

# Courage, determination and Paralympians

"I was trying to climb aboard a train that was pulling out of the station when I fell. While under the train, my leg was caught in the wheels and mangled. I was flown to a nearby hospital where they had to amputate my left leg below the knee. After recovery and rehabilitation, I was back at work on a prosthesis two-and-a-half months later. I'm still able to drive my stick shift car and even ski on two legs thanks to the DeRoyall BK brace." Kevin Muller's story is typical of how it starts for amputees and paraplegics. The long road back from despair and immobility to achievements and recognition as some of the fittest, most courageous athletes on the planet. With the Paralympics in Athens just a few months away both the athletes and the equipment they wear are being tested.

Following the 'larger' Olympics, over the past 40 years it has been the honour of the home nation to host the Paralympics for the physically disabled. Not to be confused with the Special Olympics, (for athletes with mental disabilities) the Paralympics is now held for both summer and winter sports. This year in Athens the world's elite amputees and physically disabled athletes will assemble from many parts of the world to show off their running, lifting, jumping, swimming and shooting skills in 21 sports events. As courageous and determined as they are, they cannot do it alone. Making it possible for them to compete in Athens is the dedication and progress of the orthopaedic and prosthetics industry, a market segment whose achievements are relatively unsung by modern standards.

Considering the diversity of the twenty-one different sports categories under the Paralympics banner, the range of equipment required for the participating athletes can become rather demanding. Within some sports, such as track and field, there are specific classifications at different disability levels of amputation. Other sports, such as tennis or basketball, have just two

categories for wheelchair athletes and amputees. Some athletes such as swimmers or soccer players will compete without the use of a prosthetic device; however, most disabled athletes will use a modified prosthesis or orthopaedic device to improve their performance.

Wheelchair athletes, already famous for completing marathons as well as embarrassing able-bodied tennis and basketball players on court, usually strap themselves into their specially designed stabilised competition chairs. If prescribed, wheelchair athletes may use a moulded or padded body or spinal brace for support during sports activity. Atlantic Rim Brace Manufacturing Corp. in Nashua, New Hampshire, has several pre-sized braces available including moulded thermoplastic shells with  $\frac{3}{16}$ " thermaliner and a Soft Body design in latex-dipped foam. Atlantic Rim manufactures both custom and pre-sized body braces in the traditional method or with modern technology using its CAD/CAM design system. Opec in Georgia, USA, also offers a line of prefabricated



*Critical to the use of any orthopaedic device is the prosthetic socket fitting between the residual limb and the sports device. A company that has become famous for their expertise in this field is Scott Sabolich Prosthetics and Research based in Oklahoma City, USA.*

 Sabolich Prosthetics and Research

or custom fabricated spinal orthoses that must be built to fit the wearer as precisely as possible.

Usually, when a brace is prescribed for sports use, it is built for support but it must also offer the wheelchair athlete maximum comfort without restriction. Comfort Products Inc. in Croydon, Pennsylvania, makes a special body sleeve under-garment that can be worn with a full-body brace. Available in a tube or tank-top design, the body sleeve is made from 98% CoolMax and is used as an interface between the skin and brace for comfort and moisture management. Boston Brace International in Massachusetts has been very active as an innovator and educator in the field of spinal orthoses for over thirty years specialising in the treatment of scoliosis, osteoporosis and trauma-related injuries. The company said that a spinal brace should be as minimally restrictive as possible, as in a wraparound belt design or a full neck-to-lumbar orthosis with hip joint splint.

### Upper Limb Prosthetics

Paralympians rarely suffer from self-pity; in fact, they seem to be a feisty lot. Upper arm amputees still play tennis, hockey, cycle and swim. In order to hold a hockey stick or balance themselves correctly of them will wear hand, lower arm or full arm prosthesis. Three types of upper limb prosthesis have been developed for arm and hand amputees: passive function, mechanical and myoelectric. The passive function hand or arm (which is a bit of a misnomer in this instance) is the most popular for active athletes because it is the most adaptable and rugged. Hybrid upper-limb prostheses, such as the mechanical type made by Otto Bock or Kingsley, use cables and pulleys and can be battery operated. The Myoelectric Utah Arm made by Motion Control (which translates electromyography muscle signals from the residual limb to the inside of the prosthesis) may be the state-of-the-art for everyday use but it is too fragile for sports use. Several companies offer upper limb replacements, but for the active, even rugged athlete, TRS Inc., based in Boulder, Colorado, has grown to become the leading innovator of body-powered prosthetic devices in the world.

Specialising in hands only, TRS was formed in 1979 by upper limb amputee Bob Radocy, who was frustrated by the limited performance of commercially available prosthetics devices. Bob lost his left hand about four inches below the



*High performance hand prosthetics for archery and basketball from TRS.*



elbow in an auto accident in 1971 and started experimenting with all types of prosthetic devices while at graduate school. Using his engineering and biological sciences education and design experience, he applied this knowledge to create a high performance prehensor (to allow a grasping facility) which allowed him to be competitive with two handed peers in almost any activity he chose.

Today, TRS makes an incredible range of specialized hand prosthetics for the following sports: aerobics/dance, archery, baseball/softball, basketball, cycling, canoeing/kayaking, fishing, football/volleyball, golf, hockey, pool/billiards, skiing, swimming, weight lifting, and wind surfing. Every sport's 'hand' is unique; as an example - for basketball TRS has produced a prosthetic basketball hand that enables the wearer to display safe, fast reaction control of the ball during any dribbling, shooting and passing situation. The Re-Bound Pro is strong but flexible and it provides a unique, resilient wrist/hand and finger-like type of ball control. It perfectly matches the basketball's contour and its raised "friction discs" enhance ball handling. Weighing in at 6 ounces, its threaded, stainless steel stud fits all standard, body-powered mechanical prosthetic wrists.

For swimming the TRS prosthesis design mimics a folding wing, reducing resistance during the power stroke. The device can be rotated to optimize various swimming strokes and styles or used for aerobic exercise. Where a grip/release mechanism is required, prehensors can be modified to accept a special "locking pin" accessory which provides a reliable means of handling a piece of equipment, such as a bow for archery, a golf club or barbells in weightlifting.

### Lower Limb Prostheses

A chance water-skiing accident in 1976 turned out to be the catalyst for a revolution in the field of lower limb

prosthetics, where innovation was badly needed. The loss of his foot just above the ankle transformed an active young American sportsman, Van Phillips - then a 21 year-old student in Arizona - into a frustrated amputee. Quickly determining that the existing prosthetic feet offered in the seventies were inadequate, young Van Phillips teamed up with Dale Abildskov, an aerospace composite engineer, while working at the University of Utah in 1982. Using carbon fibre material, well known in the aerospace industry for its superior strength and flexible properties, they developed an L-shaped foot attached to a sole below and a prosthetic socket above. When weight was applied by landing on the heel, it was converted into energy that literally put spring into the step, simulating the spring action of the normal foot and allowing the wearer to run and jump. The Flex-Foot concept was born in 1984 and demand for the new foot soared as active amputees across America became aware of its incredible spring and energy return features. Today more than 90 percent of amputee athletes worldwide wear some model of the basic Flex-Foot. Its widespread availability has given amputees the opportunity to run, jump and compete at a new level in the Paralympics.

Össur, an Icelandic company, now produces the carbon fibre Flex-Foot, which has been further improved to simulate natural biomechanical functions such as a shock absorbing heel, active tibial progression, full-length toe lever, proportional response, vertical shock pylon and torsional rotation. It's no wonder that Shea Cowart, Paralympic champion sprinter at 100 and 200 meters can cover the distance at a remarkable 13.68 seconds for 100 meters and 29.64 seconds for 200 meters (T-43 Double leg below the knee amputee Classification). Leading amputee runners like Shea Cowart and Marlon Shirley attach a spike plate (cut from a track shoe) directly to a

carbon fibre custom foot rather than wear a mechanical and prosthetic foot inside a shoe. The women's world record for a qualified Paralympic sprinter at 100 meters is held by Purificacion Santamarta from Spain at 12.33 seconds (T-11 classification) and Adjibola Adeoye from Nigeria in the men's 100 meters (T-20 Classification) in 10.72 seconds. Össur makes three types of Flex-Foot designs. The Cheetah, which is preferred as a transtibial sprinting foot, the Flex-Sprint - recommended for transfemoral amputees - and the C-Sprint custom foot model for distance running. Otto Bock also has a carbon fibre foot called 'Sprinter', which is custom made for the serious track and athlete. It is extremely lightweight with double contoured toe for high propulsion and decreased drag.

Otto Bock is a progressive company with offices in Germany, USA and Canada, that manufactures performance lower limb prosthetics for the Paralympic class athlete. In addition to the 'Sprinter' mentioned in the previous paragraph, the 'Gold Medal' foot is designed for amputees with higher body weights to perform at high activity levels with more stability. It comes with three removable plugs to provide different stiffness adjustments. The "Gold Medal" lower leg and foot device can be used either with a silicone prosthetic cover inside a sports shoe, as in basketball or tennis, or it can be used directly in a specialised sports boot such as an ice-hockey style.

The company also concerns itself in the fabrication of silicone partial foot prostheses that, when placed over the amputation, can function extremely well inside a sports shoe. Inside a soccer boot or similar specialised footwear, partial foot prosthesis cannot be detected and function to give the foot balance and stability. Ron Mann, a mixed martial arts champion on the regular KickBoxing circuit, uses the Venture foot made by College Park Industries in Fraser, Michigan. The Renegade prosthetic foot from Freedom Innovations features an industry first all-carbon fibre shock pylon. This unique design allows maximum shock absorption during vertical loading in an ultra-light weight design. Additionally, Freedom Innovations has launched the Ski Foot, which facilitates direct linkage to a ski binding and eliminates the need for a ski boot. This can be considered an advantage for the amputee not to have to wear a ski boot with the additional weight it represents and the significant limitations on movement it imposes.



 Otto Bock

The aim of a prosthetic device is to imitate the function of the human body as closely as possible, but unless it is comfortable to wear, it loses much of its intended effect. The interface material used between the residual limb and the prosthetic device is both crucial for fitting and as a comfort component to enable the athlete to perform at his or her optimal level. Fortunately, there is a vast array of sleeves, socks and interface materials from which to choose. Prosthetic socks, such as those produced by Royal Knit in Lee's Summit (Kansas City) come in a variety of materials and designs to fit specific amputations and orthotic devices. Royal Knit's prosthetic seamless socks contain CoolMax to help with moisture management and Lycra stretch for conformity. Kingsley, another big name in prosthetic supplies, makes the Knit-Rite "Hole-In-One" sock range offering the amputee a range of thickness, from sheath to six-ply, which allows precise fit adjustments. Kingsley's "Hole-In-Toe" prosthetic sock is made with a distal hole especially for use with pin suspension mechanisms. The knit construction eliminates the need for cutting the sock, helps prevent unravelling and adds little or no

additional distal thickness.

Silipos, the leader in gel technologies in the medical field, has introduced a new reinforced version of its popular Explorer Suspension Sleeve that offers enhanced flexibility and freedom of movement for below-knee transfemoral amputees. Fabricated from the Silipos proprietary medical-grade Tri-Block Polymer Mineral Oil Gel, the Explorer Reinforced Suspension Sleeve incorporates an inner flexible band of fabric for additional durability, resistance to shear forces and abrasion. The reinforced sleeves are recommended for all activity levels and are designed to easily flex at the knee joint without constriction and without impeding range of motion.

After three years of research and development, Ohio Willow Wood has introduced the Alpha AK Liner for above knee amputee comfort. This completely new concept incorporates:

- A customized gel pattern for added comfort, eliminating the need to build padding into the socket. The gel pattern protects the often-tender lateral side near the femur and at the distal end, while thinning dramatically proximally.
- A unique Alpha AK Liner fabric, which provides flexibility and allows easier donning and doffing of the liner, plus enhanced comfort.
- A selection of sizes especially designed with the variety of shapes in mind.

There are several other companies offering complete ranges of prosthetic liners and sleeves for amputees. One such is Alps Products in St. Petersburg, Florida that list an impressive chronological string of industry firsts in silicone valve-integrated sleeves and liners. The diversity of the Össur company, with its brand name Icecross, is evident in the production of silicone liners under the brand-name SenSil, a medical grade silicone material, and their newest introduction, DermoGel, an exceptionally durable silicone gel.

Whether it's an orthopaedic dynamic splint, spinal brace, mechanical foot, prosthetic arm or sports specific hand attachment, there seems to be something unique built for the disabled athlete in every sport. Moreover, if it's not available today, the dynamic industry's enthusiasm, drive and innovation will make it a reality for the Paralympic athlete of tomorrow. When it comes to sports equipment for the world's leading disabled athletes one can honestly say they are not at a disadvantage. 

*Mel Cheskin*