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**TITLE:** Do Adaptable Sockets Improve Military Performance?

**PRINCIPAL INVESTIGATOR:** Joan E Sanders PhD

**CONTRACTING ORGANIZATION:** University of Washington, Seattle, WA

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Fort Detrick, Maryland 21702-5012

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Joan E Sanders PhD, W. Lee Childers PhD

E-Mail: jsanders@uw.edu

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**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**

The focus in Year 3 was on data collection. A total of 4 participants completed all three protocols (locked, manual, and auto modes) in the CAREN and FCE-M. Three additional participants have been consented and are partway through socket fabrication. Project logistics were improved at both UW and CFI so that we now have a steady stream of participants proceeding through the study. Collection of bioimpedance data was dropped because of instrumentation issues and because sensed distance data from the posterior mid-limb locations provided comparable information. Data analyzed from CAREN testing on two participants to date demonstrated a reduced socket fit error when participants wore the socket in auto mode compared with the locked and manual modes. For FCE-M activities that involved walking, socket fit error was reduced for the auto mode compared with the locked and manual modes. Weight-carrying activities caused participant residual limbs to sink deeper into the socket, to which auto mode adjusted to stabilize socket fit.

**15. SUBJECT TERMS**
None listed.

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## 1. INTRODUCTION:

The subject of the research is to make prosthetic limbs more comfortable for Service Members who seek to return to active duty or engage in an active lifestyle. The purpose is to evaluate a currently available automatic-adjusting socket technology. Findings will inform whether automatic-adjusting sockets affect user outcomes compared with user-adjusting and traditional sockets and establish best practices of how Service Members and Veterans should incorporate adjustable socket technologies to achieve optimal outcomes in their daily lives. There are two aims. The first aim is to fabricate microprocessor-adjusting sockets for Service Members and Veteran participants that can be easily modified into two alternative configurations – user-adjusting and static (traditional). The second aim is to test performance of all three socket configurations (microprocessor-adjusting (termed "auto mode" in this report), user-adjusting (termed "manual mode"), and static (termed "locked mode") in a return to duty assessment simulator reflecting Military relevant environments and duties. The hypothesis is tested that the microprocessor-adjusting socket improves fit, and users experience less pain and perform Military specific tests nearer to pre-injured levels of performance.

## 2. KEYWORDS:

Microprocessor-adjusting socket, residual limb volume, socket fit sensor, amputee, transtibial, adaptable socket, CAREN, FCE-M

## 3. ACCOMPLISHMENTS:

### What were the major goals of the project?

The major goal of the project in Year 3 was to collect data on additional participants, executing the CAREN and FCE-M protocols. Targeted and actual completion dates for important phases of the project are listed below:

| | Timeline | Progress | Completion Date |
|---|---|---|---|
| **Major Task 1: Study Set Up** | Months | | |
| Hire research assistant and research prosthetist | 1-6 | 100% | Apr 2020 |
| Place order for precision socket digitizer | 1-6 | 100% | Mar 2020 |
| Obtain IRB and HRPO approval | 7-9 | 100% | July 2020 |
| *Milestone Achieved: IRB and HRPO approval received* | 7-9 | 100% | July 2020 |
| Train personnel to monitor limb fluid volume and use microprocessor-adjusting socket | 7-9 | 100% | Apr 2021 |
| Prepare logistics for upcoming study | 7-9 | 100% | May 2021 |
| **Major Task 2: Participant Recruitment and Data Collection** | Months | | |
| Recruit and consent initial participant (n=1) | 10-12 | 100% | Nov 2020 |
| Fabricate adjustable sockets for participant | 10-39 | 100% | Feb 2021 |
| *Milestone Achieved: 1st participant data collection successful* | 13-15 | 100% | Aug 2021 |
| Recruit and consent remaining participants (n=15) | 13-39 | 47% | |
| Collect data in three socket configurations | 10-42 | 33% | |
| *Milestone Achieved: ½ of participant data collected and analyzed* | 22-24 | 67% | |
| *Milestone Achieved: ¾ of participant data collected and analyzed* | 34-36 | 44% | |
| *Milestone Achieved: All participants tested* | 43-48 | 33% | |
| **Major Task 3: Data Analysis** | Months | | |
| Analyze data and prepare results for discussion | 13-48 | 33% | |
| Zoom discussion of data for ¼ of participants | 13-15, | 100% | Aug 2022 |
| Zoom discussion of data for ½ of participants | 22-24, | 67% | |
| Zoom discussion of data for ¾ of participants | 34-36, | 44% | |
| Zoom discussion of data for all participants | 43-48 | 33% | |
| Discuss results for manuscript prep | 43-48 | | |
| **Major Task 4: Dissemination** | Months | | |
| Write manuscript | 43-48 | | |
| *Milestone Achieved: Manuscript submitted for publication* | 43-48 | | |
| Write final report | 43-48 | | |

*Milestone Achieved: Final report submitted* 43-48

**What was accomplished under these goals?**

The specific objective in Year 3 was to fabricate sockets and execute data collection on additional participants. The major activities included: completion of testing of 4 participants total; recruitment of 3 additional participants who are now partway through testing; and completion of the content and format of plots that are generated for each participant. Most of the COVID-19 restrictions were lifted in Year 3.

*Logistics*

Project logistics were improved to distribute the socket fabrication tasks at UW among more staff members, essentially an assembly line approach. Each staff member was trained to perform most of the tasks. Incorporating the additional personnel decreased the time between participant consent and initial fitting. CFI is recruiting new candidates regularly so that we now have a continuous stream of participants proceeding through the project.

Because the researchers at CFI now fully assemble the sockets, UW researchers do not have the socket/pin sensor/locking pin combination on hand to calibrate. As a result, researchers at CFI were given the necessary components, training materials, and coaching to collect pin calibrations at CFI. That data is applied later by UW to process the collected data.

*Firmware Update*

Early in Year 3, we updated the auto-adjustment firmware to remove the universal +2 mm socket size limit and the base size ±1.5 mm limit. The limits are unnecessary for this high-activity participant population.

*Study Protocol*

The decision was made to drop bioimpedance data collection from the protocol since there continued to be problems with the instrumentation. Because the socket distance sensors at the posterior mid-limb locations provide comparable information to bioimpedance data, this change has had minimal effect on data interpretation. Elimination of this step in the protocol reduces testing time and should enhance recruitment for this study.

During testing, CFI personnel now ensure that participants walk on the socket before CAREN/FCE-M testing starts, helping to ensure that their limb is at a stable depth into the socket when the plant gain test is run. Previously, participants had been permitted to doff during or just before the CAREN/FCE-M. The modification has improved quality of the plant gain data, improving operation of the research socket in auto adjustment mode.

*Study Execution*

Testing was completed on a total of 4 participants. Socket design and fabrication are partway completed on 3 additional participants. An updated list of study progress is provided in Table 1. Issues that occurred during testing and how they were managed are summarized in Table 2.

**Table 1. Procedures Completed on Study Participants to Date**

| **Procedure** | **T01** | **T02** | **T03** | **T04** | **T05** | **T06** | **T07** |
|---|---|---|---|---|---|---|---|
| Signed consent form | X | X | X | X | X | X | X |
| Pre-monitoring* | X | X | X | X | X | X | |
| Check fitting of socket from UW** | X | X | X | X | X | | |
| Automatic socket fitting*** | X | X | X | X | | | |
| Locked/RedOp/CAREN/FCE-M test | X | X | X | X | | | |
| Manual/RedOp/CAREN/FCE-M test | X | X | X | X | | | |
| Auto/RedOp/CAREN/FCE-M test | X | X | X | X | | | |

*Includes socket scan; and questionnaire surveys of participants' normal socket

**Includes clinical assessment of the test socket shape

***Includes plant gain test; and optional in lab walking on final test socket to become familiar with socket operation

**Table 2. New Issues and Corrections**

| Issue | Correction |
|---|---|
| T03 scanning errors | Coaching provided to CFI on how to properly mount a blade in the scanner, and how to scan flexible inner liners with minimal error |
| Bad plant gains for T03 & T04 auto | UW researcher joined in by video conferencing during subsequent plant gain collection, new scripts were given to CFI researchers, and more educational material was provided for CFI to understanding the plant gain results. Auto collection sessions were repeated |
| T01 no controller activation during auto | The controller firmware was updated and tested to remove safety limits intended for weeklong unattended take-home tests (+2mm upper limit, ±1.5mm base size limitation), CAREN data collected was repeated |
| Bioimpedance collection difficulties | Bioimpedance collection was omitted in favor of focusing on sensed distance data |

*Data Analysis*

An updated list of plant gain results is show in Table 3. The consistency of plant gain results for a participant during the different sessions indicates that the microprocessor socket system is performing well.

**Table 3. Participant Plant Gain Results**

| Participant | Plant Gain | | | | |
|---|---|---|---|---|---|
| | Fitting | 1st test session | 2rd test session | 3rd test session | Mean [range] |
| T01 | 3497 | 3000 | 3146 | 4858 | 3625 [3000-4858] |
| T02 | 3481 | 4422 | 4263 | 3622 | 3947 [3481-4422] |
| T03 | 3049 | 4499 | 3347 | 4105 | 3750 [3049-4499] |
| T04 | 4836 | 4813 | 3842 | 3528 | 4255 [3528-4836] |
| T05 | | | | | |
| T06 | | | | | |
| T07 | | | | | |

*CAREN data plots:* For the CAREN data, a series of 5 plots is created for each participant. A description of the information in each plot and the figure numbers of example data in this report for participants 1 and 2 are listed in Table 4.

**Table 4. List of plots, descriptions, and figures from CAREN testing**

| Plot | Description | Figures in this report |
|---|---|---|
| CAREN | Conducted in the virtual reality facility on a 3-d tiltable treadmill | |
| *Socket fit over time* | Three horizontal data plots (locked manual, auto) of the socket fit metric (SFM) over time. The area under the curve is highlighted green to indicate a looser fit compared to the median SFM (zero) and highlighted red to indicate a tighter fit compared to the median SFM. The more the green and red in the plot, the greater the deviation in socket fit during the session. A fourth plot at the bottom indicates the actions being conducted per the CAREN protocol. | 1 |
| *Integral of absolute error over time (IAE)* | Summation over time of the area under the absolute value of the *Socket fit over time* plot. A high IAE indicates a large accumulation of socket fit error. This plot helps to indicate to what degree and when the socket fit error increased or decreased for each mode, and how the modes differed from each other in terms of their capability to maintain fit. | 2 |

| | | |
|---|---|---|
| *Integral of error over time (IE)* | This metric is similar to IAE but the direction of error is included. Very high positive or very low negative values indicate a large deviation in socket fit. Note that the IE sometimes changed direction over time. IE values consistently near zero indicate a consistent socket fit over the session. | 3 |
| *Socket fit stability by cycle number (variance)* | Socket fit variance, calculated as $S^2 = \frac{\sum(x_i - \bar{x})^2}{n-1}$ for each cycle. The green horizontal line in each plot indicates the median variance for all cycles in the session. | 4 |
| *Socket fit distribution by cycle number* | This is a horizontal bar graph indicating the distribution of socket fit during each cycle. The blue boxes indicate the 50% inner quartile range. The red vertical line within each blue box indicates the median. The dashed black lines indicate standard deviation. The red '+'s indicate the data points outside of the standard deviation. The shorter the blue box, the closer the red vertical within the blue box is to zero, the shorter the dashed black line, and the closer the red '+'s are to zero, the lower the socket fit error. | 5 |

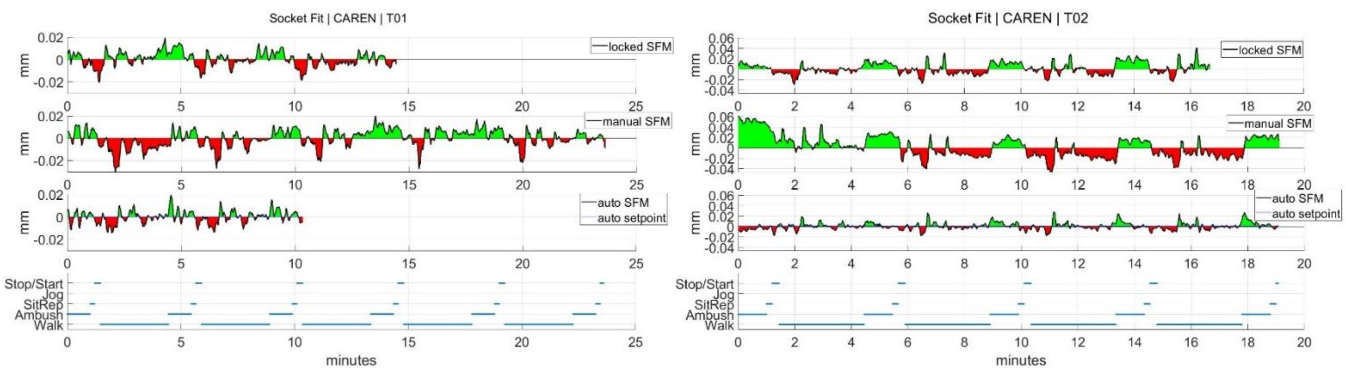



*Fig 1. Socket fit over time – CAREN. Left panel: participant T01. Right panel: participant T02.*

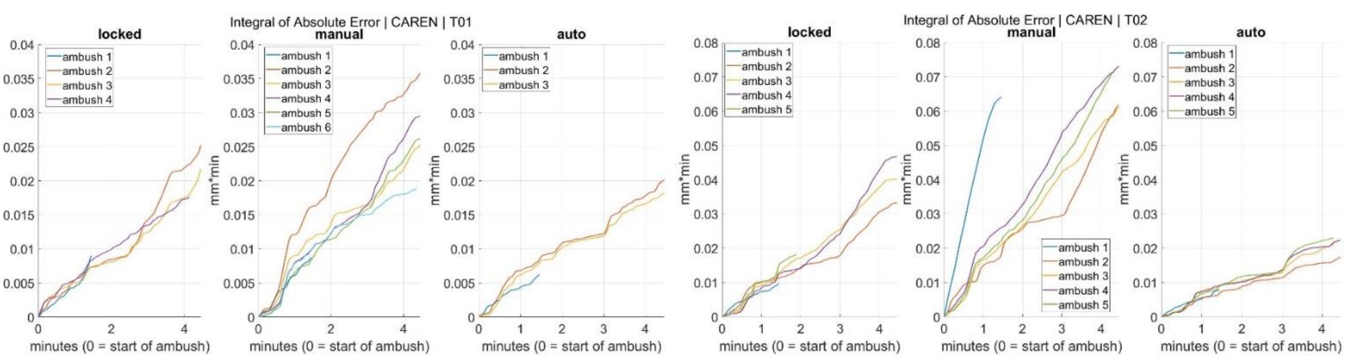



*Fig 2. Integral of absolute error over time – CAREN. Left panel: participant T01. Right panel: participant T02.*

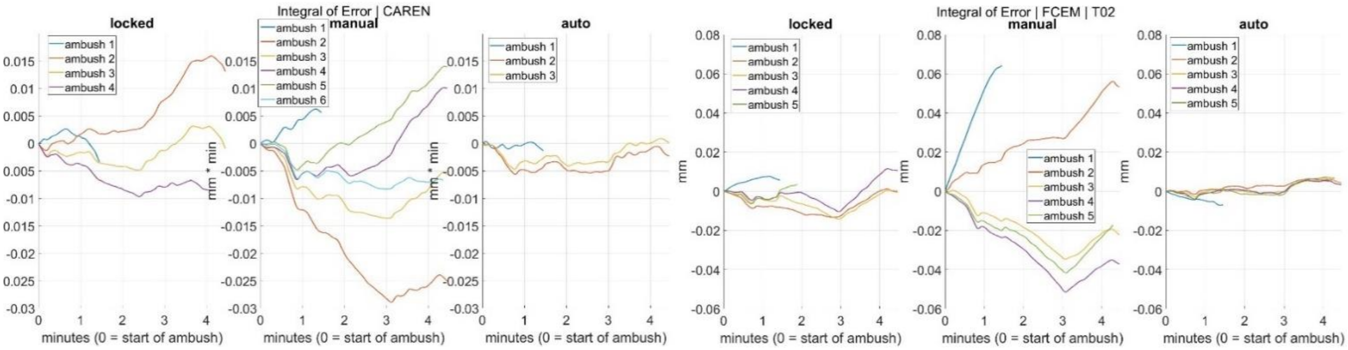



*Fig 3. Integral of error over time – CAREN. Left panel: participant T01. Right panel: participant T02.*

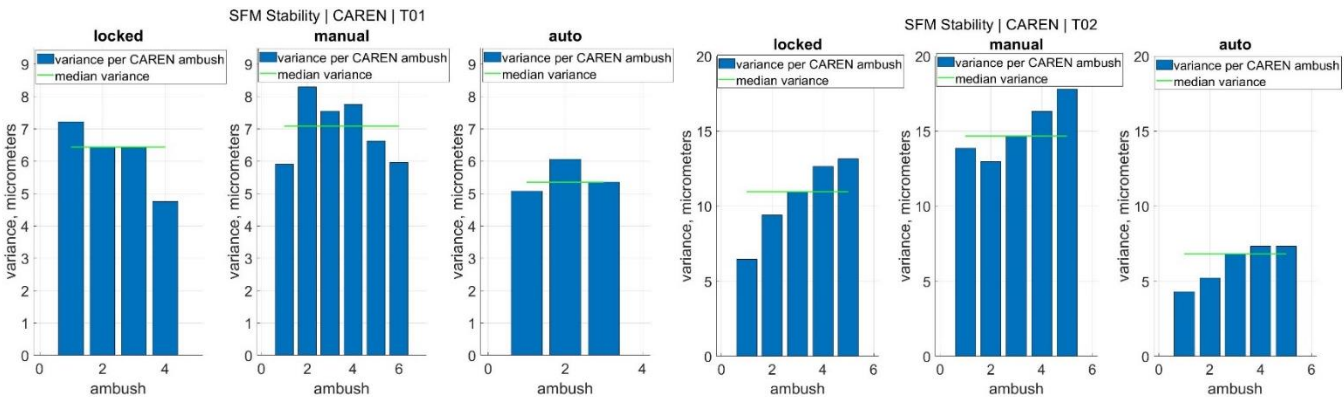



*Fig 4. Socket fit stability by cycle number (variance) – CAREN. Left panel: participant T01. Right panel: participant T02.*

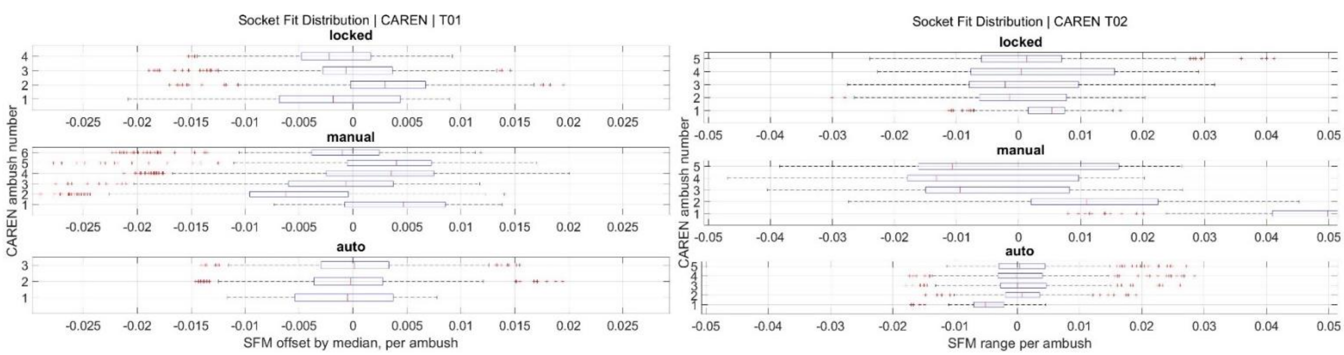



*Fig 5. Socket fit distribution by cycle number – CAREN. Left panel: participant T01. Right panel: participant T02.*

For both T01 and T02, there is a decrease in the integral of absolute error (IAE) and in the integral of error (IE) in auto mode relative to the manual and locked modes (Figs. 2 and 3). Visually, there is a decrease in SFM (limb closer to the socket) in both participants when walking, as evidenced by a greater prevalence of red shaded regions (Fig. 1). and a slight decrease in integral of error (Fig. 3) at approximately 2-3 min into the ambush period. This result suggests that the speed increase that occurs during the stop/start and walk states (1.40-1.48 m/s) relative to the ambush (0.60 m/s) and sitrep (1.00 m/s), as well as the changes in incline and roll, causes the socket to fit tighter, resulting in a greater deviation in socket fit from the median. This trend is less prevalent in the auto mode, where the controller makes size adjustments to respond, as evidenced by a lower range of error, and less negative deviation from the median.

Variation within each cycle also is lower for the auto mode than the locked and manual modes, with the manual mode having the greatest variance (Fig. 4). The spread of the socket fit data is also tighter for auto mode, with T01 and T02's auto mode having a much more consistent median socket fit per cycle, and an interquartile range generally within ±6 µm, and ±7 µm, respectively (Fig. 5). The interquartile range for locked and manual modes exceeded these ranges, suggesting a more stable fit in auto mode, less variation per cycle, and a more consistent fit across the CAREN test session.

*FCE-M data plots:* For the FCE-M data, a series of 3 plots is created for each participant. A description of the information in each plot and the figure numbers of example data in this report for participants 1 and 2 are listed in Table 5.

**Table 5. List of plots, descriptions, and figures from FCE-M testing**

| Plot | Description | Figures in this report |
|---|---|---|
| FCE-M | Conducted in the Military Performance Gait and Motion Lab | |
| Socket fit over time | Three horizontal data plots (locked, manual, auto) of SFM over time. The different tasks are highlighted in different colors. The area between the SFM and setpoint during walk detect is highlighted green to indicate a looser fit, and highlighted red to indicate a tighter fit. It is highlighted gray during a task when walk is not detected. Pin clicks are indicated with green and red triangles, respectively. Socket size adjustments are shown by the blue line. | 6,9 |
| Distal tibia motion over time | Three horizontal data plots (locked, manual, auto) of the upper envelope and lower envelope of distal tibia position over time. Area within the envelope is highlighted a different color for each task. The more color in the plot, the greater the distal tibial motion for the different tasks. | 7,10 |
| Locking pin motion over time | Three horizontal data plots (locked, manual, auto) of the upper envelope and lower envelope of locking pin position over time. Area within the envelope is highlighted a different color for each task. The more color in the plot, the greater the locking pin motion for the different tasks. Y-axis shifts of the data indicate proximal or distal displacement. | 8,11 |

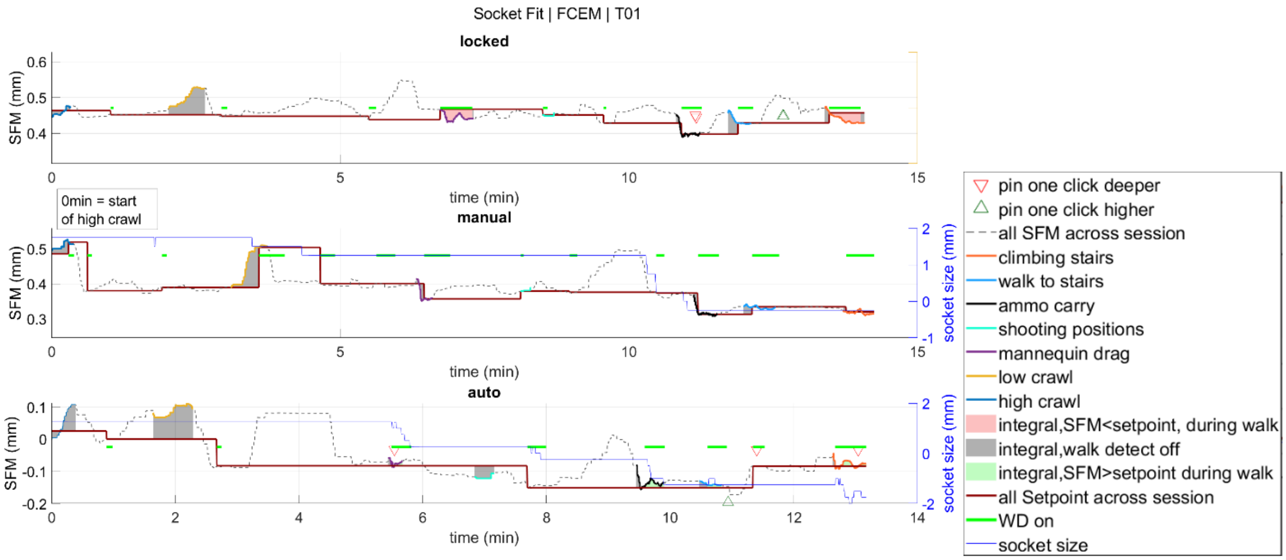



*Fig. 6. T01 Socket fit over time – FCE-M*

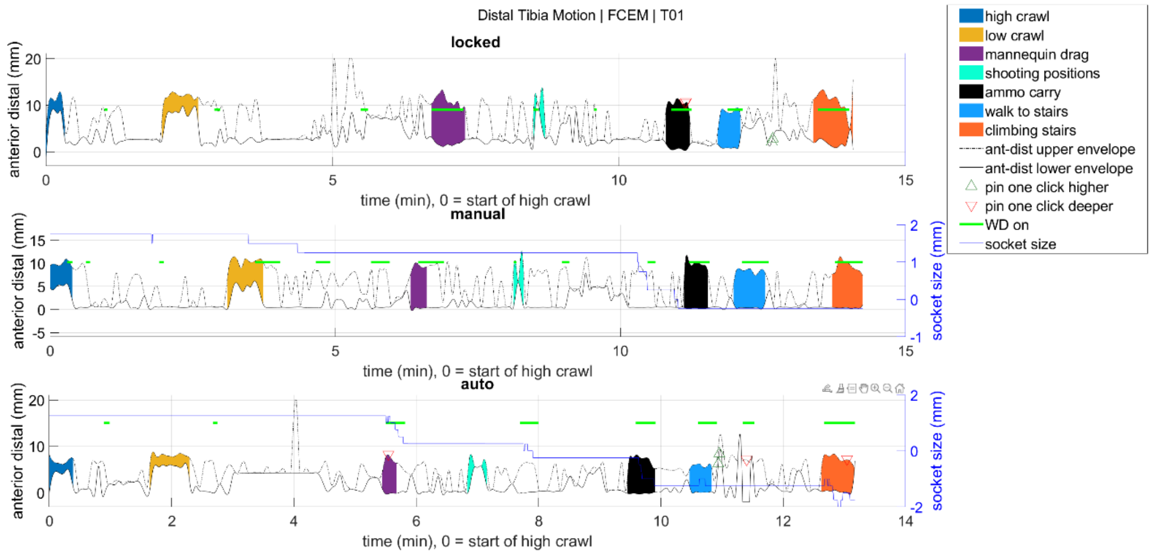



*Fig. 7. T01 Distal tibia motion over time – FCE-M*

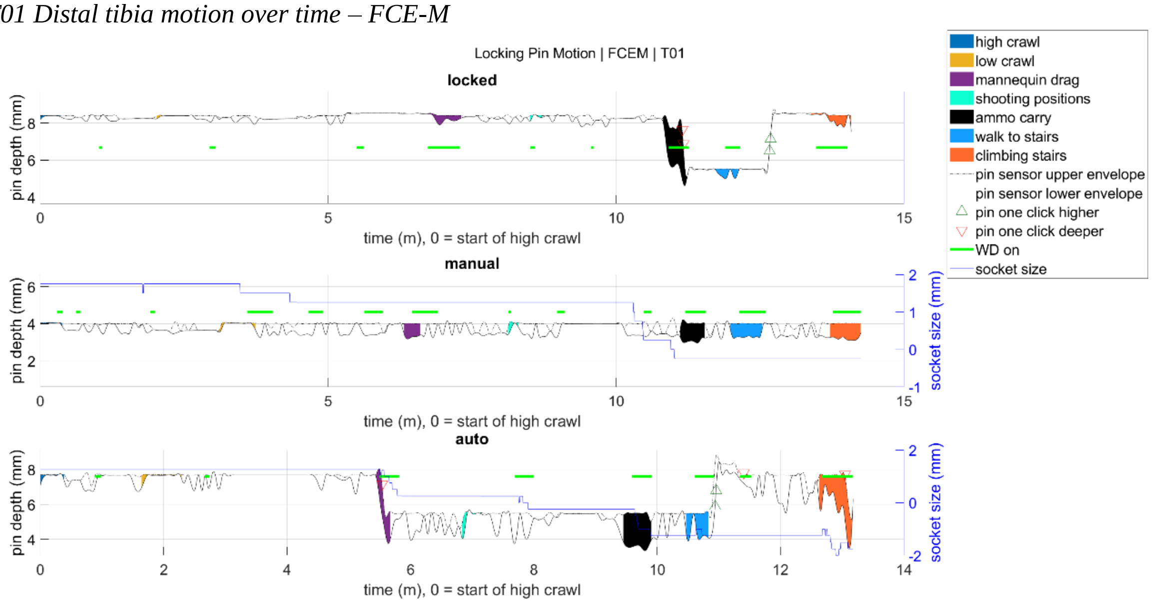



*Fig 8. T01 Locking pin motion over time – FCE-M*

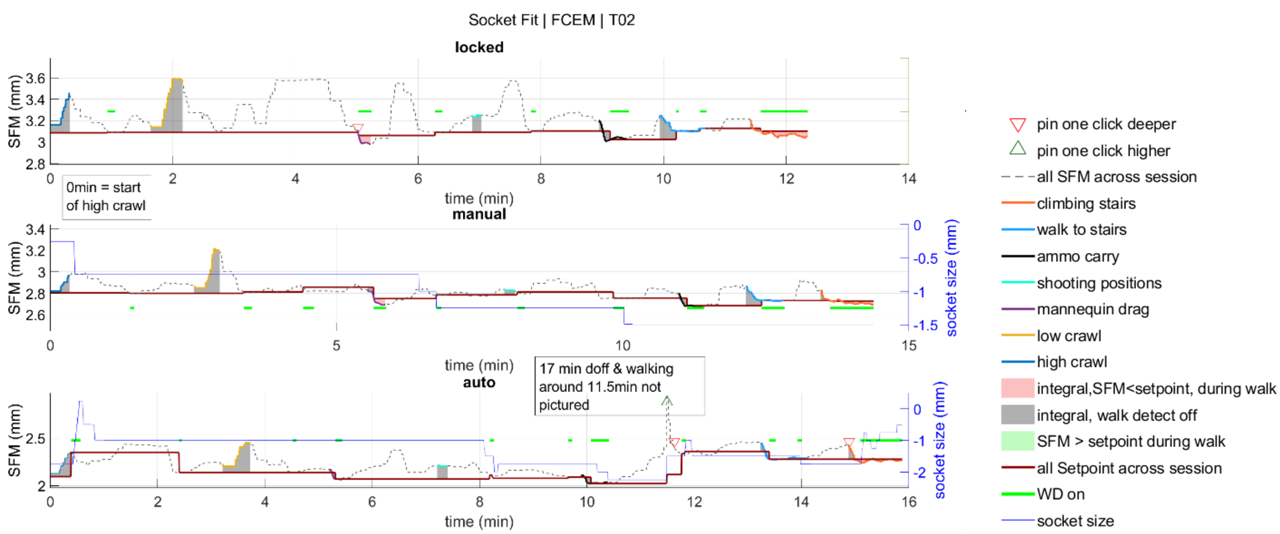



*Fig. 9. T02 Socket fit over time – FCE-M*

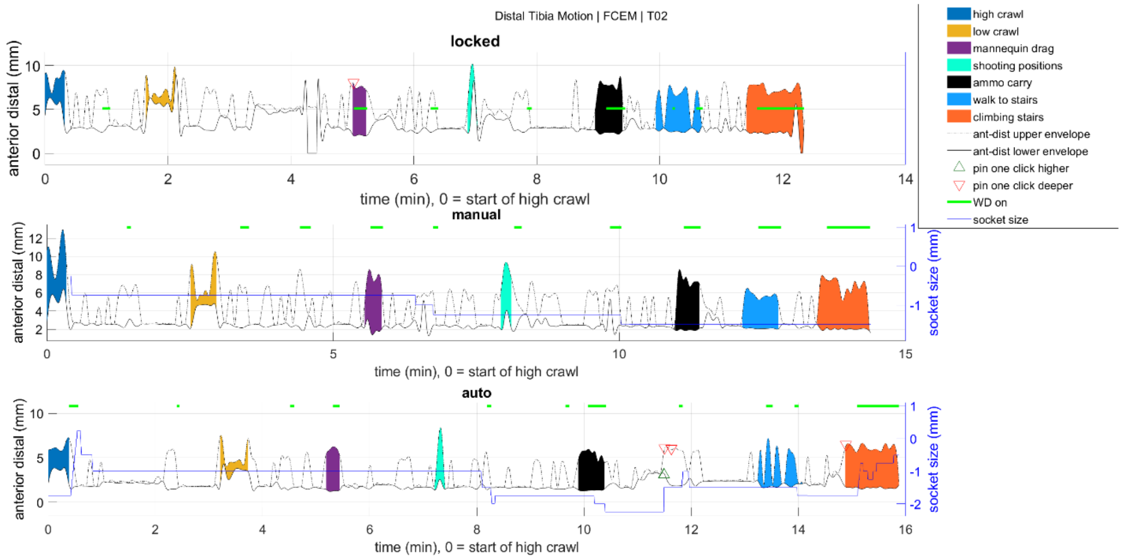



*Fig. 10. T02 Distal tibia motion over time – FCE-M*

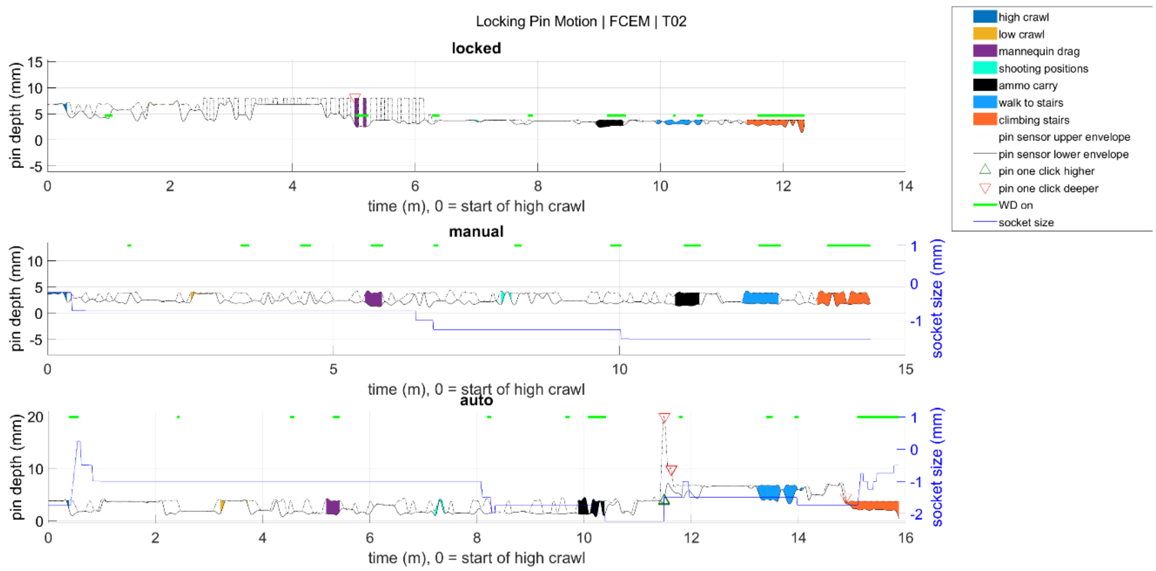



*Fig. 11. T02 Locking pin motion over time – FCE-M*

For the crawling activities, in all three evaluations (socket fit (Figs. 6 and 9), anterior distal motion (Figs. 7 and 10), and locking pin motion (Figs. 8 and 11)), the socket is unloaded as it is being dragged behind the participant. The socket fit metric is well above the setpoint, anterior distal motion is high, and the locking pin is at the upper limit of the pin click.

Across all modes, the ammo carry and mannequin drag show similar trends. The socket fit becomes tighter and the limb sinks deeper into the socket at the start of the activity, presumably due to the added weight of the mannequin (81.8 kg) and the ammo canisters (2 canisters, 9.1 kg each). For both participants, the socket fit becomes tighter during the first ~1/3 of the activity, then eventually levels off, as the participant stabilizes deep in the socket. For both participants T01 and T02, the new setpoint is selected at about the location the SFM stops its initial decrease. These activities have lower stance phase minima in the anterior distal channel than surrounding unweighted walks, and in some cases, the participant sinks in 1-2 pin clicks deeper, highlighting the increased distal loading.

The stair climb causes a similar change – the socket fit becomes tighter over time. For both participants in auto mode, the controller size adjustments during the stair climb stabilized the SFM, improving results compared to the locked mode configuration. In locked mode for both participants, SFM decreases throughout the stair climb, whereas in auto mode the downward trend ceases after the first ~1/4 of the activity, stabilizes or oscillates about the setpoint, resulting in reduced error. For both participants in auto mode but not locked or manual mode, the participant sank one pin click deeper into the socket. T01 in both locked and auto modes reached down and released his pin lock, pulling the pin out two pin clicks prior to the stair climb. This may have been a response to having experienced two pin clicks deeper displacement into the socket during the ammo carry in locked mode.

**What opportunities for training and professional development has the project provided?**

*Nothing to Report.*

**How were the results disseminated to communities of interest?**

Conference presentations:

Price CA, Baumann ME, Allyn KJ, DeGrasse N, Guerrero NA, Lanahan CR, Childers L, Sanders JE. Effects of an Adaptable Socket on Comfort During Military Specific Tasks. Poster presented at: American Academy of Orthotists & Prosthetists Annual Meeting & Scientific Symposium; 2022 Mar 2-5; Atlanta, GA

Price CA, Baumann ME, Allyn KJ, DeGrasse NS, Guerrero NA, Lanahan CR, Ramesh BJ, Garbini JL, Childers L, Sanders JE. Impact of Microprocessor-Adjusting Socket on Prosthetic Fit During Military Specific Tasks. Podium presentation at: George E. Omer Jr. Research Symposium; 2022 Jun 23; San Antonio, TX. Received the Milton S Thompson, MD Award for Most Outstanding Research in the Field of Neuromuscular Rehabilitation

Baumann ME, Price CA, Allyn KJ, DeGrasse NS, Guerrero NA, Lanahan CR, Ramesh BJ, Garbini JL, Childers L, Sanders JE. Effects of an Adaptable Socket on Socket Fit during Military Specific Task. Poster presented at: Military Health System Research Symposium; 2022 Sep 12-15; Kissimmee, FL

Price CA, Baumann ME, Allyn KJ, DeGrasse NS, Guerrero NA, Lanahan CR, Ramesh BJ, Garbini JL, Childers WL, Sanders JE. Impact of Microprocessor-Adjusting Socket on Prosthetic Fit During Military Specific Tasks. Podium presentation at: American Orthotic & Prosthetic Association National Assembly; 2022 Sep 28 – Oct 1; San Antonio, TX

**What do you plan to do during the next reporting period to accomplish the goals?**

During the next quarter, we expect to continue recruitment, socket fabrication, data collection, and analysis.

## 4. IMPACT:

**What was the impact on the development of the principal discipline(s) of the project?**

CFI investigator Ciera Price received the Milton S Thompson, MD Award for Most Outstanding Research in the Field of Neuromuscular Rehabilitation for this project at the George E. Omer Jr. Research Symposium, highlighting the enthusiasm for this direction of research.

**What was the impact on other disciplines?**

*Nothing to Report.*

**What was the impact on technology transfer?**

*Nothing to Report.*

**What was the impact on society beyond science and technology?**

Results to date suggest that microprocessor auto adjusting sockets improves socket fit during Military relevant tasks, providing evidence to stimulate incorporation of adaptive socket technology into clinical care.

## 5. CHANGES/PROBLEMS:

**Changes in approach and reasons for change**

Changed to video conference meetings rather than in person meetings for Major Task 3 – because of COVID issue. Also, removed bioimpedance data collection because of instrumentation issues and because the sensed distance results are providing comparable information.

**Actual or anticipated problems or delays and actions or plans to resolve them**

These are summarized in Table 2.

**Changes that had a significant impact on expenditures**
*Nothing to Report.*

## 6. PRODUCTS:

*Nothing to Report.*

## 7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

*Name:* Joan Sanders, PhD
*Project Role:* PI
*Researcher Identifier (ORCID ID):* 0000-0002-8850-243X
*Nearest person month worked:* 2
*Contribution to Project:* Dr. Sanders coordinates the project, communicating regularly with Dr. Childers on study-related issues

*Name:* Lee Childers, PhD
*Project Role:* Co-PI
*Researcher Identifier (ORCID ID):* 0000-0002-6119-983X
*Nearest person month worked:* 1
*Contribution to Project:* Dr. Childers manages IRB and other administrative issues, and study personnel at the CFI

*Name:* Noel Guerrero
*Project Role:* Research Assistant
*Researcher Identifier (ORCID ID):* 0000-0002-5129-1763
*Nearest person month worked:* 4
*Contribution to Project:* Study preparation and execution, materials prep

*Name:* Ciera Price, CPO/L
*Project Role:* Research Prosthetist
*Researcher Identifier (ORCID ID):* N/A
*Nearest person month worked:* 9
*Contribution to Project:* Recruitment, materials prep, prosthetic support, study execution

*Name:* Alyssa Salazar
*Project Role:* Researcher
*Researcher Identifier (ORCID ID):* N/A
*Nearest person month worked:* 3
*Contribution to Project:* Recruitment, materials prep, study execution, analysis

*Name:* Molly Baumann, PhD
*Project Role:* Research Prosthetist
*Researcher Identifier (ORCID ID):* 0000-0002-5462-405x
*Nearest person month worked:* 4
*Contribution to Project:* Recruitment, materials prep, study execution, analysis

*Name:* John Fergason, L/CPO
*Project Role:* Collaborator (formerly Associate Investigator)

*Researcher Identifier (ORCID ID):* N/A
*Nearest person month worked:* 1
*Contribution to Project:* Recruitment
*Funding Support:* Salary is covered for this project as a DoD employee

*Name:* Mathew Weissinger
*Project Role:* Research Engineer
*Researcher Identifier (ORCID ID):*
*Nearest person month worked:* 1
*Contribution to Project:* Mechanical design

*Name:* Katheryn Allyn
*Project Role:* Research Prosthetist
*Researcher Identifier (ORCID ID):*
*Nearest person month worked:* 1
*Contribution to Project:* Clinical advisor, prosthetic support, recruitment

*Name:* Gabriel Lake
*Project Role:* Research Engineer
*Researcher Identifier (ORCID ID):*
*Nearest person month worked:* 1
*Contribution to Project:* Electronics design and debugging

*Name:* Nicholas DeGrasse
*Project Role:* Research Engineer
*Researcher Identifier (ORCID ID):*
*Nearest person month worked:* 1
*Contribution to Project:* Study execution management, data processing, and analysis

*Name:* Daniel Ballesteros
*Project Role:* Research Engineer
*Researcher Identifier (ORCID ID):*
*Nearest person month worked:* 1
*Contribution to Project:* Data presentation

*Name:* Nicholas McCarthy
*Project Role:* Research Engineer
*Researcher Identifier (ORCID ID):*
*Nearest person month worked:* 1
*Contribution to Project:* Data analysis

*Name:* Bailey Ramesh
*Project Role:* Research Engineer
*Researcher Identifier (ORCID ID):*
*Nearest person month worked:* 1
*Contribution to Project:* Control system debugging

**Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?**

**Sanders**
New grant that has started:
R01HD103815 (Sanders)

National Institutes of Health – National Institute of Child Health and Human Development
"An automatically-adjusting prosthetic socket for people with transtibial amputation"
Level of effort: 2.4 months

**Childers**

Previously active grant that has closed:

W81XWH-16R-BAA1 (Childers – site PI)
US Army Medical Research and Materiel Command
"Assessing rehabilitation outcomes after severe neuromusculoskeletal injury"
Level of effort: 0.9 month

New grants that have started:

W81XWH-23-CCCRP (Childers – site PI)
US Army Medical Research and Development Command, Combat Casualty Care Research Program
"Development of the Intrepid Battlefield Exoskeleton to enable continued battlefield lethality during prolonged field care scenarios"
Level of effort: 1.2 months

OPORP (Childers)
CDMRP
"The relationship between residual limb skin health measurements and clinical outcomes"
Level of effort: 0.6 month

**What other organizations were involved as partners?**

*Nothing to Report.*

## 8. SPECIAL REPORTING REQUIREMENTS

**QUAD CHART:**

# Do Adaptable Sockets Improve Military Performance?

OP180051

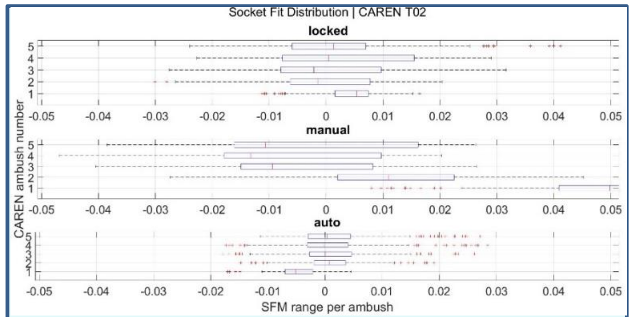
**PIs: JE Sanders PhD** **Orgs.:** University of Washington **Award Amount:** $1.48M

**Study Aims**

1. Fabricate microprocessor-adjusting sockets specific for Service Members and Veterans with transtibial limb loss who have goals of returning to high-level physical activities
2. Evaluate Military task performance using "Readiness Assessments," testing three different socket configurations – microprocessor-adjusting, user-adjusting, and static:
   * Simulated combat patrol in a Virtual Realty Environment
   * Military version of a Functional Capacity Evaluation
3. Characterize performance, user preference, and usability of different socket configurations

**Approach**

A novel adaptable socket is tested on Military participants with transtibial limb loss.




Example result showing lower socket fit error for auto v. manual and locked modes.

Accomplishments: Data collection on 4 participants was completed.

## Timeline and Cost

| Activities CY | 19 | 20 | 21 | 22 |
|---|---|---|---|---|
| Prepare microprocessor-adjusting sockets for Military participants | | | | |
| Evaluated under simulated combat | | | | |
| Characterize performance, user preference, and usability | | | | |
| **Estimated Budget ($K)** | **$369** | **$398** | **$409** | **$304** |

**Updated:** October 15, 2022

**Goals/Milestones**

**CY19 Goals** – Prepare for data collection

☒ IRB/HRPO approval

☒ Training

**CY20 Goals** – 1st group data collection

☒ Socket fab at UW, testing at CFI (25%)

☒ Analysis of collected data (25%)

**CY21 Goals** – 2nd group data collection

☒ Socket fab at UW, testing at CFI

☐ Analysis of collected data

**CY22 Goal** – 3rd group data collection

☐ Socket fab at UW, testing at CFI

☐ Analysis and interpretation of all data

**Comments/Challenges/Issues/Concerns**

- NA

**Budget Expenditure to Date**

Projected Expenditure: $ 1180k

Actual Expenditure: $ 870k

## 9. APPENDICES

None.