Evolving technology in prosthetics is improving the life of physically challenged people. Many health care professionals who work with physically challenged patients believe that a total care approach is necessary to fully understand their patients’ needs in terms of physical and emotional well-being. The focus is on improving the quality of life for people with amputations, allowing them to lead as full and active lives as possible.

In the case of John, a 25-year-old man who lost his right leg below the knee due to a motor vehicle accident, the goal was to improve his mobility, strength, and endurance. The prosthetist, working with the patient, identified the needs and desires of John and designed a prosthetic leg that would meet those requirements.

A check socket was then created from a plaster cast of John's remaining limb segment, which was used to create a positive model. This model was then used to fabricate the definitive socket. The socket was then fitted to John, ensuring a comfortable and functional fit.

The final outcome was a significant improvement in John's mobility and quality of life. He was able to walk more comfortably and with more enjoyment of life. He readily credits his new socket fit for the improvement in his abilities as a technician or in life. Josh is an inspiration to us all as he meets life's challenges with his abilities in the care of physically challenged patients and those who wear orthotic and prosthetic devices. It goes without saying that John’s socket is not only a result of the hard work of the personnel involved but also the result of the patient’s dedication to participating in the process.

Down to Cases

Creating a 21st Century Prosthetic Socket

By Bob Beck Health Care

Note to Our Readers

Mention of specific products in our newsletter neither constitutes endorsement nor implies that we will recommend selection of those products. The appearance of a product name in this publication should not be construed as approval or rejection of the product by Falk Prosthetics & Orthotics, Inc.
Building Blocks of O&P Fabrication

S

Materials

Selected from page 1

How Great Prosthetic Limbs and Orthoses Come to Life

(Continued from page 1)

Molds and Measurements

In standard casting, a plaster of Paris bandage or water-activated synthetic is wrapped around the affected limb or torso to create a three-dimensional mold. Upon hardening, the mold is carefully removed, sealed and filled with plaster to create a positive mold of the body segment on which the prosthetic socket or orthosis will be formed.

A contemporary alternative, computer-aided design (CAD), allows practitioners to design and modify O&P components with mouse and monitor. Once completed, the design can be exported to a computer-aided manufacturing (CAM) curve to generate a foam positive model. A hybrid option utilizes a laser scanning device to digitize the interior contours of a traditional mold, allowing the technician to then rectify the model electronically.

After initial casting or digitizing, casting orthotist-prosthetist modifies the design to build in therapeutic strategies, provide focused support as needed, accommodate anatomical irregularities and enhance patient comfort.

The more accurately the fit and the greater the comfort, the better the functional outcome, so the importance of an accurate and properly modeled model cannot be overstated...

To cool to retain the desired shape.

A positive model of the affected body part needs to be formed. A hybrid option incorporates workbenches, specialized tools and equipment, a supply of plastics, metal, fabrics, foams, leather and other raw materials, and safety mechanisms to ensure fabrication is performed in a safe environment for staff and surrounding areas.

The introduction of sheet thermoplastics and thermoset plastic laminations has revolutionized the fabrication of limbs and braces, providing a total-contact fit and superior strength in a lightweight package (see Materials article at left).

In both upper- and lower-extremity prosthetic limbs, custom sockets form the key interface between anatomical remnant and replacement limb.

Getting the socket right is critical to functional success; thus, one or more check, or test, sockets of transparent plastic may be fabricated to ensure an optimal fit. When the definitive (final) socket is ready, the limb is completed with various pre-made components (feet, knees, pylons, hand units, etc.) chosen specifically for that patient.

Plastics are used to an even greater extent in orthosis construction, notably in ankle-foot orthoses (AFOs), spinal braces, upper-extremity orthoses and cranial remodeling helmets. Various foams and fabrics are added for enhanced comfort and skin protection.

Fabrication time can vary considerably depending on design complexity and patient characteristics.

Some devices can be made in hours; others take many days. Our intention is to take whatever time is necessary—but no more—to fabricate every limb/brace as “right” as we possibly can.

We welcome your questions and comments regarding the fabrication process.

Selection of foams used in fabricating and adjusting O&P devices. Courtesy Fillauer Inc.

Reinforcing fabrics for O&P laminations. Courtesy Fillauer Inc.

CAD/CAM system creates positive limb mold digitally. Courtesy Fillauer Inc.

Building Blocks of O&P Fabrication

S

strength, light weight, durability and comfort are paramount requisites for modern prosthetic and orthotic devices. From space-age plastics and high-tech composites to advanced metal alloys, today’s O&P fabricators enjoy tremendous flexibility to choose materials that will produce the best combination of these variables for each patient’s individual needs.

High-temperature sheet plastics provide varying degrees of rigidity, thickness and color for use in prosthetic sockets and a wide range of orthotic devices. Polyethylene, for example, is a highly flexible soft thermoplastic frequently used as the inner, interface, layer of a flexible socket, while polypropylene is quite rigid and thus appropriate for the outer socket structure. Numerous other “blended” thermoplastics offer varying degrees of strength and flexibility for particular needs.

These plastics are heated in high-temperature ovens, then formed over a positive model of the affected body segment under vacuum and allowed to cool to retain the desired shape.

Plastic laminates (thermosets), consisting of one or more fabric layers (carbon fiber, kevlar, nylon, fiberglass, etc.) impregnated with a liquid resin and formed over a positive model under vacuum, are also widely used in the fabrication of prosthetic sockets and lower-limb orthoses (AFOs and KAFOs). When a catalyst is introduced, the resin bonds the reinforcing fabric layers together creating a laminate that is both lightweight and strong. Different selections of fabrics and resins provide significant latitude in the rigidity, strength and thickness of the finished product, which can thus be fabricated to reflect the weight, physical capabilities and lifestyle of the user.

Carbon composites are increasingly being used in prosthetic and orthotic fabrication due to their extremely high strength and low weight. In addition to sockets, carbon composites are used extensively in AFOs and KAFOs (including sidebars), prosthetic pylon, knee joints, and dynamic response foot.

Metals—Steel, long used for making AFO and KAFO sidebars, is strong, lightweight and flexible, and enhances comfort. Aluminum is now commonly used as a lightweight alternative when deemed strong enough to meet O&P design criteria. Titanium alloys, though relatively costly, provide perhaps the best combination of high strength and low weight and are increasingly being used in lower-extremity applications.

Others—While these newer plastics and metals have become the building blocks of choice in O&P fabrication, traditional alternatives such as leather, wood, foams and basic metals still have their uses, notably in devices for long-term orthosis or prosthesis wearers who are comfortable with their older device design and composition and do not wish to change.

Whatever the needs and desires of our patients, we are prepared to fabricate the most appropriate materials into each device we create.

The role and scope of orthotic and prosthetic practice have advanced significantly since those days, now requiring formal education (generally at least a bachelor’s degree), board certification and licensure in many states.

As the effectiveness and complexity of the specialty have grown, today’s orthotists and prosthetists now spend increasing more time in the clinic than interacting with patients, evaluating their condition, needs and desires, then designing and manufacturing the most appropriate rehabilitation device for those variables.

We welcome your questions and comments regarding the fabrication process.

The role of orthotic and prosthetic practice has advanced significantly since those days, now requiring formal education (generally at least a bachelor’s degree), board certification and licensure in many states.

As the effectiveness and complexity of the specialty have grown, today’s orthotists and prosthetists now spend increasing more time in the clinic than interacting with patients, evaluating their condition, needs and desires, then designing and manufacturing the most appropriate rehabilitation device for those variables.

We welcome your questions and comments regarding the fabrication process.

The role of orthotic and prosthetic practice has advanced significantly since those days, now requiring formal education (generally at least a bachelor’s degree), board certification and licensure in many states.

As the effectiveness and complexity of the specialty have grown, today’s orthotists and prosthetists now spend increasing more time in the clinic than interacting with patients, evaluating their condition, needs and desires, then designing and manufacturing the most appropriate rehabilitation device for those variables.

We welcome your questions and comments regarding the fabrication process.

The role of orthotic and prosthetic practice has advanced significantly since those days, now requiring formal education (generally at least a bachelor’s degree), board certification and licensure in many states.

As the effectiveness and complexity of the specialty have grown, today’s orthotists and prosthetists now spend increasing more time in the clinic than interacting with patients, evaluating their condition, needs and desires, then designing and manufacturing the most appropriate rehabilitation device for those variables.

We welcome your questions and comments regarding the fabrication process.

The role of orthotic and prosthetic practice has advanced significantly since those days, now requiring formal education (generally at least a bachelor’s degree), board certification and licensure in many states.

As the effectiveness and complexity of the specialty have grown, today’s orthotists and prosthetists now spend increasing more time in the clinic than interacting with patients, evaluating their condition, needs and desires, then designing and manufacturing the most appropriate rehabilitation device for those variables.

We welcome your questions and comments regarding the fabrication process.

The role of orthotic and prosthetic practice has advanced significantly since those days, now requiring formal education (generally at least a bachelor’s degree), board certification and licensure in many states.

As the effectiveness and complexity of the specialty have grown, today’s orthotists and prosthetists now spend increasing more time in the clinic than interacting with patients, evaluating their condition, needs and desires, then designing and manufacturing the most appropriate rehabilitation device for those variables.

We welcome your questions and comments regarding the fabrication process.
Creating a 21st Century Prosthetic Socket

A transfoveal amputee John T., 45, presented with a seven-year-old, outdated prosthetic leg, which no longer fit or functioned properly.

Like many traumatic amputees, John maintains an active lifestyle and expects a lot from his replacement limb, including comfort, performance and endurance. For those expectations, an intimate socket fit is essential. John’s prosthetist recommended an all-new limb design and components featuring a rigid laminated socket with suction suspension, polycentric knee unit and dynamic ed socket with suction suspension, reinforcing materials were chosen by the prosthetist to achieve desired strength and rigidity. These reinforcing materials were placed one by one over the rectified positive model and saturated with a thin coat of resin.

When all prescribed layers were added, this “lay-up” was placed under vacuum, and a catalyst-pigment mixture was introduced via a funnel at the top of the outer bag. The resulting chemical reaction hardened the lamination, which when cooled was removed from the mold, trimmed and smoothed. Voilà: Finished socket!

Once the soundness and fit of the socket were confirmed, John’s new leg was completed with attachment of the remaining prescribed components: knee, pylon, foot and ultimately a total-contact fit and thus require custom manufacture.

If a prosthetic socket as the connecting link between human anatomy and prosthetic designs and thereby help patients realize their lifestyle and vocation goals.

To produce a superior outcome for amputees and individuals requiring orthopedic braces, O&P assistive devices must: (1) fulfill the functional potential of their design, (2) fit intimately and wear comfortably on the patient’s anatomy, and (3) be sufficiently durable to withstand the stresses of daily use.

Present-day prosthetists/orthotists are well-trained to determine their patients’ capabilities, needs and functional desires and to design a prosthetic limb or brace to maximize mobility and lifestyle within those parameters. It remains for the device built to that design to deliver on the promise of the clinician’s vision, a result that inevitably depends on careful, accurate fabrication.

Because of the critical role of the prosthetic socket and braces, custom orthotic prosthesis, most all prosthetic limbs today are custom-fabricated. Although some bracing needs can be solved with prefabricated products, the majority of orthosis designs depend on a precise, total-contact fit and thus require custom manufacture.

An off-the-shelf device is modified and adjusted to achieve the best result possible, given that its fit is, at best, an approximation. Custom prostheses and orthoses, on the other hand, are one-of-a-kind devices molded intimately to a cast or computer-generated model of the patient’s anatomy to deliver the best result possible.