IPRO 309 Final Report

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Educational and Technical Support of Orthotics and Prosthetics Education in Latin America

IPRO 309 Team

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Introduction

The International Society of Prosthetics and Orthotics, or ISPO, serves as an accreditation board for educational programs in the manufacture and prescription of prosthetics and orthotics. The number of certified practitioners in the world is small in comparison to the number of people who need these assistive devices. Bogotá, Columbia has one of the highest rates of limb losses in the world due to landmine explosions in the world. By introducing a program to educate high school students in the manufacture of prosthetics and orthotics will greatly help the many people affected by these landmine explosions as well as anyone suffering from congenital diseases who may need these devices. Not only will the program help those in need of devices, it will provide a career with opportunities to advance in the field for those students graduating from the program.

Project Background

Overall there is a strong need for aide to the prosthetics and orthotics education programs in Latin America. This is exhibited by the size of the population, over 550 million people, in comparison to one ISPO accredited Category II program in the area. This program is located at Don Bosco University in El Salvador. In addition there are two unaccredited orthotics and prosthetics schools, one in Mexico and the other in Argentina. Through out all of Latin America there are less than 50 certified orthotic and prosthetic practitioners and approximately 1500 uncertified practitioners. There are approximately 2.5 million people with unmet needs for this type of care.

The available resources for establishing an educational program in Bogotá are addressed below. A large faculty with training in the fields of orthotics and prosthetics from both the Centro Don Bosco and Laboratorio Gilete located in Bogotá and the United States who are willing to contribute to the program. The Centro Don Bosco has available facilities with over 60 years of history in vocational and technical training. Most importantly there is an increasing amount of students interested in enrolling in the program as well as seventeen students who have already enrolled in the current unaccredited program at Centro Don Bosco.

Many commitments have already been made in an effort to improve the orthotics and prosthetics educational programs in Latin America. Among these commitments is an agreement signed in October 2004 by Centro Don Bosco, Don Bosco University (El Salvador) and Laboratorio Gilete establishing the first O&P educational program in Colombia. Approximately 3500 square feet of space has been allotted for the new program at Centro Don Bosco and it is currently being modified to meet the needs of the program. The Health Services Administration of the Colombian Army, Navy and Air Force, as well as the Colombian National Police force, has also endorsed this new program. Support from the USA has come from Rotary clubs from Minneapolis, Cary and Chicago who have been partnering with the Rotary club in Santa Fe de Bogotá to provide funding for scholarships as well as specialized equipment. The Lion's Club from Area 73 is also willing to find ways to partner with the Rotary clubs for this project.

The impact this program will have on the area is significant. In two years, the first class of the seventeen students that entered the program in February of 2005, will graduate; each of them will fabricate approximately 200 new prosthetic and orthotic devices per year which over their entire career could affect over 100,000 patients. In addition to a career opportunity this program spawns career advancements by allowing the graduated Category III students to become Category II certified after they have acquired enough experience and have passed an examination. This program and its opportunity for advancement will develop revenue streams that will help foster its sustainability.

Project Purpose

The ultimate purpose of this project is to create a Category III ISPO accredited program at the Centro Don Bosco in Bogotá Columbia. A category III program educates students in the manufacture of prosthetic and orthotic devices. The accreditation of the program entails several different aspects. The direct purpose of this project is to write the curriculum for the biomechanics portion of the program. The curriculum is geared towards a high school aged student. A series of power point presentations, handouts, worksheets, and visual aides were created for the curriculum. The presentations created during the semester will be taken to Columbia and presented at a seminar for prosthetics and orthotics. The presentations along with any handouts and visual aides will be left in Columbia for the use of the program there. By helping in the effort to create an accredited program hundreds of thousands of people in need of the devices will be helped as well as creating job opportunities for anyone who completes the program.

Research methodology

The Biomechanics group initially did a preliminary research on the different educational modules that were to be created and rough versions of the PowerPoint presentations were completed. This being done, the group came up with a timeline to create brochures, PowerPoint presentations and worksheets for each module. The biomechanics group primarily used the internet in order to gather information for the educational modules. Dr. Meade also provided valuable inputs for making the demonstrations.

The upper limb group followed their original project plan. Every two weeks the new research was compiled into a power point presentation which added information to the previous research. Along with the power point presentations handouts and pamphlets were made. The handouts were left blank to provide an interactive experience with the power point lectures. Each pamphlet provided an overview to the power point presentations that coincided for easy reference to the material covered.

For the most part, the lower limb group followed their original project plan. Each week research was done which complimented the previous work. The actual research mainly involved searching the internet for relevant information as well as reading through several helpful books. One research idea that was planned but never executed involved contacting Children's Memorial Hospital to learn about the orthosis making/fitting process. Time constraints prevented this part of the research. Originally the group

planned on creating an in-depth educational module for all types on foot orthotics and lower limb prosthetics. The scope of that research was too vast, so in the end, the focus shifted to drop foot.

The spine subgroup researched both the healthy spine and abnormalities of the spine to create a basis for understanding the goal of orthotics. Types of orthotics and their working were also researched. The group prepared presentations of their findings and pamphlets and worksheets for students to review.

The materials group tried to find a productive and effective way to investigate information regarding materials used and the fabrication processes used to form these materials into a desired prosthetic and/or orthotic device. The group decided to use information from highly regarding sources, such as the Academy of Orthotics and Prosthetics, in order to properly present and organization our research information. Essentially, other information came from search engines on the internet. Upon noting areas of focus the group used the search engines to find pertinent information to document for the final project.

Assignments

The Biomechanics group was assigned to create educational modules on general concepts of biomechanics, balance, posture, the use of crutches, types of joints and gait. Creating these educational modules involved making brochures, PowerPoint presentations, worksheets and some demonstrations that would be used by the students.

David researched information on balance and posture. He also translated the PowerPoint presentation and the worksheets that would be used in the group's presentation in Columbia. David also designed the group's website in Spanish.

Kristen gathered information on general biomechanics, gait, crutches and different types of joints in the body. She also made brochures on gait, crutches and balance. Kristen created the final PowerPoint presentation and worksheets that would be used in the group's presentation in Columbia.

Vinit gathered information on the history of biomechanics and posture. He made brochures on posture, general biomechanics and types of joints in the body. With the assistance of Kristen and David, Vinit helped put together all the PowerPoint presentations for the different modules. He also built a demonstration of lever classes that would help the students understand certain concepts of lever classes.

The upper limb group worked collectively on each lesson so each member would have a complete understanding of each module. Natalie compiled the research into pamphlets that provided a brief overview for each lesson. Michael and Elise organized the research into Power Point presentations that report the research in more detail.

The lower limb group consisted of Jahir Caro, Sandra Obbonnaya and Peter Maksimowicz. The group gave out assignments of what to research on a weekly basis. The group would then get together and combine their work.

Jahir did all of the group's research on Trans-Tibial prosthetics, putting together a presentation on them. He also gathered information about diabetes and its effect on the foot.

Peter did the initial research on Ankle-Foot orthosis. He also gathered information on some biomechanics of the foot, such as the range on motion. When the group was covering the pathologies of the foot, Peter studied up on stroke and its effect on the foot. He also created the website for this project.

Sandra researched the anatomy of the lower limb, including the skeletal, muscular and nervous system in the limb. She also did the preliminary research on drop foot. In terms of deliverables, Sandra put together most of the group's brochures on the anatomy and biomechanics of the foot.

Once the group shifted its focus to the condition known as drop foot, they collaborated to make presentations describing this problem. The group studied an AFO with dorsiflexion assist, which they decided was the most practical device to help drop foot patients. They created a video showcasing the consequences of drop foot.

The spine group consisted of Matthew Hamblen, Shea Lemley and Sonali Patel. This group assigned certain areas of research to each team member so that these areas could be explored in more detail. Matthew covered topics such as spinal loading and orthotics. Shea researched the anatomy of the spine. Sonali gathered information on diseases and deformities of the spine.

The group worked together to create PowerPoint presentations, handouts and other deliverables which will be used as part of the educational module.

The materials group worked collectively on each lesson so each member would have a complete understanding of each module. Prachi and Chris worked together to find information pertaining to the material selection, fabrication, and production of the final orthotic and/or prosthetic device. They made pamphlets to help communicate important information that we collective decided upon. The group gave weekly updates to present information that was investigated the prior week.

While completing the first lesson plan, lack of knowledge of proper manufacturing and material terms created minor barriers. Understanding other areas such as manufacturing processes, materials selection, and even fabrication posed initial problems for the group. However, having numerous resources available the materials group was able to gather any and all information needed to further expand our research background. One of the areas of focus was to differentiate between materials and structures. Initially the group had a relatively general idea of what was to be investigated. However, after speaking to

Dr. Meade, the group found themselves looking for more information to be able to present their ideas to a group of non-engineers. It is difficult to say that there could have been specific ways to prevent these obstacles. Essentially, this IPRO was to create an Educational Module for a group of students in an area that the members had no prior knowledge of. As a result this project incorporated a lot of learning and research to better understand the topic to be presented.

Obstacles

While completing the first lesson plan, knowledge of proper medical terms created minor barriers for the upper limb group. While researching movement of the arm these terms were referenced but not explained or defined. By searching the internet for these terms the barrier was easily overcome. In researching for the upcoming lesson plans again terms specific to the field have created obstacles in the group's work. Many of the websites refer to procedures as "the usual manor" however because we are just learning about the processes by which things are made "the usual manor" is part of our research. It was difficult to use the internet while researching orthotics and prosthetics. Much of the information pertaining to orthotics was too general for our research purposes. By using a medical book to determine the exact name of the orthotic device needed to be researched, the group reduced its search and was able to find the information it needed. The internet research pertaining to prosthetic limbs was focused mainly on the advancing technologies. Again by using a medical book and refining our search, the information needed was more readily available.

The biomechanics group did not run into any major problems. There was slight miscommunication and two members did similar work but this ended up enhancing the content on that topic. Also a model of joints that was ordered did not arrive. Other than that the group worked well together and all the work was completed in a timely manner.

The lower limb group did not encounter any major, crippling obstacles. The biggest problem was the time constraint. The original project plan could not be followed and had to be streamlined. Instead of researching all types of orthotic and prosthetic devices for the lower limb, the group focused on one condition, drop foot, and the ankle foot orthosis which helps patients with that condition, the dorsiflexion spring assist AFO.

A solution to this problem would be to focus on one or two specific conditions right from the beginning. This will provide much more time to be devoted to specific research, as opposed to doing a great deal of basic research on a wide range of conditions. This strategy should be followed in the continuation of this project.

The spine group faced some obstacles because only one member of the team was an engineer. Two members of the group collaborated on the anatomy and alignment segments, but there were some difficulties developing a curriculum for how the orthotic devices worked. There was also some concern on how detailed the curriculum needed to be, but these obstacles were overcome with continued research and work.

Results

The biomechanics group has created PowerPoint presentations, brochures and worksheets for all the modules. Physical demonstrations of different biomechanical concepts such as lever classes in the human body and using crutches have also been built. The group has created an extensive module comprising of reference guides, brochures, PowerPoint slides and demonstrations that can be used by the students in the orthotics and prosthetics program in Colombia.

As the research began it became apparent that even though the upper limb group was only focusing on the upper limb orthotics and prosthetics it was too much information to research each device. From further research it was determined that the trans-radial prosthetic and wrist driven flexor hand splint orthotic were the most common upper limb devices so the research was focused on those two devices. The first module focused on the anatomy of the hand which was necessary for later modules on fitting of the devices because anatomical landmarks are used to properly place and measure the devices. The second and third modules focused on the most common devices mentioned above. Each module included information on the purpose of the device, the measuring for the device, and the fitting of the device.

The lower limb group completed an extensive educational module to be used as a study guide by students enrolled in the orthotics and prosthetics program in Colombia. This guide describes the anatomy of the foot and lower leg, some problems with the foot and the biomechanics of the lower limb and orthotic devices.

The group has created brochures covering key points of the anatomy of the lower limb as well as the biomechanics. The group also compiled information in a PowerPoint presentation on the pathologies of the lower limb, including diabetic foot, problems caused by cerebral palsy, the effects of stroke, and drop foot.

The Spine subgroup created presentations, pamphlets, and worksheets and acquired visual aides to help educators present the curriculum to students.
The materials group focused their efforts on materials selection, manufacturing process, and fabrication of orthotics and prosthetics. The materials selection research was extremely fruitful and precise in the amount and type of information available to the group. Each thermoplastic has different characteristics and therefore some are better suited for a specific orthotic or prosthetic device. It is extremely important to use the proper type of thermoplastic otherwise the device may fail under a given load. In general, polypropylene has good resistance to fatigue and the rigidity, strength and this resistance allows the material to be used in lower extremity applications. Co-polymers have more resilience to fatigue than the polypropylene however typical shrinkage of the material is 1.5 to 2 percent. Therefore more material is used to manufacture an orthotic or prosthetic. Polyethylene materials are flexible, have high puncture resistance, and are used mostly for socket liners.

After researching the manufacturing processes for orthotics and prosthetics it was determined that a majority of these devices are made through a vacuum forming process. Essentially, molten plastic is molded around a pre-formed mold of the patient's extremity. Once the molten plastic is positioned, a seal is made and the vacuum is turned on to initiate the process. All of the trapped air is evacuated as quickly as possible to deter bubbles from forming in the orthotic.

Everything that was to be researched was looked into at great depths. The information gathered will help to create an educational module to further the education of Category III Orthotic and Prosthetic Technicians.

By researching these topics as well as organizing the information into lesson plans this project will impact the society of Columbia where the curriculum will be introduced. Although the modules are specific to one device they give an example of what the curriculum should look like for other devices. By introducing this curriculum into the high schools in Columbia students taking these courses will be able to enter society making devices for people in need of them. This career path allows the students to advance as they gain more experience and pass examinations. The results have been put into a streamlined presentation which will be shown to key figures of the orthotic/prosthetic program in Colombia. The completed product will be used, in whole or in part, to teach students how to fabricate orthotic devices and prosthetics. This will potentially create a large impact in that region, as there are no such programs there currently.

Recommendations

The IPRO 309 team would like to see future teams work to design the educational module to be used in the Joliet Junior College curriculum. We would also like to see this project continue to act as supplemental material to the education of Category III technicians in Bogotá, Columbia.

It is recommended that the biomechanics research group work with other sun-groups and research different biomechanical principles involved in different types of orthosis. The group should also address biomechanical principles involved in specific joints and body parts. Moreover, the feedback obtained from the Columbia trip would provide a useful insight as to what areas in biomechanical principles need to be investigated further.

From this project we have learned that by dividing the project into different subsections the material was much easier to handle and present. Each subsection has several devices used to assist or imitate many different body movements. Choosing one or two devices allows the material to be more thorough rather than several devices with little or no detail. Most of the preliminary research has been completed. The hand anatomy as well as the correct way to measure the hand has been researched and made into modules. Because this work has been completed this may allow the next group to focus on three or four devices instead of just one or two.

This semester, the lower limb group covered the basics which are necessary to understand a patient's problems and needs. The next step is to design an orthosis which will facilitate the problem at hand, and fit comfortably on the patient. The next group who works on this project will need to create easy to follow manuals describing how to construct an AFO. A good bit of advice would be to concentrate on a single AFO and conduct extensive research on it, as opposed to trying to cover everything in one semester.

It would be beneficial for future groups to see first hand the manufacturing process of orthotics. Because this work has been completed this may allow the next group to focus on three or four devices instead of just one or two. The modules and pamphlets have been excellent learning tools and it is recommended that the next group follow this format.

The modules and pamphlets have been excellent learning tools and it is recommended that the next group follow this format for continuities sake.

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