

WESRA. Electronics for disabled people. Progress report of WESRA (Tokyo) April 1990.

World Health Organization. Training in the community for people with disabilities, by E. Helender and others.

Yousif, F.Y. Microcomputer-based speech recognizer using zero crossing histogram. 4th Scientific Conference, Scientific Research Council (Iraq), 23-28 October 1986.