the major unsolved problem lies entirely within the domain of physiology. A similar comment from another engineer indicates that the engineering knowledge is much farther ahead than the physiological knowledge. However, he believes that we should immediately get to work on the application of the latest engineering techniques to develop visual replacements while waiting for the physiologists to learn more about the operation of the human brain.

One scientist indicates that research has been conducted for several years in his laboratory on the conditioning of animals to electrical stimulation introduced directly into various brain regions. In addition to the theoretical interest of these studies with respect to information processing methods of the brain, they are concerned with the practical possibilities for sensory prosthetic devices. In his judgment there is already physical evidence that information can be directly introduced into the brain, but currently there is inadequate evidence to evaluate the information handling capacity of such as input channel. However, he believes that such stimulation, under specific conditions, could replace some of the qualities of normal sensation, but he hesitates to speculate how good this reproduction might be.

One of the more optimistic indicates that he is convinced, from a technical point of view, that the creation of an "artificial eye" is sufficiently feasible at this time to warrant serious research efforts for its development. The image pickup, signal conditioning and filtering aspects of the problem are well within the current state of the engineering art. He believes that the application of microelectronics and solar power supplies to current technology could result in a substitute eye that would produce a signal similar to that which enters the optic nerve.

From these comments plus the information provided in many other sources, one may evidence cautious optimism about the likelihood of developing an artificial eye. Optimistic statements have been made by some scientists, although the pessimistic comments of others cannot be disregarded. Yet the expressed pessimism has emerged in the light of minimal level funding with little or no organized systems analysis of the types of information needed and the research that should be undertaken.

Thus there is reason to believe that an organized major effort, adequately funded, involving both systems analysis and systems engineering, *might* result in the development of artificial sight within the lifetimes of many who are now blind. It is, of course, impossible to compare the magnitude of such an effort with that of the present space program. Such a comparison cannot be made until a sustained effort analogous to that of the space program has been undertaken.

Prospects for Hardware and Technology

Obviously, any group of devices which together provide artificial sight must meet certain practical limitations. Among these are portability, comfort and economy. Fortunately, electronic circuitry that contains a full complement of transistors, resistors, capacitors and other essential components and, yet occupies less space than a pinhead, is now regularly produced on the assembly lines of electronic manufacturers. In a recent article by Hittinger and Sparks (7) this information appeared:

"Between 1955 and 1965 the electronics industry developed and reduced to practice a remarkable microelectronic technology that has shrunk transistors and other circuit elements to dimensions almost invisible to the human eye. A complete circuit consisting of 10 to 20 transistors and 40 to 60 resistors can be built into a bit of silicon measuring only about a twentieth of an inch on a side. Between 100 and 500 such 'integrated' circuits can be manufactured simultaneously on a silicon wafer that is about an inch in diameter and less than a hundredth of an inch thick . . . With the new microelectronic technology it is hardly more costly to put 100 circuit elements on a single chip of silicon than it is to put one, 10 or 50. Moreover, the 100 elements can then be handled as a unit when the final system is being assembled. Whereas a good transistor cost about $1 as an individual unit in 1960, an integrated circuit containing several dozen transistors and other elements can now be bought for about the same price."

Thus, the routine requirements of portability and economy, and in all likelihood comfort, have been met.

In a system for substitute sight three major components must be included:

1. A scanning "device" that will convert light into electric current.
2. An "organizing device" that may temporarily store the electrical energy and serve as a transducer to produce electrical impulses.