Limbs in Limbo

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To stand on his feet and to walk with his legs wherever his heart desires are natural rights guaranteed to man by his own constitution. Heads may plan and hands may build, but only where legs and feet have brought them. Loss of the lower limb is therefore a major catastrophe.

When loss of leg occurs, replacement becomes the primary hope. Ages past, an unknown man hobbled forth from his cave in search of a willow; with one of its limbs adopted as his own, he walked back with majesty. Since then the stage of history has resounded with the staccato echo of countless amputees marching with peg-leg, grit, and gumption.

Rapid perfection of limb construction was to be anticipated after these early ventures had focused human ingenuity upon the problem. To the superlative talent which mankind has shown in the production of machinery both intricate and sturdy, the building of a mechanical leg would appear to offer little difficulty. Why is it, then, that artificial limbs have so generally belonged to the limbo of things undeserving either of unstinted praise or of utter condemnation?

Failure of artificial legs to satisfy our hopes results less from the imperfection of their mechanisms than from the extravagance of our expectations. People who do not expect a glass eye to see or a prosthetic hand to play the piccolo are disappointed when an artificial leg squeaks while dancing the polka. Man has never commanded clear appreciation of his means of locomotion. From time to time he has been ecstatic about the eye and the liver, the heart, the brain, the hand. Legs have been referred to most frequently as symbols of neighboring functions, so lightly have their own merits been regarded.

Why is the performance of the lower extremity so much less spectacular than that of the upper? Independence of the upper limb from obligation to the rest of the body allows it to indulge in ornamentation of movement, so impressive to the eye. The lower limb, sandwiched between the ground and the torso, must ever be responsive to the needs of the body as a whole. It cannot choose to support some parts of the body and not others or to walk with the body through only portions of each step. The intricacy of function of knee and ankle does not

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exhibit itself in capricious movements but excels when it modulates countless disturbing factors so that no tremor mars the stark simplicity of normal locomotion.

No one can rightly expect an artificial limb to take over completely the functions of its predecessor unless it is endowed with an equivalent of muscular and nervous control. Difficult as it is to provide substitutes for bones and joints, such provision is simplicity itself compared with the incorporation within the prosthesis of its own control. Although considerable progress has been made in the field of decelerating mechanisms for lower-extremity prostheses, the leg amputee must still use his own resources when he needs to supply energy or to exercise discretion.

The contribution which the amputee makes to the over-all prosthetic result far exceeds that of acting as a model for exhibiting the achievements of inventors. It is he who must finish creation of the new locomotor mechanism by reshaping the pattern of his muscular activity and establishing alertness to new sensory cues. The success of the artificial leg depends on how thoroughly it becomes a part of the form and the function of the amputee after he has blended its metal, wood, and plastic with his muscle and perception. It is only appropriate that the new mechanism, having superseded the natural limb, should contribute to amputee gait that special accent which identifies the supernatural walk.

The complexity of human motion makes it inevitable that fundamental improvement in leg prostheses must come slowly, since it is based on factors so numerous that no one individual can comprehend them all. In addition to the profession of engineering, there is needed the cooperation of the physician, the physicist, the physiologist, the physiotherapist, the prosthetist, and the psychologist—to list them in alphabetical order—so that the patient may get the total care he deserves.

The problems which need attention are of different degrees of complexity and must be approached by different methods. Choice of materials, details of construction, and provisions for repair require less consideration of the over-all characteristics expected in the rehabilitated amputee than do problems of fit and socket shape. More general considerations must be weighed in projects concerned with alignment, basic design of mechanisms, and evaluation of performance. For these there should be a conscious choice of a realizable objective, the attainment of which requires integration of man and machine into a functional unit.

All of these are practical problems amenable to increasingly useful solutions year by year, provided we do not surrender to the impatience of those who must have the answer to the question of the century today and of the millennium tomorrow. It is necessary to preserve clear vision of long-term objectives, although some members of every team find the environment more familiar when details arise.

Had trial-and-error and serendipity been able to produce truly satisfactory lower limbs, we would not still be waiting for such. It was left for the National Academy of Sciences—National Research Council to initiate the development of artificial limbs on a modern basis by creating the Committee on Prosthetic Devices and, later, its successor, the Advisory Committee on Artificial Limbs. By carefully balancing the fundamental and the practical in their program, these Committees have laid a firm basis for some progress today, much more tomorrow.

This is the key to the future in lower-extremity prosthetics. Used wisely, it will allow us eventually to rescue the limb problem from limbo and to provide the amputee of the future with a fitting legacy.