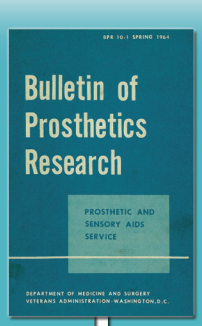

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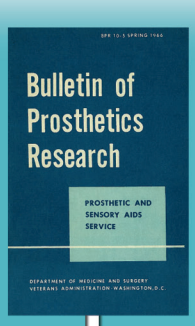

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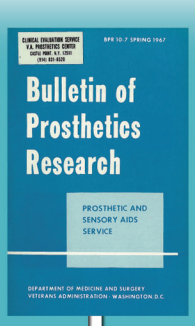

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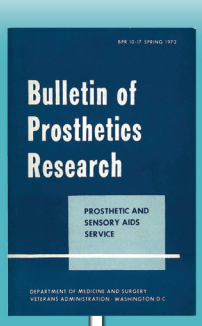

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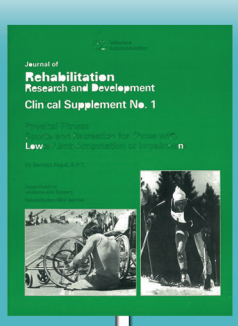

1985

1990

1994

THEN & NOW

2001

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Bulletin of Prosthetics Research
PROSTHETIC AND SENSORY AIDS SERVICE
BPR 10-1, 1964

THE SWING PHASE OF WALKING WITH ABOVE-KNEE PROSTHESES

EUGENE F. MURPHY, PHD

After many years of development, fluid control of the swing phase of walking now exists in commercially available above-knee prostheses, and other models soon should pass the experimental stage. The purpose of this review of historic and modern principles for control of artificial knee joints during swing phase is to assist the professions concerned with amputee rehabilitation to provide these new devices, not only for appropriate disabled veterans but also for all others who may be able to use them effectively. The two papers following this discuss principles of mechanical and fluid friction, specific mechanisms, and recent clinical application studies (1, 2).

Fluid-controlled mechanisms for the *stance* phase are also to be expected. At least one example, the Henschke-Mauch Model A "Hydraulik" Swing-and-stance Control System, is at an advanced stage of evaluation. A subsequent issue of the Bulletin will consider this portion of gait.

FLUIDS

Fluid-controlled mechanisms make use in varying degrees of several key properties of fluids. Pressure at any point in a fluid is transmitted to all other points. Pressure at any point in a fluid is transmitted to all other points. A liquid is incompressible, for all practical purposes, within the range of pressure used in prosthetics. Thus, it can transmit energy or control signals from point to point, as in hydraulic brakes on an automobile, and can return reactions, as from a spring-loaded reservoir piston. A liquid also resists shearing forces as one layer of fluid slides over another. During oozing and slow "viscous" flow, this sliding occurs in an orderly fashion like cards in a deck; during more rapid "turbulent" flow, random whirlpool-like motions result. Another key feature of fluids is that resistance to flow increases rapidly as the flow rate increases, as we all know from experience with door closers. These properties are discussed in detail in the next paper "Properties of Fluid Flow Applied to Above-Knee Prostheses" (1).

Air and other gases can be considered fluids if they are subjected to only small changes in pressure. Generally, however, a pneumatic artificial knee control may be subjected to considerable changes in air pressure so that the compressed air behaves like the air springs supporting buses, yet also to such small pressure changes that leakage of air through a control valve follows to a considerable extent the rule of rapid increase in resistance for a small increase in speed of flow.

To continue reading, please visit http://www.rehab.research.va.gov/jour/64/1/1/5.pdf.

JRRD Volume 50 • Number 9 • 2013

COMMENTARY ON "THE SWING PHASE OF WALKING WITH ABOVE-KNEE PROSTHESES" BY DR. EUGENE F. MURPHY

STEFANIA FATONE, PHD, BPO(HONS)

Dr. Eugene Murphy's tour de force article provided a detailed and well-illustrated description of the various prosthetic knee mechanisms in use or in development in 1964 along with an understanding of the locomotor functions required of prosthetic knees based on the formidable gait analysis work of his compatriots Drs. Inman and Eberhart (p. 6–10). Fluid control remains a major component of current commercially available prosthetic knee joint technology, with major technological gains in the control of hydraulic resistance and the ability to do so throughout the gait cycle rather than just in swing phase, as described by Dr. Murphy.

While our technology has evolved, Dr. Murphy's insights about gait and the needs of the person with lower-limb amputation continue to ring true. The prosthetic knees in use and in development today try to more fully match the function of muscles that Dr. Murphy so aptly described as "brakes and motors" (p. 8), allowing not only for swing phase control as discussed by Dr. Murphy, but also improved function during stance and other mobility tasks. While many of the challenges faced by persons with transfemoral amputation have been resolved by commonplace use of hydraulic mechanisms and, in particular, microprocessor-controlled knees, some of the very same problems mentioned by Dr. Murphy, e.g., slower than normal walking speed, increased oxygen cost, and the high incidence of stumbles and falls, remain a focus of our research efforts to help improve the mobility of people living with transfemoral amputation.

Dr. Murphy presaged our ongoing challenges of simulating "the active functions of muscles as motors" (p. 9) and providing sensory feedback (p. 12). Powered prosthetic knees have recently emerged as commercial products. In these devices, sensors work through a microprocessor to control the actuation of a motor that can provide the active torque needed to perform functions like climbing stairs step over step or negotiating slopes with ease. More powered technology is on the horizon, with researchers integrating powered knee and ankle function and adding control input from residual-limb muscles. With such technologies in sight, perhaps we're closer than ever to answering Dr. Murphy's challenge of providing as much, if not more, sensory feedback than a peg leg!

http://dx.doi.org/10.1682/JRRD.2013.03.0069