Engineering — Hope of the Handless

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THE human hand, with its elaborate control system centered in the brain, is doubtless the most widely versatile machine that has ever existed anywhere. Its notorious deficiency lies in its persistent inability to create a similar machine as versatile as itself. This circumstance accounts for the fact that, while there has been from earliest times a great need for hand replacements, all attempts to produce successful hand substitutes have thus far ended in only a rather crude imitation of a very few of the many attributes of the living counterpart. For want of complete knowledge of the natural hand-brain complex, and of the ingenuity requisite even to the most modest simulation of the normal hand, artificial hands have always resembled the natural model in a superficial way only. Voltaire is said to have remarked that Newton, with all his science, did not know how his own hand functioned.

But the science of Newton, basic as it was, is itself remote from the advanced technology of our own day. Failure in hand prosthetics, though owing in part to the difficulty of replacing any living organ with an inanimate contrivance, stems also in part from failure to apply intensively the principles of modern science generally, and of engineering in particular, to the problems of artificial-hand design. Because in general the engineering profession had not theretofore been much concerned with the development of improved artificial limbs, the hand prostheses available a decade ago represented no appreciable improvement over those to be had at the end of World War I.

In all fields of human endeavor, the problems for which men have found tentative solutions in the past often merit the attention of the engineer of today. A new look by competent technologists usually yields gratifying results, for the solutions found by our forebears, while seemingly adequate at the time, do not reflect the progress made in the development of methods of experimental analysis, in the measurement of behavioral characteristics, in the establishment of criteria, in the development of materials, and in the evolution of forming techniques for application of the materials to the needs of man. Just so in the

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field of prosthetics, where the problem of matching a device to the human system is particularly acute and where, consequently, the application of new methods holds special promise.

Perhaps the most compelling reason today for the importance of engineering in prosthetics research lies in the approach and methodology now implicit in the profession. Introduction of the requirements of man in a quantitative manner without neglect of the qualitative, subjective aspects places design on a rational basis for the first time in history. During World War II there arose the problem of designing numerous complicated systems to be operable within the limits of human capabilities. In that urgent work, a substantial number of engineers had occasion to become acquainted with certain important physiological and psychological characteristics of man, so that by the end of the war the stage was set for the impact of the engineering profession on the development of prosthetic devices, which is, after all, a unique and particularly challenging field of biomechanics.

When, therefore, in 1945, the then Committee on Prosthetic Devices undertook to conduct basic studies toward the provision of better hand substitutes, it enlisted the services of engineers to cooperate with the medical profession and others in developing the necessary data and in applying the results to improved hand design. In the Artificial Limb Program, principal responsibility for the development of improved hand substitutes has almost from the beginning resided with the Department of Engineering at the University of California, Los Angeles Campus, and with the Army Prosthetics Research Laboratory, Walter Reed Army Medical Center. Out of this cooperative effort have now come not only new and improved devices but also, and perhaps more important, a set of criteria which lay down the basic principles of hand design toward further improvements in the future.

Because of the importance of the hand in all human activities, because of the critical nature of adequate hand replacement in the rehabilitation of upper-extremity amputees, and also because of the rather striking advances that have been made in the design of artificial hands in recent years, this issue of ARTIFICIAL LIMBS is devoted entirely to a little symposium on the hand and its substitutes. The mutual cooperation of the several contributors toward a unified approach to the whole subject is typical of the cooperation that has characterized the Artificial Limb Program since its inception.

The work in prosthetics will, it is to be hoped, serve as a pattern for further investigations jointly by the medical and engineering professions wherever developments in materials, controls, and systems in general can be brought to bear to augment human functions which an individual can himself no longer provide. One continuing problem is that of convincing able young people now studying engineering that a satisfying future exists for them in such cooperative ventures with the medical profession designed to rehabilitate the less fortunate throughout the world. Those now engaged in prosthetics development can be

of great help in presenting to these young men and women the perspective of the future in such a manner that fresh engineering graduates might elect to carry forward the work now already so well under way.

Finally, it ought to be noted that, despite the distinct accomplishments evident at this, the tenth anniversary of the establishment of the Artificial Limb Program, only the first faltering steps have been taken toward the "ideal" prosthetic hand. Structural elements and prehensile function are not enough. It remains to provide some reasonable substitute for the sensory-motor apparatus which, in the living hand, is of such consummate perfection as to beggar description. A problem like this should charge the imagination of any young engineer in search of a field of application for service. To him belongs the future in prosthetics research.