Paraphrasing Dr. Robert Bennett, former Director of The Georgia Warm Springs Foundation, the ideal orthosis is one which replaces function, is weightless, invisible, and costs nothing. While it is impossible to produce orthoses at no cost, it is conceivable that replacement of functional loss with an orthosis which weighs little and is virtually invisible is potentially possible. The actual design of such an orthosis appears to be a long way off, given the history and difficulty to achieve such an “ideal.”

Historically, orthotics has been the stepchild to prosthetics. Prosthetics has a more dramatic, perhaps glamorous appeal to clinicians and designers than orthotics, because of the far greater technical problems encountered in the design of orthotic devices. It is relatively less complex to provide prosthetic limb movements, as space is available in the limb to house power, actuator, and control systems. To provide similar movements in paralyzed limbs, one would need to place actuator and control systems exoskeletally. This increases weight and bulk of the limb substantially and places greater demands on power and actuator systems. In orthotics, the need and challenge to restore function is far greater than in prosthetics because of the nearly infinite permutations of problems in various pathologic conditions affecting limb movements. The realization of these design problems perhaps accounts for the relative dearth of research proposals submitted to the U.S. Department of Veterans Affairs Rehabilitation Research and Development Service over the past number of years.

For centuries, little progress had been made in bracing until the application of modern plastic materials. Everyone remembers the cumbersome caliper braces worn by President Franklin D. Roosevelt in the 1930s and 1940s. This and similar types of braces were not beginning to be replaced until the 1970s. Ankle-Foot-Orthoses (AFOs), made from lightweight laminates or thermoplastics, were first reported in the late 1960s. By that time, the term orthotics had been well established. Ortho is derived from the Greek orthos, the adjective meaning “straight.” The suffix “ics” suggests the art or science of the root of the word. There were, nevertheless, earlier proponents of the word “orthotics” as it matches the sound of the long-established word “prosthetics.”

Unlike bracing, which is defined as providing rigidity to unstable structures, orthotics embraces a broader spectrum of devices, including those that provide movement (e.g., electrically-driven prehension orthoses for quadriplegic patients). The state of the art of orthotics has been greatly influenced by the application of various modern plastic materials, resulting in more cosmetic, less bulky, lighter weight, and often more functional devices. AFOs are routinely made of plastics, or a combination of plastics, for dynamic response utilizing the effects of gravity to store energy (i.e., to convert potential energy to
kinetic energy), for example, posterior leaf spring or spiral AFO. This is possible through proper design of the material used. Selective reinforcement of the orthosis with graphite fibers can provide control of ankle movement in prescribed ranges and directions, including torsional (transverse) pathomechanical conditions.

Similar or motorized designs to provide knee and hip movement do not exist at this time, hence the function of Knee-Ankle-Foot Orthoses (KAFOs) has not been improved in the present state of the art. Ongoing research in functional electrical stimulation (FES), however, may lead to functional improvement at the clinical level for a selected patient population in due time.

While the function of conventional KAFOs has not changed, the application of plastic materials has reduced the bulk and weight and improved cosmesis of orthoses. In children, the availability of various color choices (i.e., neon and pastel colors to allow matching and mixing of colors) by the child has proved to enhance acceptance of orthoses.

Other than the application of modern plastics to orthotic designs, there has been no real breakthrough in many years. One wonders whether there is a lack of interest because of the great challenge posed by orthotics. Yet, the need remains to improve the quality of life of the physically challenged in this particular area.

Returning to Dr. Bennett’s “ideal” orthosis, it seems that FES offers a real potential, if combined with modern orthotics, to improve the functional capacity of at least the spinal cord injured patient. Although much research time and funding have been spent on FES, it has not reached the clinical level of application, perhaps because the contribution of modern orthotics combined with FES has not been fully realized. The exception is the perineal nerve stimulator for hemiplegic patients, which has been commercially available for many years. It is now rarely used, perhaps because of the competition with lightweight AFOs and the nuisance of proper application and maintenance of the system by the patient to achieve good ankle-foot control. For patients with lower motor neuron disorders, one could conceive an invisible orthosis (e.g., a surgically implanted orthotic motor, consisting of an electromagnetic bladder, simulating muscle contraction). For quadriplegic patients, FES for prehension, guided by a flexor-hinge hand-wrist orthosis, myoelectrically controlled by a functioning, more proximal muscle, has already been shown to be technically feasible.

To achieve major breakthroughs and progress in these areas of improved orthotics along Dr. Bennett’s “ideal” orthosis, it would seem that research teams need to be working together closely to combine the skills of at least the physiatrist, orthopedist, orthotist, engineer, and physical and occupational therapist in a setting that emulates the progress achieved in the area of prosthetics.

H. Richard Lehneis, PhD, CPO