High technology for low vision

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What do cordless power tools, running shoes, the coating on the Statue of Liberty, and the new low-vision enhancement system (LVES, pronounced “Elvis”) have in common? Known as spin-offs, these products were originally developed by the National Aeronautics and Space Administration (NASA) for the space program, then applied to the consumer-oriented market.

This is good news for the 9,302,000 Americans afflicted with chronic low vision that cannot be corrected medically, surgically, or with prescription glasses. Space-age technology and research from Johns Hopkins Medical Institutions are being applied to bring the world into focus for those with many types of legal blindness and to give them a new quality of life. Technology once used for computer processing of images from satellites for the NASA space station projects is now being used to improve vision by appropriately magnifying, altering, and enhancing visual images to compensate for the individual patient’s impaired eyesight.

Previously, the only form of assistance for patients with disabling visual impairments was through the use of low-technology tools such as magnifiers, telescopes, and closed-circuit television. Now patients with low vision have two new high-technology options: the LVES by Visionics Corporation and the Magni-Cam system developed by Innoventions, Inc.

LVES introduces patients with low vision to virtual reality, which enables them to immerse themselves in a visual world of extra-large, extra-bright three-dimensional (3-D) computer images that imitates what a normal sighted person ordinarily sees. You may remember one of the first virtual reality machines developed in the 1940s and mass-market in the 1950s and 1960s, known as a View-Master viewer. A slide disk or reel was inserted into a viewer, and the lenses produced two slightly skewed images, creating a 3-D effect.

Computer technology allows LVES to go far beyond a 3-D image, enabling the user to zoom, change contrast polarity (reverse a white background with black letters to a black background with white letters), and, through an enhanced contrast sensitivity, create well-defined images (faces that before appeared only as a blur now become clearly and distinctly outlined).

LVES is a lightweight (about 2 pounds) head-mounted device that looks like a small welding visor (Figure 1). The images from two fixed high-definition monochrome video cameras are displayed, one for each eye, to give the patient a 1:1 stereoscopic (3-D) view with a visual field at least 50 degrees wide and 40 degrees...
high. Because this field is restricted in comparison with the 180-degree field of normal vision, its intended use is not for walking or driving.

The image seen in the headset is black and white and similar to that seen when viewing a 60-inch large-screen TV from a distance of 4 feet. A third camera is mounted above the visor with an adjustable zoom lens, capable of magnifying images from three to 10 times, for near vision tasks such as reading or cooking. By adding a special cap, magnification can be increased to 25× for near vision. What separates LVES from other video devices is the focus range of 1 mm to infinity, allowing patients to use a single device for viewing both near and distant objects.

A 40-inch cable connects the LVES headset to a portable control unit the size of a small book (2 x 4 x 7.5 inches), weighing 2.5 pounds, which can be hung from the shoulder or across the chest or attached to the waist in a hip pack (Figure 2). It is powered by a 90-minute rechargeable battery (recharges in about 1 hour) or with an adapter through a standard AC outlet. The unit can bypass the video cameras and be connected directly to the television set for viewing TV programs and videocassette tapes, as well as computer screens, instantaneously.

**Who can use LVES**
LVES is not indicated for patients with vision better than 20/100 because the reduction in optics does not provide any additional visual benefit. Conversely, it is not indicated for patients with vision worse than 20/800 because their vision is too poor to use the magnified images. For patients identified as candidates for LVES, however, vision can be improved as much as seven lines on the Snellen chart. LVES may even help patients with a central scotoma by electronically processing and remapping the image to compensate for the distortion or blank area. This way, no portion of the visual acuity is lost.

The LVES headset is individually fitted to each user with his or her own prescription lenses, which are dispensed only by trained ophthalmologists, optometrists, and their staffs. Currently about 260 units have been dispensed for patients in the United States. Visionics has developed a 2- to 3-day ophthalmic video technician course that instructs personnel at selected sites in the basic functions and capabilities of the system. These programs are available for open enrollment, and the company plans to offer them quarterly or bimonthly, depending on the demand. In 1996, Visionics will offer additional training opportunities in rehabilitation and practice management, including intensive training programs for technicians and physicians (John Lampland, Visionics Communications Manager, personal communication, October 4, 1995).

By the end of 1995, Visionics expected to have approximately 35 clinical affiliates throughout the country offering patients evaluation, dispensing, and training for the LVES device. The cost for these programs runs about $1100 to $1500.
Currently some charges are covered by insurance for the examination and evaluation, but Medicare does not pay for the LVES device itself. However, with a little persistence, some employers and state rehabilitation services may be persuaded to provide financial assistance.

LVES fitting at Johns Hopkins
At the Johns Hopkins Wilmer Eye Institute potential LVES recipients enter a 3-day comprehensive vision rehabilitation program for education and training. Because Johns Hopkins is a leading research center, extensive data are collected to develop understanding of low vision and ensure success with the system. Being comprehensive in nature, the evaluation helps to determine which low vision aid would be most suitable if the patient is not a candidate for the LVES unit.

The program begins with two 1-hour preappointment telephone interviews that include four comprehensive questionnaires. The first questionnaire is the telephone interview for cognitive status to assess memory and reasoning capabilities, which helps prepare team members for the level of learning necessary for each patient. Second, the Symptom Checklist-90 is used to determine which low vision aid would be most suitable if the patient is not a candidate for the LVES unit.

Evaluation and training sessions at Johns Hopkins Wilmer Eye Institute cost about $1600 and usually take place over 2 to 3 days. First, patients become oriented to the features and operation of the LVES unit. Then patients learn and practice how to read, write, and perform functional tasks such as cooking, working on hobbies, caring for themselves, and doing schoolwork with the LVES unit prescribed specifically for them. But the program does not stop there. Once the patient returns home, telephone interviews are made 2 and 4 weeks after the visit to assess personal progress with the system. In addition, at 2, 6, and 12 months after the visit, the telephone questionnaires of the Symptom Checklist-90, Sickness Impact Profile, and Activity Inventory are administered, and rehabilitation progress is evaluated again.

Improvements to LVES
In October 1995, Visionics released a new and improved version of LVES. This model adapts two user recommendations, which are an autofocus capability designed especially for patients with macular degeneration and an improved head mounting system to better distribute the weight of the device on the head. (John Lampland, Visionics Communications Manager, personal communication, October 4, 1995.)

Clearly, LVES is not for everyone with low vision. For some, it can be claustrophobic, cumbersome, a little difficult for...
elderly people to become accustomed to, and cost-prohibitive (around $5200 for the original device, now being phased out, and $5795 for the updated autofocus system). However, it certainly is promising and has revolutionized the way in which low-vision aids will be developed in the future.

The Magni-Cam system

Another high-technology device that may be simpler and easier to use for a greater number of patients is the Magni-Cam system (Innoventions, Inc.). Originally introduced in 1990 for patients with macular degeneration, it is a 7-ounce handheld electronic magnifier that scans reading material and plugs into any television set, which serves as a monitor for the magnified image. The magnification power is variable, depending on the size of the TV screen. At its maximum setting, magnification can be up to twice the size of the TV screen. It is capable of contrast enhancement and reverse polarity, and it is always in focus, thanks to a patented technology. Because of their flexibility, thousands of these cameras have been sold.

In 1994, the unit was made portable for use in circumstances when a TV set is not readily available. A 6-inch liquid crystal display monitor weighing less than 2 pounds presents magnification power of 5x to 25x at a typical viewing distance of 12 inches. The rechargeable battery lasts for approximately 3 hours, and the unit has an automatic shut-off function built in to help preserve the battery life. Batteries can be recharged in about 5 hours. AC power can also be used when available. At an affordable price of $695 for the Magni-Cam camera, or $2300 for the portable system, this device remains quite popular.

Head mount system

In October 1995, a Magni-Cam head mount system was introduced. The Magni-Cam camera is disconnected from the TV, and a thin wire connects the headset to a microprocessor, computer, and battery in a hip pack (Figure 3). Looking similar to a pair of wraparound UV sunglasses, it allows patients to use the unit while out and about (enabling them to read labels while grocery shopping, menus while dining out, papers in the office, or homework at school). It does not take over the patient’s entire field of view, thereby allowing users to have a spatial relationship to things around them. When the patient glances upward, the unit moves into the line of sight and the image appears in front of the eyes, appearing the size of a 20-inch screen at a distance of 3 feet (Figure 4).

Who can use the Magni-Cam headset

No fit is necessary; this headset fits over anyone’s glasses and will be successful 80% of the time for users with low vision. After a trial session, patients know immediately whether the unit will be beneficial for them. The beauty of this system is best summed up by Tom Winter, Vice President of Marketing at Innoventions, Inc.: “There are no lessons or courses necessary. It either works or it doesn’t” (personal communication, October 30, 1995). At $2500, it appears to be a viable option for those willing to give it a try.

With the introduction of LVES and the
Magni-Cam device, the high technology of today moves low vision from the dark ages light years ahead.

References

Bibliography
Dreyfack K. Running shoes make a leap into the space age. Business Week 1987 Jan 19;70.

For more information on these high-tech systems for low vision, contact the following businesses:

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