



FP 2F5 - Innovation in Prosthetic Components for Non-Industrial Countries

FP 2F5.1 - Technology Development and Transfer of the CIR Sand Casting System

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Introduction

The dilatancy phenomenon, initially patented in the 1940's, is commonly used in food vacuum packaging for coffee beans or tea leaves and has been utilized to custom-fit wheelchair seats for patients with cerebral palsy. For six decades, many researchers worldwide attempted to apply dilatancy to prosthetic socket fabrication. After four years of research and development the Center for International Rehabilitation (CIR) introduced a prosthetic socket fabrication system based on the dilatancy phenomenon.

In the CIR Sand Casting System¹, sand replaces Plaster-of-Paris as the primary material for making both the prosthetic *negative mold* and the *positive model*. The positive model, made from sand, can then be modified for socket fabrication using thermoplastics or thermosetting resins. We believe this system is a *tool* that can revolutionize prosthetics delivery in many parts of the world by assisting prosthetics service providers to produce better, cheaper and faster transtibial prostheses. This paper describes how the CIR brought a 60-year-old idea of "dilatancy" to a simple and effective procedure for transtibial socket fabrication.

Research and Development

The evolution of the CIR Sand Casting System is a continuous refinement process. From initial needs assessment to the development plan we focused on the goal of developing something "better, cheaper and faster". In the R&D process, we designed and evaluated six casting systems. Each prototype system was tested with plaster models, before the system was used with human subjects. After a clinical study with nine research subjects in 1999 and 2000, many modifications were made to simplify the fabrication procedure. Recognizing that prosthetists are the ultimate decision makers for adopting this new technology, several practicing prosthetists participated during the clinical evaluations to provide feedback. Throughout the R&D process there were many improvements that reduced the set-up costs, simplified the process, and assured assembly and repair using locally available materials, including:

- Using a PVC drainage pipe as the sand container;
- Adding compressed air to fluidize the sand;
- Reducing the number of vacuum lines from three to one by incorporating a manifold design;
- Replacing expensive latex and silicon liners with inexpensive plastic bags for mold making;
- Simplifying the CIR Mandrel and holder.

Advantages of the CIR Sand Casting System

The advantages of the CIR Sand Casting System, which includes the CIR Casting Station, an air compressor, a vacuum pump and additional accessories, are as follows:

Easy to set up, operate and maintain

The primary material, sand, is recyclable

Fast process in making negative sand mold and positive sand model for forming socket.

The typical fabrication time of a transtibial socket, from patient evaluation and casting to dynamic alignment, can be less than 60 minutes. Because of this, the prosthetist may be able to work with a greater number of patients in a single day.

Field Trials

After development and testing of the current design, a CIR Sand Casting Module Set was developed to facilitate training on the assembly and use of the System. The core unit of the System, along with the training module set, was shipped to VIETCOT, Vietnam for an ISPO sponsored field-test in 2003. An ISPO sponsored workshop at TATCOT, Tanzania has been organized for May 2004.

Worldwide Technology Transfer

Dissemination activities of the CIR Sand Casting System will target prosthetics service providers in developing countries through workshops at prosthetics schools (i.e. VIETCOT, TATCOT), CIR's Distance Learning Program (Latin America and Balkan regions), and volunteer expatriate prosthetists from various NGOs. Technology transfer will use a variety of mechanisms including training modules on a CD-ROM and CIR's website (www.cirnetwork.org), as well as on-site workshops.

References

1. Wu, Y., Casanova, H., Smith, W.K., Edwards, M., Childress, D.S.: CIR sand casting system for transtibial socket. *Prosthetics and Orthotics International*, 27:146-152, 2003.

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