ABSTRACT OF SUMMARY REPORT ON RESEARCH AND DEVELOPMENT IN THE FIELD OF ARTIFICIAL LIMBS (July 1973)[a]

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At the end of the contract year, close to 2,600 *Swing and Stance Control Systems* had been distributed by the Veterans Administration and Mauch Laboratories, This extensive distribution proves the need for this type of above-knee control system as well as the acceptance of Mauch Laboratories' design. Nevertheless, the intensive effort toward further improving the function and extending the maintenance-free life of the S–N–S system has been continued throughout the contract year. This effort led to a total of eight additional design changes and improvements.

The most important design change is the so-called air-bleeding feature which prevents air from accumulating in the swing-control part of the hydraulic system, where it could cause a swishing noise. This design change, which has been applied to all production and repair systems since November 22, 1972, utilizes the walking motions to produce automatic elimination of air from the hydraulic working spaces inside the unit. It has also the desirable effect that any abrasive particles that may be produced inside the swing-control portion of the system do not stay there but are deposited in the bottom of the cylinder where they can do no harm.

This feature was further improved in June by making the air bleeding dependent on the bending speed of the knee joint at the initiation of the swing phase. This so-called *dynamic* air bleeding prevents the inadvertent transfer of air into the hydraulic working spaces during certain infrequent modes of usage such as kneeling, etc., which was possible previously.

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[a] Based on work performed under VA Contract V101(134)P–67. For a copy of the complete report, write to: Editor, Bulletin of Prosthetics Research, Research Center for Prosthetics, VA, 252 Seventh Avenue, New York, N.Y. 10001.

The remainder of the improvements resulted in:

1. the prevention of internal leaks in two places,
2. the reduction of wear in one place,
3. the reduction of mechanical friction during the swing phase,
4. the prevention of fatigue fractures of the piston rod bolt,
5. a design simplification for cost reduction.

There is already clear evidence that these measures are having the desired effect. However, it is too early to judge how close Mauch Laboratories is to its goal of an initial maintenance-free life span of 2 years, because it takes considerable time to arrive at such a statistical conclusion from observing the maintenance, updating, and repair flow of the systems put in use over a period of several years.

However, confidence is such in the effectiveness of these improvements that it was decided to increase the guarantee period for the S–N–S system from the former 6 months to 12 months beginning May 1, 1973.

Shake-down testing of the *Hydraulic Ankle Control Unit* by VAPC in New York continued throughout most of the contract year. The testing had to be interrupted several times due to minor malfunctions involving mainly the attachment of the hydraulic unit to the foot. One malfunction was caused by the fracture of a lever inside the hydraulic unit. All these malfunctions concerned parts which will be eliminated or modified by the redesign mentioned in last year's Summary Report.

The last uninterrupted wear period extended over 4-1/2 months and was terminated on June 22nd due to an oil leak which cannot happen in the redesigned unit. Disassembly and inspection of the unit yielded the gratifying result that no significant wear had taken place in the 4-1/2 months of rather intensive usage. Specifically, the design features which will be retained in the modified design proved to be entirely satisfactory. This finding gives the modified design a much firmer foundation. Since no further significant findings could be expected from this stage of test wearing, it was discontinued.

Work on the design of the modified ankle had already started during the shake-down testing and includes the following features:

a. Hydraulic System Proper: As mentioned in past reports, the 5 deg. forward motion of the shank to initiate the dorsiflexion stop will be eliminated, and the stop will now be produced solely by the application of the amputee's weight onto the ankle unit.

b. Foot Attachment and Eversion/Inversion: The control principle for eversion/inversion will be changed. There will no longer be motions in both the eversion and inversion directions nor a friction effect to hold the foot in a laterally slanted position. Instead, the eversion will be blocked to provide stability in the lateral direction,

but inversion will be permitted against a moderate elastically yielding resistance. The unit will be attached to the foot by two vertical screws, one each in front and in the rear of the unit. The prosthetist can vary the toe pick-up by rearranging leather washers located on the two screws.

c. Shank Attachment and Transverse Rotation Control: The anterior/posterior adjustability of the top end of the vane piston rod inside the shank will be eliminated. This will permit the installation of the ankle system in standard small diameter pylons (down to 1 in. i.d.). The prosthetist will be able either to block or to permit transverse rotation by rearranging or exchanging rubber elements located around the top of the vane piston rod.

The new design of the unit and its attachment to the foot and shank is much simpler, less expensive, less prone to noise, easier to install, and probably more durable and maintenance-free than the previous design, without loss of significant functional features.

Work will now be concentrated on the completion of the redesign and the building of a few prototypes of the modified unit.

Work on the prototype of the *Voluntarily Actuated Swing and Stance Control Unit* has been continued on a low priority basis due to other more important work load. The use of a small speaker coil for the combined hardness sensing probe and feedback stimulator was studied. The use of such a device appears promising because it would be less expensive and would give a better signal than the electromagnetic device considered so far.