3. A mechanism that will use the pulses from the transducer for stimulating the "visual areas" of the brain.

The first component can be accomplished by applying routine technologies and hardware already developed by NASA. Obviously, devices capable of scanning the Martian surface from several thousands miles and producing adequate signals for later transmission to the earth over a distance of many million miles are readily adaptable for such a component. The Technology Utilization Program of NASA is available as a resource. (8)

Formidable Neuro-physical Difficulty

Specifications for the hardware for the second component are still a matter of some conjecture. However, technologies are nearly refined for producing information storage devices with capacities for staggering amounts of information and which seem to have the capabilities desired. Among these devices are the ferrite memories such as the IBM Flute for which fabrication methods are in final stages of dovelopment. (9) It has been estimated that in some of these systems it will be possible to store 250 billion digits of information in a volume of seven cubic inches with mocrosecond retrieval. The adaptability of such ferrite memories in a transducer component seems eminently practical.

The problem with the third component is, of course, one of the more formidable as has been indicated in many references already cited. The problem, essentially neuro-physiological rather than technical, involves the connection of artificial organs to body parts. Some efforts in which attempts have been made to implant materials in the brain have been far from successful. Thus, this approach does not seem currently to be the most practical solution.

Some research efforts about which there is little publicity involve the stimulation of the nervous system by means of electronmagnetic induction. The application of such principles might eliminate the need for implantation and connecting artificial and regular body parts. However, in order to apply such a principle for stimulating vision, much needs to be learned about the mechanisms by which visual imagery is produced in the brain. There is no reason, however, to assume that such information is illusive and its acquisition insuperable. Neither is there evidence that its acquisition will require vastly different avenues of neurophysiological research than are now being employed.

Need for Great Caution

Before making any recommendations for proceeding with "Project Big Think" in a major research effort to develop substitute sight, *the writer wants to emphasize the need for the greatest amount of caution.* Under no circumstances should any statements in this article be used as support for diminishing efforts in improving current techniques of orientation and mobility, whether such efforts involve dogs, the long cane, or ultrasonics.

If the efforts in developing some system of substitute sight are successful, it is likely that the pioneer devices will be crude and at best will serve only a few of the blind population. It is also reasonable to expect that the entire blind population may not be served, even if more sophisticated systems emerge.

It is likely also that medical services necessary for compromising the device-man interface will be relatively sparse, and that for some time only a few of the blind who are anticipating prosthesis can be accommodated. Thus, efforts in improving and disseminating present techniques for orientation and mobility, however mundane they may seem, also must be accelerated.

$100 Million Per Year Is Trivial

Obviously, several steps are needed if efforts for marshaling talent and technology are to be successful. One of the most important involves appropriate publicity, which will lead to adequate funding.

The funding must obviously be at the Federal level and should constitute a commitment of at least $1 billion over ten years. A commitment of $100 million per year, however, is trivial. When one considers the U.S. population of nearly two hundred million persons, any one of whom has a chance to be blind, a gamble of fifty cents per year per head for a system of "substitute sight" is "small potatoes" indeed. This point must be brought to the attention of those at the "decision-making" level both from a mundane pecuniary viewpoint, as well as from one of social conscience. This matter, however, can be debated later.

Most important, the very best brains in the fields relevant to such a system must be recruited without regard for cost. Their talents must be directed toward the various unsolved aspects of the problem, which are identified by a thorough systems analysis and attacked through systems engineering.