UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	*Atrium Musculoskeletal Institute, Atrium Health*	**Date Submitted**	*11/30/2018*
Project Title	*Orthotic and prosthetic data capture and analysis* **(AH_ORTHO)**	**Planned Starting Semester**	*Spring 2019*

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	1	Electrical	1
Computer		Systems	
Other (Biomed)	2		

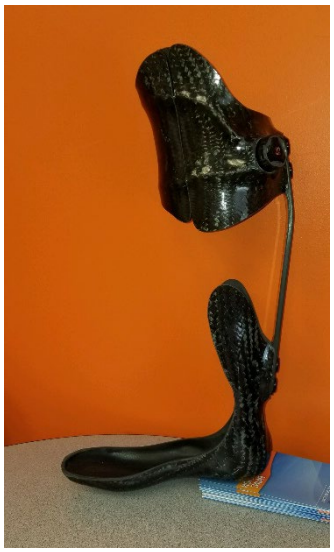
*We welcome the input and adjustment by the senior design committee to the disciplines needed and number of students per discipline.

Company and Project Overview:

The Atrium Musculoskeletal Institute was established to be the first and best choice for musculoskeletal care in our region. The MSK Institute includes orthopaedic surgeons, primary care sports medicine, and other health professionals treating a wide range of injuries and conditions. Specifically, the Division of Research, Quality, and Outcomes, led by Rachel Seymour, PhD, Vice Chair for Research, and Joseph Hsu, MD, Vice Chair for Quality, is focused on pushing innovation in care delivery and outcomes for our patients. Drs. Hsu and Seymour collaborate on a wide variety of research projects, including several focused on patients utilizing orthotics and prosthetics to enhance quality of life and participation in activities. We have a robust clinical and translational research infrastructure that includes divisions of clinical research, engineering research, and basic science research. The proposed project represents a collaboration between clinical and engineering research.

Musculoskeletal injuries and conditions are among the most common and disabling conditions affecting adults in the United States of America. A clear gap exists in returning to functional mobility, running, and activities/active duty with foot and ankle conditions and injuries. Functional limitations may result from chronic pain, muscle weakness and nerve injuries leading to substantial direct and indirect healthcare costs. The Return To Run (RTR) clinical pathway was originally created at San Antonio Military Medical Center and the Center for the Intrepid (CFI) in order to address the needs of the combat wounded limb salvage population. The team at the Atrium Musculoskeletal Institute has developed and expanded the pathway to the larger population of

patients with occupational and recreational injuries and disabilities that have shown benefit in the trauma population.



The Variable Cadence Orthosis (VCO) is a custom device with a pre-fabricated dynamic strut. Our team has extensive experience with this and several other VCO designs and will train the other centers. The full-length carbon fiber foot plate has a semi-rigid full-length rollover design to optimize gait efficiency in stance phase (Figure 1). This shape and material allow for gradual progression from heel to toe. In addition, the design stabilizes and protects the ankle, subtalar joint, and foot to allow loading of the device even with painful conditions. The carbon fiber strut (composite spring) is eccentrically mounted in a posterior position connected to both the footplate and the proximal cuff. This eccentric position allows active loading and deflection of the energy-storing strut. Passive return of this energy propels the limb and provides surrogate plantar-flexion strength. The proximal cuff is a patellar-tendon-bearing design similar to a prosthetic or fracture brace. This allows optimization of comfort and offloading of the limb. A dynamic strut attaches the proximal shell and the footplate. This eccentric posterior strut deflects under load and returns the energy to the limb. The cuff is bivalved with a Boa or similar type of adjustable closure for easier donning and doffing with a tensioned closure to allow efficient loading and energy transfer to the strut.

Our team conducts a series of research studies with patients that utilize the VCO as well as amputation studies with patients using a wide variety of lower-extremity prosthetics. We currently do not have a way to measure utilization of the device (ie, time spent wearing the device each day) or physical activity. A tool that can be embedded in orthotics and prosthetics that provides regular or continuous data on utilization and physical activity would be invaluable.

Project Requirements:

Design a device that can be embedded in orthotics or prosthetics to capture utilization and activity. Considerations should be made for different customizable VCO's; that is, a somewhat modular design that can be adapted to different VCO's.
Ideally, export of the data should be accomplished via wireless technology. However, a manual download may be acceptable as long as data preservation can be assured regardless of an unexpected power cycle.

The device should be continuously operable for a minimum of 24hrs between charges.

Users should readily be able to tell whether the device is powered on and/or collecting data.

Primary variables to be collected are:

- Number of steps taken
- Self-selected walking velocity (SSWV)
- Time of usage

- Force experienced (localized pressure would be ideal if time allows)

Expected Deliverables/Results:

- Bullet list of all deliverables that the team is to provide to the supporter at the end of the project. Be specific here to avoid misunderstandings.

  - A device that can be embedded in custom orthotics and prosthetics that captures utilization and physical activity.
  - The data should be downloadable or streamed to a database via blue tooth or other wireless technology.
  - Software that distinguishes the raw data collected. Statistical analysis or determination of clinical significance is not expected from students; however, basic exports of variables such as number of steps, self-selected walking velocity (SSWV), time of usage, force/pressure would be expected.
  - Information and documentation necessary to produce additional devices.

Disposition of Deliverables at the End of the Project:

Handover within a reasonable timeframe following the expo is acceptable.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

Requirements:
Some travel to meet with Atrium Health technical contacts and representatives may be required.

Skills/Courses:

- Programming (Matlab, Python, C based languages, LabView (if necessary))
- Familiarity and or interest in wireless technology, instrumentation and DAQ (Wi-Fi, Bluetooth, Arduino)
- Firm grasp of dynamic systems (MEGR3122)
- Beneficial courses: MEGR 3171(L) MEGR 3221 MEGR 2279 MEGR3234
- Input from the senior design committee on courses/disciplines needed is welcomed.