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In the United States, the Medicare Functional Classification Level (MFCL or K-level) classification system exists in order to estimate a patient's rehabilitation potential. Physicians assign a K-level rating from 0-4 of increasing functionality, which serves to designate what kind of prosthetic device to provide a patient with and what insurance will cover. This study aims to interpret kinematic data recorded from transtibial amputees with two different functional levels of prosthetic feet and interpret the effect on gait and functional performance when switching to a higher/lower prosthetic level than the one currently equipped with. Kinematic data are collected via motion-capture and force-plate technologies while subjects interact with a virtual reality environment and processed using the GOAT (Gait Offline Analysis Tool) analysis software.

STUDY OF KINEMATICS AND GAIT IN DYNAMIC RESPONSE FEET
ACROSS FUNCTIONAL K-LEVEL CATEGORIES

Russell Donevant, B.S.

APPROVED:

Dr. Rita Patterson, Major Professor

Dr. Nicoleta Bugnariu, Committee Member

Dr. Armando Rosales, Committee Member

Dr. Meharvan Singh, Dean, Graduate School of Biomedical Sciences

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By

Russell Donevant, B.S.

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CHAPTER I

INTRODUCTION

The Medicare Functional Classification Level (MFCL or K-level) classification system is used by physicians to estimate a patient's rehabilitation potential and to provide them with an appropriate level prosthetic device. The K-level rating runs from 0-4, in order of increasing mobility and functionality. At K0, a patient is not expected to have the potential or the ability to move about with or without the assistance of a prosthetic, and thus, a prosthetic is not usually prescribed because it will not directly enhance quality of life. A K1 patient is expected to have some ability or potential to use a prosthetic for short-term movement on a level surface, and usually describes a patient limited to moving about the house. Patients classified at a K2 level have somewhat limited mobility, able to walk for short periods of time, and cross minor environmental boundaries, like stairs or curbs. Patients classified at a K3 level have mobility that satisfies most day-to-day activities, can cross most environmental boundaries, and are considered community ambulators. Finally, a K4 patient is considered to have potential or ability above normal everyday mobility and usually describes an active adult or athlete. Due to the differences in expected mobility, the prosthetics developed at each K-level differ in terms of complexity, construction materials, and base design that result in measurable differences in quality and gait performance (Agrawal et al., 2013).

Walking gait is a series of alternating and cyclic movements consisting of a stance and a swing phase that defines the complex pattern of motion a person employs for forward progression. The stance phase begins when the heel of the foot begins to make contact with the

ground and pushes down and backwards in order to generate forward momentum. This phase ends when the foot begins to lift and the toe leaves contact with the floor, leading to the beginning of the swing phase. During this phase, the leg swings forward to reposition and prepare for the next step. The stance phase ends when the heel makes contact with the floor, leading to the next stance phase and the cycle continues. Thus, a complete gait encompasses both a stance and a swing phase, and is counted individually per leg. Normal gait is considered to be symmetric, as each leg performs similar to the other in order to maintain balance.

Compared to a K3 level prosthetic, a K2 level prosthetic allows for a smaller range of motion and reduced mobility. During a rehabilitation intervention, a patient given a K2 level prosthetic may then be hindered in their potential ability to return to full pre-operation functionality because of the limitations of the prosthetic design.

However, there remains a possibility that patients can actually transition to a higher activity level than their initial K-level designation when given a more advanced prosthetic device (Hafner & Smith, 2009). Not everyone will have the drive or potential to do this, but it is still important to consider that a higher functional level can be achieved. If a more expensive, higher level prosthetic provided to an individual at a lower functional K-level may be initially more costly to patients and insurance providers, but may have multiple benefits, including improvements in balance, and a reduction in falls, injuries, and hospitalizations.

CHAPTER II

BACKGROUND AND LITERATURE REVIEW

In 2005, there were an estimated 1.6 million people living in the United State with limb loss, with 65% of those amputations performed on a lower extremity (Ziegler-Graham et al., 2008). That number has been predicted to rise to 3.6 million people by the year 2050 (Ziegler-Graham et al., 2008), with an estimated 185,000 additional people undergoing an amputation operation each year (Owings & Kozak, 1998). In turn, this means that the market and demand for prosthetics is only going to increase as time goes on. With such a predicted rise in prevalence of the number of people with amputations, increased focus should be directed towards rehabilitation interventions.

Studies show that at least one in five patients will experience at least one fall during rehabilitation (Pauley, Devlin, & Heslin, 2006), because of loss of balance and difficulty with the prosthesis due to a change in biomechanics of the body (Ülger et al., 2010). In the United States, Medicare has created the Medicare Functional Classification Level (MFCL or K-level) classification system in order to evaluate the functional ability of patients with lower-limb amputations following rehabilitation efforts (Gailey et al., 2002). Under this system, physicians look at the patient's current condition, age, medical history, and status of residual limb, and make a subjective determination about what functionality level they think a patient has the potential to reach (Gailey et al., 2002, Nelson et al., 2006, Vanicek et al., 2010).

Multiple studies have focused on the differences in design style of prosthetics within K-level categories to assess which class and style of prosthetic performs best; while some results show statistically significant differences among design styles (Barth, Schumacher, & Thomas,

1992), there have rarely been any clinically significant advantages for any one type of prosthetic foot compared to another rated for the same K-level (Torburn et al., 1990, Macfarlane, Nielson, & Shurr, 1997, Hsu et al., 2006, Torburn et al., 1995). These statistically significant changes are often a result of a compensatory patient adaptation to the change in biomechanics rather than some inherent quality of the prosthetic device. However, there is a well-documented difference in quality as one moves up or down a K-level. As Agrawal et al. (2013) notes, in general a prosthetic at a K2 level has a shorter keel, a flexible forefoot, and a rigid ankle that culminates in an early drop off during the stance phase, which results in a sudden transfer of weight to the other leg. In comparison, the K3 level dynamic response foot has a longer keel, which promotes improved balance, reach and symmetry of gait. It is thus even more imperative that increased care is given to prescription and application of prosthetic devices if patients are to be given the best possible foundation for rehabilitation (Nelson et al., 2006).

Further, there is precedent that amputees may benefit from using a prosthetic at K-level that is higher than their currently prescribed (Agrawal et al., 2013, Agrawal et al., 2015). Research performed by Hafner and Smith (2009) on transfemoral amputees has shown that patients at K2 and K3 level can transition to a higher activity level when given more advanced prosthetic technology, and serves as precedent for this research.

SPECIFIC AIMS

As stated previously, there may be multiple benefits to providing patients with higher K-level prosthetic feet, including improvements in balance, a reduction in falls, injuries, and hospitalizations, and a transition to a higher functional level. This internship practicum aims to support the theory by studying the kinematics and gait performance of transtibial amputee subjects classified at either a K2 or K3 level. Subjects will be tested in both their native K-level foot, as well as a foot of the opposite category.

Hypothesis 1: Subjects who enter the study as a K2 will show benefits to their kinematics and gait performance when wearing a K3 prosthetic foot in comparison to their K2 performance

Hypothesis 2: Subjects who enter the study as a K3 will show detriments to their kinematics and gait performance while wearing a K2 prosthetic foot in comparison to their K3 performance

Aim 1: Determine kinematics and gait performance of all subjects with K2 level prosthetic foot.

Aim 2: Determine kinematics and gait performance of all subjects with K3 level prosthetic foot.

Aim 3: Measure and evaluate any change(s) in performance within individual subjects, and between K-level categories in order to determine immediate benefits, if any, of providing K2 subjects with a K3 level prosthetic foot.

Aim 4: Develop and implement a method of visualizing the relationship between the gait cycle and all outcome measures included in the parent protocol.

SIGNIFICANCE

As emphasized previously, this research is important because it has the potential to improve long-term health outcomes in amputee patients. Patients on the lower end of the K-level system may grow frustrated and disillusioned with their rehabilitation efforts when the limitations of their prosthetic device prevents them doing all of the things they were previously accustomed to doing. This can instill a negative attitude towards their recovery and when combined with the physical limitations of the prosthetic's design, it may work to reduce their ultimate rehabilitative potential.

While providing more people with higher level prosthetics may be more costly initially, it does allow for a greater number of patients to regain a higher degree of control and sense of agency over their lives. They will be given a better foundation with which to work towards reintegrating themselves into their pre-operative lives, as providing a higher level prosthetic to a patient at a lower K-level can help promote a transition into higher functional classification.

RESEARCH DESIGN AND METHODOLOGY

This study protocol is adapted from approved and ongoing UNTHSC IRB Project # 2013-184, titled Functional Performance and Evaluation of Dynamic Response Feet. The scope of this Internship Practicum will focus solely on analysis of the 2D and 3D kinematic data collected, and thus only describes the study procedures relevant to collection of these data.

Equipment. The V-gait CAREN system (Computer Assisted Rehabilitation Environment Network) created by Motek Medical was used to create virtual reality environments similar to everyday life situations. It provided subjects a medium to interact with while functional kinematics and gait were analyzed. This system involves the use of an instrumented treadmill with separate belts for each leg, and force plates mounted beneath each belt. In addition, the platform can move with 2 degrees of freedom to simulate various inclines and terrains, or it can remain stationary and act as a normal treadmill. All these functions are controlled by the D-flow program, and example of the user interface and virtual reality scenario are shown in Image 1.



Image 1. D-flow and Virtual Reality

Subjects were asked to wear a fitted shirt, fitted pants, and comfortable walking shoes. By placing reflective markers on key locations across the body, a computer model of the body can be built using the 12-camera motion capture system. This recorded XYZ coordinate

positioning that was then used to calculate various kinematic parameters and the full range of joint motion that occurred during movement. An example of the model building and a complete marker model can be seen in Images 2 and 3. Image 4 demonstrates what subjects look like with all the markers affixed, and an example of the t-pose subjects are asked to assume in order to build the computer models.

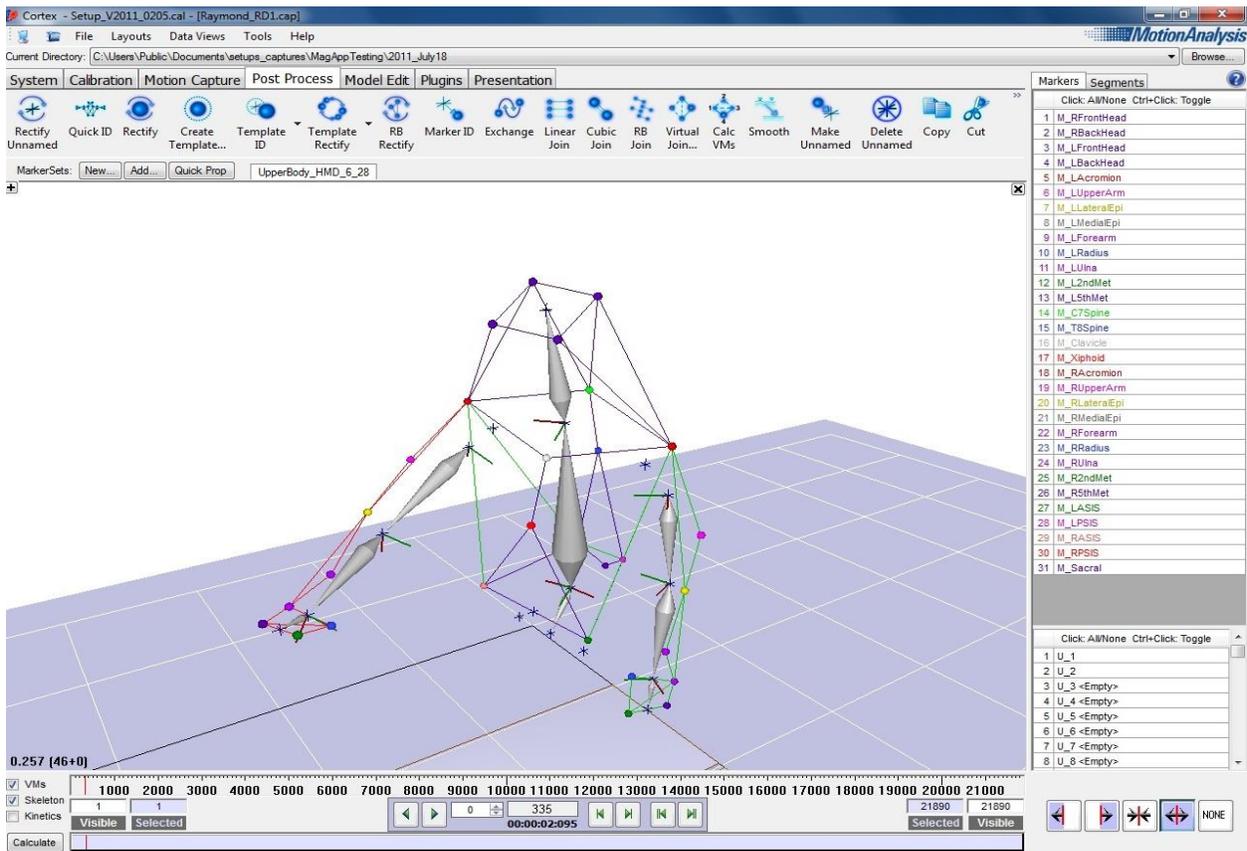


Image 2. Motion Capture Incomplete Marker Model

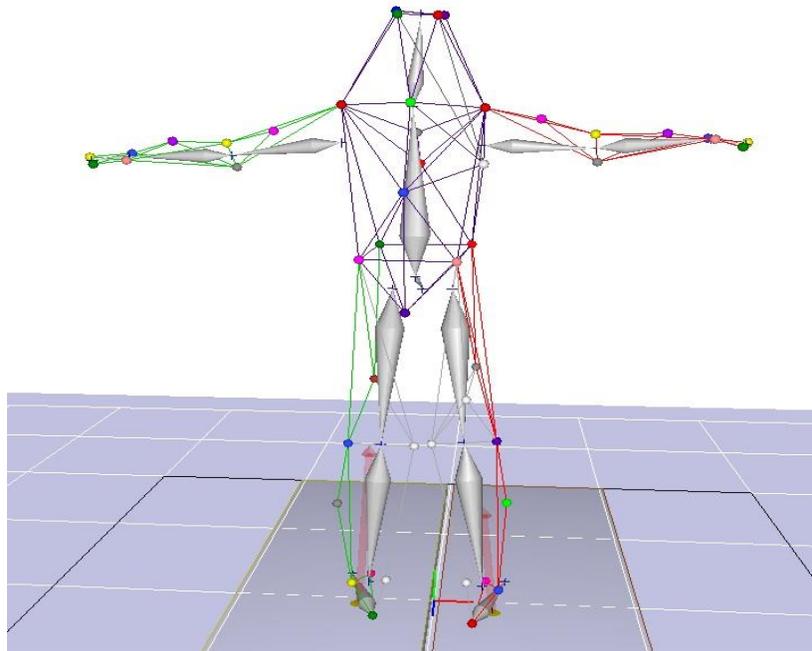


Image 3. Motion Capture Complete Marker Model



Image 4. Mock Subject Marker Model Building

The markers were secured with a non-allergenic double-sided adhesive tape designed specifically not to irritate human skin. Subjects were also secured in a harness that was attached to a support structure fixed to the ceiling, and wore the harness at all times while performing the tasks in the protocol involving the virtual reality.

The GRAIL (Gait Real-time Analysis Interactive Lab) also created by Motek Medical synchronized with the V-gait CAREN system and virtual reality and helped record movement. GRAIL and its counterpart GOAT (Gait Offline Analysis Tool) are designed to provide user-friendly functional gait analysis and were used to process the data for this report.

Recruitment. Eligible subjects were over 40 years old, had an amputation of one lower leg occurring below the knee (transtibial), and were classified at either a K2 or K3 functional level and were currently ambulating with that foot. Due to the nature of the data collection equipment, subjects also needed to be able to stand independently for at least one minute and able to walk independently for at least 100 yards. Subjects could not have a body weight exceeding 400 lbs (the limit of the harness and safety equipment), no history of motion sickness, no self-report of any major neurological diseases, no uncorrected visual deficits, no history of benign postural vertigo, and no cardiovascular conditions such as coronary artery disease or instance of a heart attack less than 1 year prior.

Procedures. Subjects walked on the treadmill while interacting with a virtual reality forest scene. The treadmill simulated different environments such as uneven terrain, inclines, and declines. Data on balance, step length, cadence, and ground reaction forces were collected via the force plates. Kinematic and gait pattern data were collected via the reflective markers and camera system.

Subjects performed the walking tasks with two types of prosthetic feet, a K2 and a K3. Subjects first performed the walking task in their native foot, and then a licensed prosthetist from Baker Orthotics & Prosthetics facilitated the transition to the other foot. Subjects were provided with a prosthetic foot opposite their K-level class (a K2 person received a K3 foot and vice versa), and were promptly evaluated by the prosthetist for proper fitting and comfort. Once the adjustment to the other prosthetic was completed, the walking task was then repeated with the new foot and data were collected.

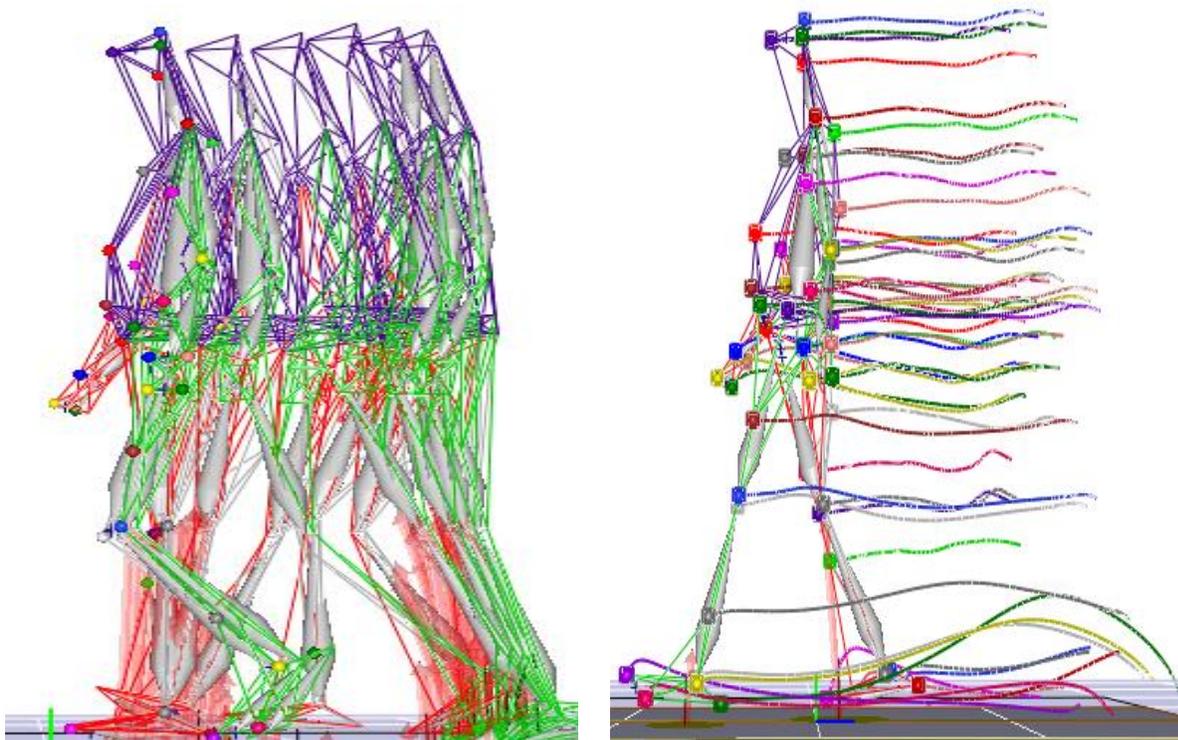


Image 5. Motion capture marker time-lapse

Data Analysis. After data collection, the CAREN system software suite was used to process the motion capture data for analysis. As there were moments during data collection where markers were not detected by the camera system, a complex series of algorithms was used by the system to calculate the approximate location of these markers based on their relative fixed

distance to other body points, as well as their previously known location, trajectory, velocity, and acceleration. Once an XYZ coordinate location was calculated for each marker at all points during the data collection, the motion capture file could then be transferred and loaded into GOAT in order to process the kinematics and gait performance. Two different visualizations of the time-lapsed computer model of this XYZ marker coordinate data are displayed in Image 4.

GOAT then analyzed the functional kinematic and gait performance and calculated a value for each percentage completion (0-100) of the gait cycle from heel strike to toe off. These values constituted variables that included rotational degree, moment of force, and power values for different types of motion including flexion/extension, abduction/adduction, rotation, and tilt in relevant areas of the trunk, pelvis, hip, knee, and ankle. GOAT also produced a .pdf report of the resulting gait performance, with graphs plotting individual performance in relation to accepted normal values, as well as an Excel spreadsheet containing all the calculations for each marker during each stride of the data collection. This data file was then further processed using an Excel template provided by Motek to calculate average values and standard deviations for each variable during the gait cycle. From these average values, a gait symmetry analysis was conducted by subtracting values of the right leg from the left leg. Additionally, a functional kinematic analysis was performed using the 2-D kinematic data from GOAT.

RESULTS AND DISCUSSION

The purpose of this study was to investigate the potential relationship between increased functional performance as a result of wearing a higher K-level prosthetic foot. A total of 2 subjects in the K2 category (AOPA08, 11) and 4 subjects in the K3 category (AOPA02, 05, 07, 12) successfully completed the study and have data included in this analysis. This report analyzes results in terms of both the subject's personal K-level and the K-level of the prosthetic foot worn. Thus, a subject entering the study at the K2 level will be referred to as a 'K2 subject', whereas a subject wearing the K2 foot type will be referred to as 'wearing a K2 level foot'.

Although the parent protocol includes 88 outcome measures (44 for right leg and 44 for left leg) including rotational degrees, moments of force, and powers, for the purposes of this internship practicum, hip flexion, knee flexion, and ankle flexion were selected for 3D gait analysis and stance swing, stance time, step width, stride length, stride time, swing time, and walking speed were selected for 2-D kinematic analysis. Muscles of the hip, knee, and ankle work in tandem to provide a range of motion at each joint location, and together were chosen for study because they comprise the kinematic chain of the leg that produces the forward progression for walking and movement. As subjects are transtibial amputees, it stands to reason that the kinematic chain in their legs is thus disrupted more so than the torso or arms, and should stand out as an area of interest.

Gait Analysis. Gait symmetry was calculated by subtracting left leg performance from right leg performance for each percentage 0-100 of the gait cycle, taking the absolute value of that result, and then calculating an average for that parameter was then recorded. If the absolute value was not taken, then the data would have positive and negative values indicating which leg had a

larger movement, and the average total asymmetry would not reflect the magnitude of asymmetry. Thus, the absolute value of the difference will reflect the maximum difference over the gait cycle, and not the direction (higher right or left leg values) of asymmetry. As this difference between left and right leg performance is actually a value of asymmetry, interpretation of a higher value results in a less symmetrical gait, and a lower value closer to zero represents a more symmetrical gait. If the subject had a perfectly symmetrical gait, they would generate a value of 0 asymmetry. In the analysis that follows, results will be interpreted in terms of symmetry.

Kinematic Analysis. Kinematic parameters were calculated by averaging the performance of individual right and left legs, and then averaging them together for a final value. This method was chosen to reflect the overall performance of a subject rather than a within-subject analysis of prosthetic leg versus sound leg performances.

GAIT ANALYSIS

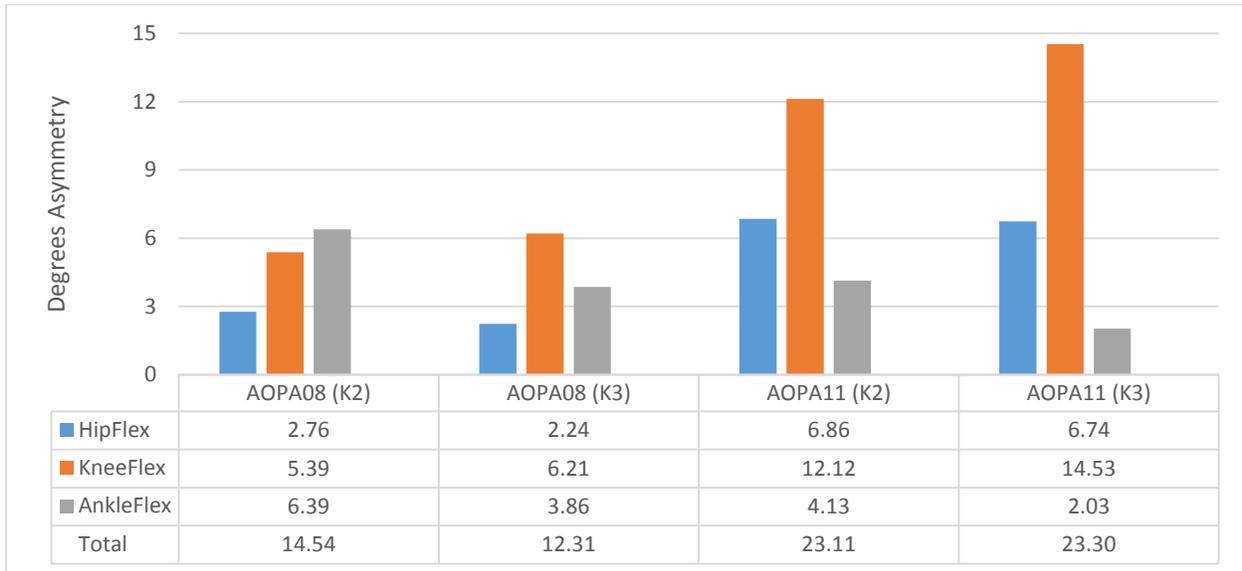


Figure 1. K2 Subject Gait Performance

K2 Subject Gait Performance. A graphical representation of K2 subjects' performance for all conditions is shown in Figure 1. Hypothesis 1 assumes that K2 subjects will receive a benefit to gait performance when wearing a K3 level foot compared to their performance when wearing their native K2 level foot.

For subject AOPA08, there is a decrease in symmetry for Knee Flexion and there are increases in symmetry for Hip Flexion and Ankle Flexion when comparing the K2 foot performance to the K3 foot performance. This suggests that there is a net benefit to AOPA08's gait symmetry when wearing the K3 level foot.

For subject AOPA11, there is a decrease in symmetry for Knee Flexion, and there are increases in symmetry for Hip Flexion and Ankle Flexion. However, this subject has an overall minor net decrease in total symmetry, which suggests that the subject did not receive significant benefits when wearing the K3 level foot.

Both K2 subjects showed decreases in symmetry for Knee Flexion and increases in symmetry for Hip Flexion and Ankle Flexion. However, one subject's total symmetry increased while the other subject's total symmetry decreased. Overall, the data from the K2 subjects cannot conclusively support Hypothesis 1's assertion that K2 subjects will receive a benefit to gait symmetry performance when wearing a K3 level foot.

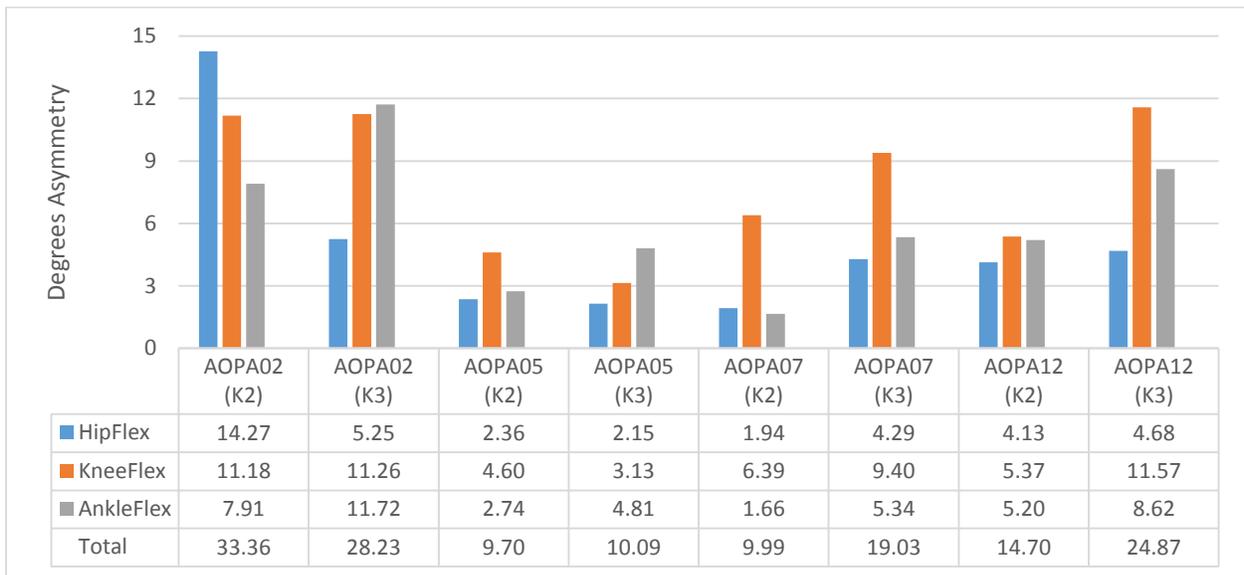


Figure 2. K3 Subject Gait Performance

K3 Subject Gait Performance. A graphical representation of the K3 subjects' performance for all conditions is shown in Figure 2. Hypothesis 2 assumes that K3 subjects will experience a detriment to gait performance when wearing a K2 level foot compared to their performance when wearing their native K3 level foot.

For AOPA02, there is a decrease in symmetry for Hip Flexion and there are increases in symmetry for Knee Flexion and Ankle Flexion. Overall, this reflects a net decrease in total symmetry, and suggests that AOPA02 experienced a negative effect on gait symmetry when wearing the K2 level foot.

For AOPA05, there are decreases in symmetry for Hip Flexion and Knee Flexion, and there is an increase in symmetry for Ankle Flexion. Overall, this reflects a net increase in total symmetry, and suggests that AOPA05 also experienced a positive effect on gait symmetry when wearing the K2 level foot.

For AOPA07, there are increases in symmetry across all parameters of flexion, which suggests that AOPA07 too experienced a positive effect on gait symmetry when wearing the K2 level foot.

For AOPA12, there are again increases in symmetry across all parameters of flexion, which suggest that AOPA12 experienced a positive effect on gait symmetry when wearing the K2 level foot.

Among all K3 subjects, half showed decreases in Hip Flexion symmetry (AOPA02, 05) while half showed an increase (AOPA07, 12). All but one subject (AOPA05) showed an increase in Knee Flexion symmetry, and all subjects showed increases to Ankle Flexion symmetry. Overall, each K3 subject demonstrated a net increase to total symmetry, which does not support Hypothesis 2's assertion that K3 subjects will experience a detriment to gait performance when wearing a K2 level foot.

K2/K3 Subject Performance with K2 Level Foot. Figure 3 shows the performance of all subjects during the K2 condition. The K2 subjects had more symmetry with respect to Hip Flexion, while the K3 subjects had more symmetry in Knee and Ankle Flexion while wearing the K2 foot. Hip, Knee, and Ankle Flexion values were summed together to demonstrate a level of total symmetry. Although individual performances do vary, the K3 subjects had a better total average symmetry than the K2 subjects did when both groups were tested while wearing a K2

level foot. This suggests that the K3 group had overall better gait symmetry during the K2 condition, even though the K2 subjects were native to that foot level. This effect could be explained by the fact that K3 subjects are medically evaluated to have better mobility and potential by virtue of the K-level system. K3 subjects may be more confident and have a higher ability to adapt, thus their baseline abilities can compensate for any potential drop in performance related to the limitations of the K2 level prosthetic design.

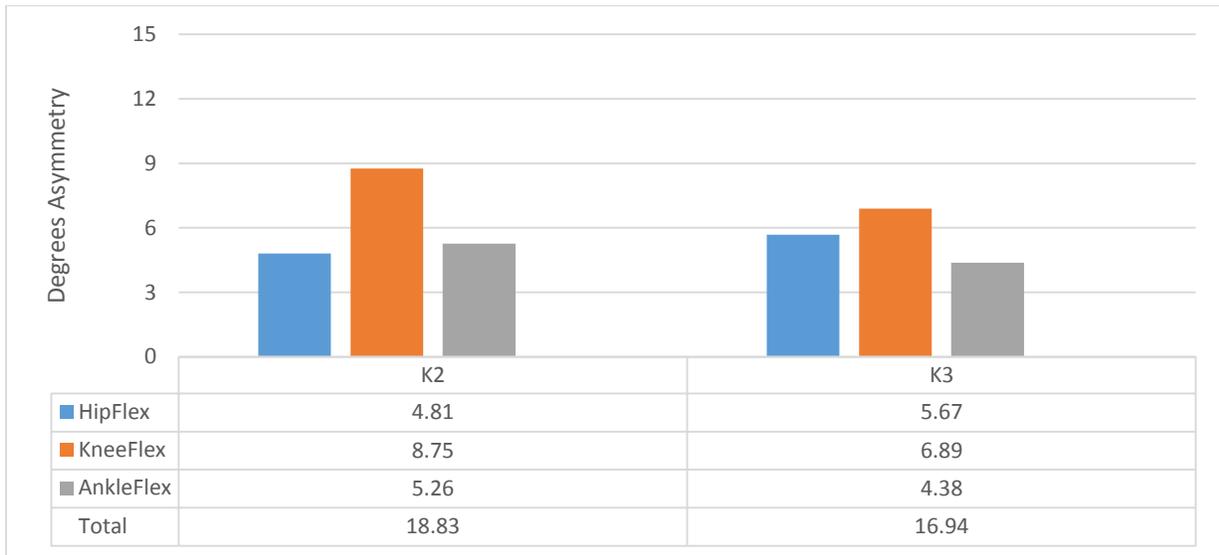


Figure 3. K2/K3 Subject Gait Performance with K2 Level Foot

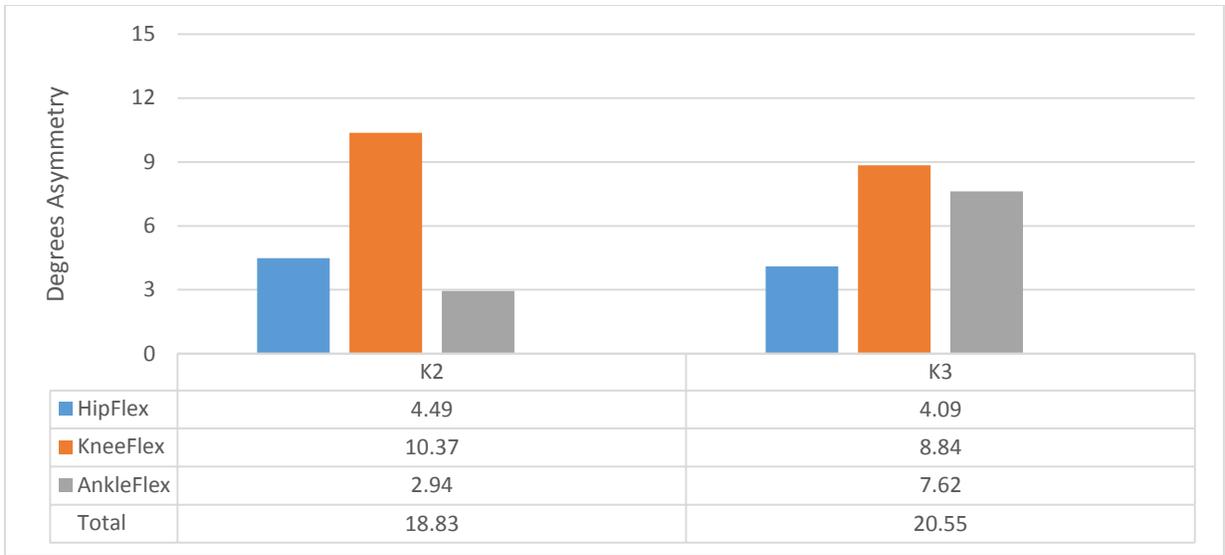


Figure 4. K2/K3 Subject Gait Performance with K3 Level Foot

K2/K3 Subject Performance with K3 Level Foot. Figure 4 indicates the performance of all subjects during the K3 condition. The K2 subjects displayed more symmetry with Ankle Flexion, while the K3 group displayed more symmetry in Hip and Knee Flexion. Individual performances do vary again, but the average total symmetry for K3 subjects is less than the average total symmetry for K2 subjects. These data seem to suggest that the K2 subjects experienced better overall better gait symmetry while wearing a K3 level foot, and that K2 subjects may indeed experience a benefit from wearing the K3 device, as they demonstrated a more symmetrical gait compared to K3 natives.

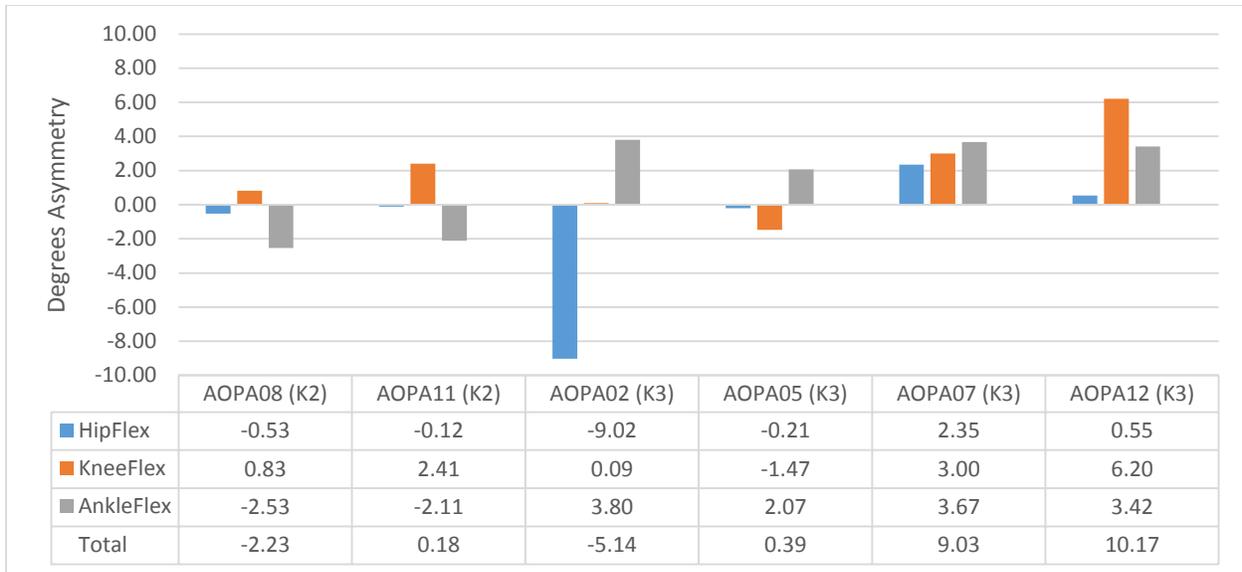


Figure 5. K2/K3 Change in Gait Performance

Figure 5 illustrates the difference in symmetry of each individual subject between conditions. This was calculated by subtracting their K3 asymmetry from their K2 asymmetry values. A positive result on this figure indicates that there was more symmetry during the K2 level foot condition, while a negative result indicates more symmetry during the K3 level foot condition. Overall, it appears that four out of the total six subjects experienced more symmetry during the K2 level foot condition; only AOPA08 and AOPA02 experienced more symmetry during the K3 level foot condition.

Statistical Analysis. A two-factor ANOVA with replication was performed on the 6 subjects in order to examine the effect of foot type and type of flexion on the level of symmetry as seen in Table 1. The results indicate that the effect of foot type was not statistically significant ($p = .551$), and that the interaction between foot type and flexion type was not statistically significant ($p = .519$). However, results do indicate that type of flexion does have a statistically significant effect on symmetry ($F(2, 52) = 3.89, p = .031$).

In order to further illustrate the relationships between foot type and flexion on symmetry, a series of paired t-tests were conducted to compare K2 and K3 level foot gait performance and the results are shown in Table 2. For Hip Flexion symmetry, there was no significant difference for K2 (M = 5.38, SD = 4.7) and K3 (M = 4.22, SD = 1.78) level foot conditions; $t(5) = 0.72$, $p = .506$. For Knee Flexion symmetry, there was no significant difference for K2 (M = 7.51, SD = 3.27) and K3 (9.35, SD = 4.10) level foot conditions; $t(5) = 1.69$, $p = .152$. For Ankle Flexion symmetry, there was no significant difference for K2 (M = 4.67, SD = 2.32) and K3 (M = 6.06, SD = 3.51) level foot conditions; $t(5) = 1.16$, $p = .299$. Altogether, these results suggest that while individuals in the study did experience varying benefits from different K-level prosthetics, there is no statistically significant effect of the prosthetic foot on symmetry and gait performance.

Anova: Two-Factor With Replication			
SUMMARY			
<i>Hip Flexion</i>	K2	K3	Total
Count	6	6	12
Sum	32.3203	25.3322	57.6528
Average	5.3867	4.2220	4.8044
Variance	22.1248	3.1693	11.8673
<i>Knee Flexion</i>	K2	K3	Total
Count	6	6	12
Sum	45.0561	56.1067	101.1629
Average	7.5094	9.3511	8.4302
Variance	10.6995	16.7859	13.4185
<i>Ankle Flexion</i>	K2	K3	Total
Count	6	6	12
Sum	28.0339	36.3666	64.4005
Average	4.6723	6.0611	5.3667
Variance	5.3635	12.3512	8.5782

<i>Total</i>	K2	K3				
Count	18	18				
Sum	105.4103	117.8056				
Average	5.8561	6.5448				
Variance	12.7687	14.2682				
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Flexion Type	91.3932	2	45.6966	3.8894	0.0315	3.3158
Foot Type	4.2678	1	4.2678	0.3633	0.5512	4.1709
Interaction	15.7642	2	7.8821	0.6709	0.5188	3.3158
Error	352.4709	30	11.7490			
Total	463.8962	35				

Table 1. Two-way ANOVA with Replication

	K2 Foot	K3 Foot	t	df	Sig. (2-tailed)
Hip Flexion	Mean – 5.3837 SD – 4.7034	Mean – 4.2220 SD – 1.7803	0.7157	5	0.5062
Knee Flexion	Mean – 7.5094 SD – 3.2710	Mean – 9.3511 SD – 4.0971	1.6873	5	0.1524
Ankle Flexion	Mean – 4.6723 SD – 2.3159	Mean – 6.0611 SD – 3.5144	1.1570	5	0.2995

Table 2. Gait Asymmetry Paired t-test Results

KINEMATIC ANALYSIS

	AOPA08 (K2)	AOPA08(K3)	AOPA11(K2)	AOPA11(K3)
Stride Time	1.86 secs	1.43 secs	1.41 secs	1.43 secs
Stance Time	1.45 secs	1.41 secs	0.99 secs	1.01 secs
Swing Time	0.42 secs	0.37 secs	0.42 secs	0.41 secs
Stance Swing	77.67 %	76.10 %	70.01 %	71.05 %
Step Width	0.08 m	0.15 m	0.19 m	0.15 m
Stride Length	0.77 m	0.95 m	1.07 m	0.95 m
Walking Speed	0.31 m/s	0.66 m/s	0.76 m/s	0.66 m/s

Table 3. K2 Subject Kinematic Performance

K2 Subject Kinematic Performance. Table 3 indicates the 2-D kinematic performance data for the K2 subject population. Hypothesis 1 assumes that K2 subjects will receive a benefit to kinematic performance when wearing a K3 level foot. Decreases to the time parameters in conjunction with increases to step length and walking speed will be interpreted as signs that kinematic performance improved, as this implies an increased ability to ambulate effectively.

For AOPA08, there is a decrease in stride time, stance time, and swing time leading to an overall decrease in stance swing when comparing K2 to K3 level foot performance. Additionally, both the step width and stride length increased as well. This is consistent with the increase in walking speed, indicating that the subject may have had an easier time with their ambulation and suggests a positive effect on kinematic performance when wearing the K3 level foot.

For AOPA11, stride time and stance time increased slightly, while swing time slightly decreased, leading to an overall net increase in stance swing. This is consistent with the decreased walking speed and decreased stride length and step width, suggesting that the subject took smaller, less frequent steps. Overall this suggests that this subject did not experience an improved ambulation, and thus did not experience a positive effect on kinematic performance when wearing the K3 level foot.

Overall, the data from K2 subjects cannot conclusively support Hypothesis 1's assertion that K2 subjects will receive a benefit to kinematic performance when wearing the K3 foot, as only one subject (AOPA08) showed a clear positive result.

K3 Subject Kinematic Performance. Table 4 indicates the 2-D kinematic performance data for the K3 subject population. Hypothesis 2 assumes that K3 subjects will experience a detriment to gait performance when wearing the K2 level foot. Increases to time parameters in conjunction with decreases to stride length and walking speed will be interpreted as signs that kinematic performance declined, as this implies a decreased ability to ambulate effectively.

For AOPA02, there is an increase in stride time and stance time, and a small decrease in swing time, leading to an overall increase in stance swing when comparing the K3 to K2 level foot performance. Additionally, both the step width and stride length decreased as well. This is consistent with the drop in walking speed, which may be leading AOPA02 to take smaller and slower steps with the K2 foot. This may indicate that the subject had a harder time ambulating than normal. Thus for AOPA02, the data suggests that subjects experienced a negative effect on kinematic performance when wearing a K2 level foot.

For AOPA05, stride time, stance time, and swing time all experienced an increase, leading to an overall increase in stance swing. Step width remained the same, while stride length decreased slightly. This is consistent with the decreased walking speed, suggesting that the subject took smaller, slower steps with the K2 level foot. Overall this suggests that this subject experienced a negative effect on kinematic performance when wearing the K2 level foot.

For AOPA07, stride time, stance time, and swing time all experienced a decrease, leading to an overall decrease in stance swing. The subject's step width decreased while the stride length remained the same. In conjunction with the increased walking speed, the data suggests that this subject experienced a positive effect on kinematic performance when wearing the K2 level foot.

For AOPA12, stride time, stance time, and swing time all experienced an increase, leading to an overall increased in stance swing. Additionally, the subject's step width and stride length both increased along with walking speed. This suggests that the subject took larger, more frequent steps, and experienced a positive effect on kinematic performance when wearing the K2 level foot.

Overall, half of the K3 subjects experienced a negative effect and half experienced a positive effect on kinematic performance when wearing the K2 level foot. Again, this may be due to the innate abilities of a person medically evaluated to be a K3 level ambulator.

	AOPA02 (K2)	AOPA02 (K3)	AOPA05 (K2)	AOPA05 (K3)	AOPA07 (K2)	AOPA07 (K3)	AOPA12 (K2)	AOPA12 (K3)
Stride Time	0.98 secs	0.90 secs	1.23 secs	1.10 secs	0.94 secs	1.02 secs	1.34 secs	1.29 secs
Stance Time	0.67 secs	0.61 secs	0.85 secs	0.74 secs	0.62 secs	0.67 secs	0.90 secs	0.87 secs
Swing Time	0.29 secs	0.30 secs	0.38 secs	0.36 secs	0.30 secs	0.35 secs	0.43 secs	0.42 secs
Stance Swing	67.63 %	66.90 %	68.78 %	67.61 %	64.84 %	65.22 %	67.51 %	67.17 %
Step Width	0.12 m	0.16 m	0.11 m	0.11 m	0.09 m	0.12 m	0.27 m	0.32 m
Stride Length	0.96 m	1.01 m	0.90 m	1.10 m	0.86 m	0.86 m	1.12 m	1.06 m
Walking Speed	0.98 m/s	1.12 m/s	0.73 m/s	1.00 m/s	0.91 m/s	0.84 m/s	0.84 m/s	0.82 m/s

Table 4. K3 Subject Kinematic Performance

K2/K3 Subject Kinematic Performance with K2 Level Foot. Table 5 indicates the performance of all subjects during the K2 condition. Individual performances may vary, but overall the K3 group had a smaller stride time, stance time, and swing time leading to a smaller stance swing. Additionally, the K3 group had a longer stride length and a faster walking speed.

This suggests the K3 group had a better kinematic performance during the K2 condition despite the K2 group being native to that foot type.

	K2	K3
Stride Time	1.64 secs	1.12 secs
Stance Time	1.22 secs	0.76 secs
Swing Time	0.42 secs	0.35 secs
Stance Swing	73.84 %	67.19 %
Step Width	0.14 m	0.15 m
Stride Length	0.92 m	0.96 m
Walking Speed	0.54 m/s	0.87 m/s

Table 5. K2/K3 Subject Kinematic Performance with K2 Level Foot

K2/K3 Subject Kinematic Performance with K3 Level Foot. Table 6 indicates the performance of all subjects during the K3 condition. Individual performances may vary, but overall the K3 group had a smaller stride time, stance time, and swing time leading to a smaller stance swing. Additionally, the K3 group had a longer stride length and faster walking speed. This suggests that K3 group had a better kinematic performance during the K3 condition as well.

	K2	K3
Stride Time	1.62 secs	1.08 secs
Stance Time	1.21 secs	0.72 secs
Swing Time	0.39 secs	0.36 secs
Stance Swing	73.58 %	66.73 %
Step Width	0.10 m	0.18 m
Stride Length	0.77 m	1.08 m
Walking Speed	0.48 m/s	0.94 m/s

Table 6. K3 Kinematic Performance per K2/K3 Group

	K2 Foot	K3 Foot	t	df	Sig. (2-tailed)
Stance Swing	Mean – 69.4070 SD – 4.3962	Mean – 69.0088 SD – 3.9658	1.0028	5	0.3620
Stance Time	Mean – 0.9125 SD – 0.2968	Mean – 0.8843 SD – 0.2967	1.2392	5	0.2703
Step Width	Mean – 0.1443 SD – 0.0737	Mean – 0.1520 SD – 0.0915	0.5109	5	0.6312
Stride Length	Mean – 0.9479 SD – 0.1325	Mean – 0.9268 SD – 0.1860	0.3817	5	0.7184
Stride Time	Mean – 1.2943 SD – 0.3360	Mean – 1.2585 SD – 0.3293	1.21458	5	0.2788
Swing Time	Mean – 0.3742 SD – 0.0643	Mean – 0.3698 SD – 0.0449	0.3231	5	0.7597
Walking Speed	Mean – 0.7566 SD – 0.2348	Mean – 0.7904 SD – 0.2850	0.5853	5	0.5838

Table 7. 2-D Kinematics Paired t-test Results

Statistical Analysis. Another series of paired t-tests were also conducted in order to analyze the relationship between the foot type and various 2-D kinematic performances, and the results are displayed in Table 7 above.

For Stance Swing, there was no significant difference for K2 (M = 69.41, SD = 4.40) and K3 (M = 69.01, SD = 3.97) level foot conditions; $t(5) = 1.00$, $p = .362$.

For Stance Time, there was no significant difference for K2 (M = 0.91, SD = 0.30) and K3 (M = 0.88, SD = 0.30) level foot conditions; $t(5) = 1.24$, $p = .270$.

For Step Width, there was no significant difference for K2 (M = 0.14, SD = 0.07) and K3 (M = 0.15, SD = 0.09) level foot conditions; $t(5) = 0.511$, $p = .631$.

For Stride Length, there was no significant difference for K2 (M = 0.95, SD = 0.13) and K3 (M = 0.93, SD = 0.19) level foot conditions; $t(5) = 0.382$, $p = .718$.

For Stride Time, there was no significant difference for K2 (M = 1.29, SD = 0.34) and K3 (M = 1.26, SD = 0.33) level foot conditions; $t(5) = 1.21$, $p = .279$.

For Swing Time, there was no significant difference for K2 (M = 0.37, SD = 0.06) and K3 (M = 0.37, SD = 0.04) level foot conditions; $t(5) = 0.32$, $p = .760$.

For Walking Speed, there was no significant difference for K2 (M = 0.76, SD = 0.23) and K3 (M = 0.79, SD = 0.29) level foot conditions; $t(5) = 0.59$, $p = .584$.

Although there are differences in mean values for K2 and K3 performances on the 2-D kinematic parameters, overall no statistically significant difference between them was found. Thus, this may suggest that current results are indicative of each subject's natural abilities rather than any overarching limitation placed on them by the design of the prosthesis.

GRAPHING TOOLS

In addition to the previous results, Specific Aim 4 of this internship practicum was to develop and implement a tool of visualizing the relationship between the gait cycle and all outcome measures. This aim was accomplished via creation of a graphing template that will automatically compare all possible analysis comparisons of test conditions for each subject's data. Each data collection includes information about the visit (1st or 2nd), K-level foot (K2 or K3), and road conditions (flat or incline), leading to a grand total of 12 different combinations of foot, visit, and road that can be used for analysis of performance.

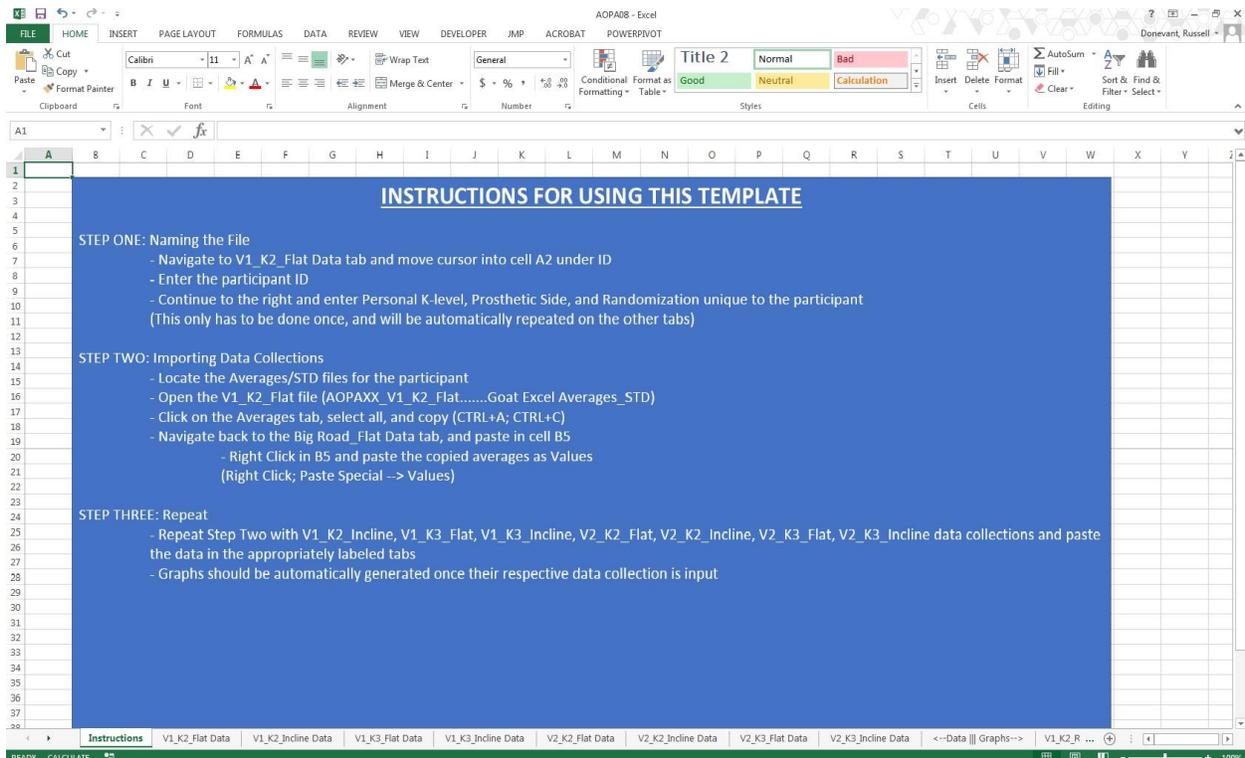


Image 6. Graphing Instructions

In order to use the template, a user must first read the instructions printed on the first tab labeled 'Instructions' and follow them to completion. Users begin manually entering demographic information into tab 'V1_K2_Flat Data' (the first data collection), such as the

subject's ID, their personal K-level, which foot they wear the prosthetic on and so-forth. This demographic information only needs to be inputted once, as these and other relevant fields are automatically populated using this information. Following this, the user then proceeds to transfer the processed GOAT data for each data collection into the appropriately labeled tab. For example, data from the first visit when the subject was wearing the K2 foot and being tested on the flat road corresponds to the V1_K2_Flat tab. Once all the data collections have been entered, the user can then scroll over to the graphing tabs where all the possible analysis combinations have already been generated.

ID	Visit #	Personal K-Level	Foot Type	Prosthetic Side	Terrain	Randomization																				
AOPAD8	1	K2	K2	Left	FLAT	K2-K3																				
Condition	Gait parameter	Stride	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				
V1_K2_FLAT	Rotation TrunkFlex	Left	9.90467105	9.90498	9.08250632	8.667151053	8.27024	7.90647	7.5816	7.30933	7.0541	6.83074	6.62132	6.42546	6.24121	6.07887	5.93952	5.83541	5.75773	5.76624	5.80261	5.8				
V1_K2_FLAT	Rotation TrunkRot	Left	-6.25271632	-6.236822632	-6.40445316	-6.482072632	-6.5515121	-6.60883	-6.6529	-6.68733	-6.7111	-6.7203	-6.71984	-6.7175	-6.71464	-6.73882	-6.77243	-6.82363	-6.89469	-6.98231	-7.08627	-7.2				
V1_K2_FLAT	Rotation TrunkTilt	Left	6.24268263	6.087393684	5.89003316	5.65657895	5.4038379	5.14814	4.89878	4.65912	4.42837	4.20452	3.98496	3.76706	3.54767	3.32757	3.10784	2.89513	2.6965	2.51977	2.36521	2.2				
V1_K2_FLAT	Rotation PelvicOld	Left	-0.29219277	0.015604836	0.2795966	0.48944737	0.6486875	0.75875	0.82653	0.85767	0.85555	0.82279	0.76275	0.67821	0.5693	0.4351	0.27842	0.10309	-0.08729	-0.28414	-0.47968	-0.6				
V1_K2_FLAT	Rotation PelvicRot	Left	-13.1481842	-13.62616842	-14.1044737	-14.56915789	-15.007095	-15.4061	-15.7620	-16.0664	-16.3241	-16.5348	-16.6994	-16.8171	-16.8824	-16.888	-16.8301	-16.7071	-16.5183	-16.2667	-15.9538	-15				
V1_K2_FLAT	Rotation PelvicTilt	Left	12.3515579	12.34235263	12.3445421	12.35785263	12.379563	12.404	12.4276	12.4493	12.4711	12.4963	12.5204	12.5765	12.641	12.7215	12.8149	12.917	13.0202	13.1317	13.2103	13.6				
V1_K2_FLAT	Rotation LHipAbAd	Left	3.52860158	3.18959474	2.87393895	2.60398525	2.3884175	2.23155	2.13202	2.0852	2.08798	2.13603	2.22201	2.33775	2.47922	2.64235	2.8205	3.00471	3.18964	3.36342	3.51831	3.6				
V1_K2_FLAT	Rotation LHipFlex	Left	35.4346316	35.08417895	34.7195421	34.37680526	34.080842	33.837	33.6391	33.4718	33.3192	33.1646	32.9979	32.8109	32.604	32.3685	32.1022	31.8031	31.464	31.0858	30.6751	30				
V1_K2_FLAT	Rotation LHipRot	Left	12.0282	12.38697895	12.6872421	12.8900421	12.975247	12.9439	12.8149	12.6109	12.3559	12.0709	11.7702	11.4581	11.1412	10.8183	10.4906	10.158	9.82116	9.4748	9.12144	8.7				
V1_K2_FLAT	Rotation LKneeAbAd	Left	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.52128	4.5				
V1_K2_FLAT	Rotation LKneeFlex	Left	27.3159895	27.19501579	27.2876474	27.55725263	27.968574	28.4861	29.0786	29.7132	30.3605	30.9888	31.5733	32.0927	32.5325	32.8757	33.1192	33.2641	33.3102	33.2703	33.1597	32				
V1_K2_FLAT	Rotation LKneeRot	Left	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2.2873	2				
V1_K2_FLAT	Rotation LAnkleAbAd	Left	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.00272	8.0				
V1_K2_FLAT	Rotation LAnkleFlex	Left	17.0803526	16.68634213	16.2913368	15.95438421	15.708384	15.5771	15.5881	15.7302	16.0312	16.4751	17.0333	17.674	18.3675	19.0848	19.8	20.4992	21.1705	21.8191	22.4462	23				
V1_K2_FLAT	Rotation LAnklePron	Left	-4.81929895	-4.574611579	-4.22320579	-3.818248947	-3.4227416	-3.0847	-2.82549	-2.64816	-2.5424	-2.49254	-2.4948	-2.54725	-2.65372	-2.82517	-3.06908	-3.40132	-3.82371	-4.33828	-4.9437	-5.6				
V1_K2_FLAT	Rotation LAnkleRot	Left	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12.8871	-12				
V1_K2_FLAT	LProgression	Left	4.36971947	4.664778947	4.82837158	4.86844	4.8232174	4.72707	4.62779	4.52406	4.44997	4.39669	4.36004	4.33778	4.31737	4.29735	4.28029	4.26712	4.25124	4.25185	4.23802	4.2				
V1_K2_FLAT	Moment LHipAbAd	Left	0.01869057	0.007101132	-0.01310817	-0.032009419	-0.0432368	-0.04767	-0.04493	-0.03714	-0.027676	-0.01415	9.6E-05	0.01458	0.02119	0.04608	0.06391	0.08138	0.10065	0.12531	0.14567	0.1				
V1_K2_FLAT	Moment LHipFlex	Left	0.15201345	0.169894037	0.18523584	0.198560795	0.2127245	0.25081	0.27704	0.30493	0.33377	0.36639	0.40298	0.43859	0.47251	0.50055	0.52429	0.54863	0.57283	0.59673	0.62179	0.6				
V1_K2_FLAT	Moment LHipRot	Left	0.00109071	0.001752193	-7.85E-05	-0.002263246	-0.0036375	-0.0043	-0.00476	-0.00453	-0.00446	-0.00439	-0.00444	-0.00397	-0.00299	-0.00158	0.000109	0.00502	0.01	0.0169	0.02433	0				
V1_K2_FLAT	Moment LKneeAbAd	Left	-0.02209803	-0.03210447	-0.04556922	-0.057220595	-0.0668087	-0.0743	-0.07805	-0.07934	-0.08031	-0.08188	-0.0852	-0.08928	-0.09284	-0.09612	-0.09797	-0.09886	-0.09897	-0.09591	-0.09249	-0.0				
V1_K2_FLAT	Moment LKneeFlex	Left	-0.10790124	-0.096955253	-0.08289224	-0.066205305	-0.0577188	-0.05345	-0.0436	-0.03323	-0.02133	-0.01478	-0.01408	-0.01392	-0.01543	-0.0149	-0.01381	-0.01312	-0.01193	-0.02803	-0.04011	-0				
V1_K2_FLAT	Moment LAnkleRot	Left	-0.00827049	-0.014239668	-0.01977748	-0.023704511	-0.0274379	-0.03031	-0.03134	-0.03123	-0.03038	-0.03003	-0.03192	-0.03352	-0.03499	-0.03665	-0.03859	-0.0414	-0.04432	-0.04726	-0.051	-0				
V1_K2_FLAT	Moment LAnkleAbAd	Left	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
V1_K2_FLAT	Moment LAnkleFlex	Left	0.00937409	0.008816216	0.01129327	0.016366093	0.0313836	0.05153	0.07002	0.09252	0.12086	0.15992	0.20968	0.26443	0.32275	0.37938	0.43356	0.48601	0.53616	0.58475	0.63244	0				
V1_K2_FLAT	Moment LAnklePron	Left	-0.00134397	-0.00388588	-0.0057096	-0.00608604	-0.0073441	-0.0093	-0.01011	-0.01028	-0.01103	-0.01365	-0.01884	-0.02611	-0.03421	-0.04237	-0.05073	-0.05935	-0.06904	-0.07852	-0.0869	-0.0				
V1_K2_FLAT	Moment LAnkleRot	Left	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
V1_K2_FLAT	Power LHipAbAd	Left	0.00566475	0.001924349	-0.00339625	-0.006823436	-0.0069839	-0.0055	-0.00334	-0.00104	0.00044	0.001	0.00032	-0.00121	-0.00379	-0.00661	-0.01009	-0.01345	-0.01635	-0.01846	-0.01916	-0				
V1_K2_FLAT	Power LHipFlex	Left	0.04722553	0.057413575	0.06152734	0.058889005	0.0553788	0.05113	0.04705	0.04589	0.04865	0.05586	0.0689	0.08379	0.10057	0.12169	0.14228	0.16735	0.19793	0.22554	0.25376	0.2				
V1_K2_FLAT	Power LHipRot	Left	8.4173E-05	0.000234512	-0.00026164	-0.00050937	-0.0002674	0.00021	0.00073	0.00103	0.00123	0.00118	0.00125	0.00119	0.00086	0.00043	-0.00032	-0.00145	-0.003	-0.00511	-0.00695	-0.0				
V1_K2_FLAT	Power LKneeAbAd	Left	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
V1_K2_FLAT	Power LKneeFlex	Left	-0.02527232	-0.000293024	0.01504373	0.021441032	0.0345256	0.02695	0.02407	0.0187	0.01138	0.00728	0.00645	0.00517	0.00332	0.00143	-7.5E-08	-0.00172	-0.00367	-0.007	-0.0					

Image 7. Data Tab

At the top of a graphing tab screen, the user can find automatically generated information about the subject and what test conditions are being graphed for analysis. Below this, the user will find four columns of graphs, divided in the center by a thick black line. Each individual row

of graphs represents subject performance for a single outcome variable, represented in a variety of ways. The graphs to the left of the divider line will display each test condition of the comparison separately, with left and right foot printed on the same graph. The graphs to the right of the divider line have the left leg and right leg performances separated into their own graphs.

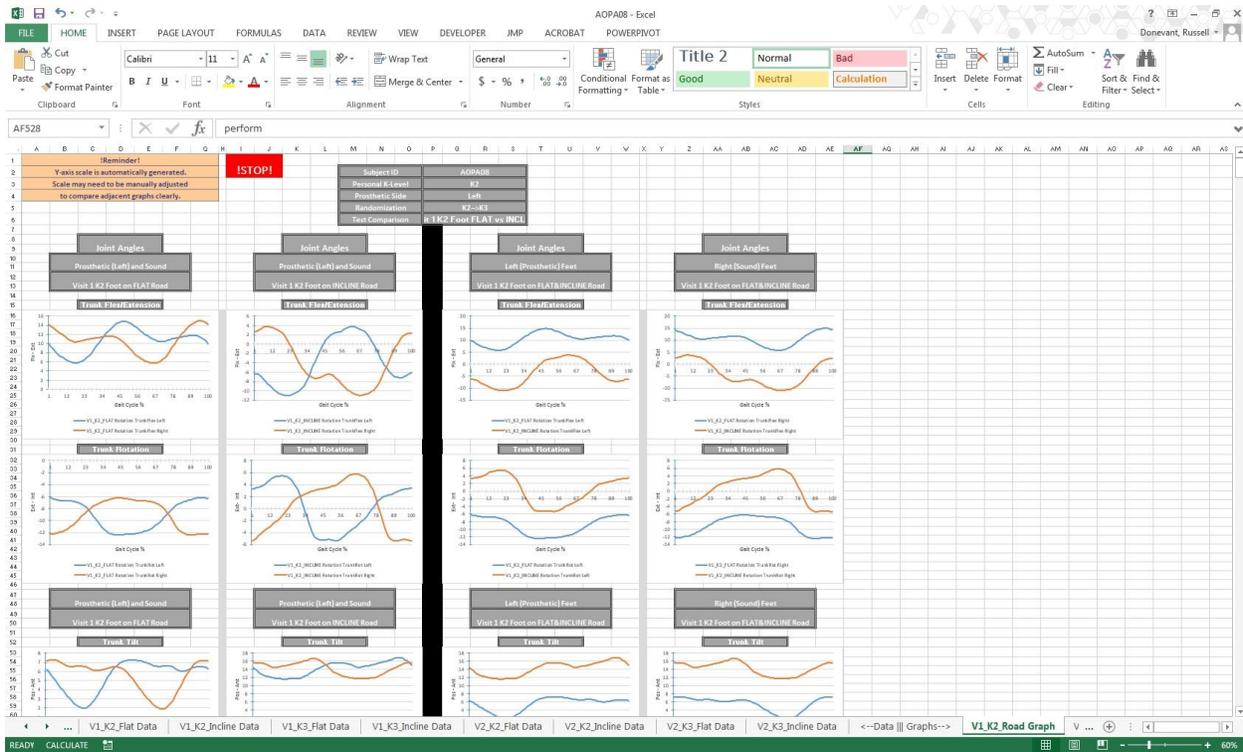


Image 8. Graphing Tab

In this way, the user has four different methods of visualizing the relationship between the two test conditions. They can compare each condition's performance separately, or they can look at a certain leg's performance for both test conditions at the same time. In each instance where right or left leg is declared, the fields will also indicate whether that corresponds to the prosthetic leg or the sound leg. This distinction is useful because it allows the user to compare the performance of the prosthetic leg to the sound leg and draw further conclusions.

This graphing template tool was designed to be as streamlined and user-friendly as possible. As seen in Image 7, the light gray tabs are areas where the user is supposed to enter data and information, while the dark grey areas are pre-generated and should not be edited. As seen in Image 8, there are automatically printed reminders of what each column of graphs represents every few graphs so as to not lose track of what's being compared. Successful usage of this graphing template relies on several factors. 1) The user must be careful when transferring the processed GOAT data into the correct tab. If data is inputted into the wrong tab, there is no warning of this mistake. In order to help prevent this kind of mistake, data labels in the dark-grey areas of data tabs are pre-generated, and should help serve as reminders to the user what data tab they are on. 2) Users must be cognizant that the y-axis scales of each graph are automatically generated to best fit the data. When comparing two graphs side by side, the graphs may appear to have the same shape and size, when in reality, one graph scales from 0 to 10 while the other scales -10 to 25. A reminder of this fact is printed at the top of every graphing tab in bright orange and purple lettering.

Ultimately, this template should serve to save time and provide helpful visualizations of the relationship between the gait cycle and outcome variables measuring gait and kinematic performance. Without this tool, each time a researcher wanted to look at the relationship between two factors of the experiment, they would have to pull the individual data and graph each variable manually. With the tool, not only are all the graphs automatically generated, but the values for all data collections are stored within it as well. This makes it easier to pull data that needs to be represented in a table or a different format, such as the symmetry analysis conducted for this practicum report.

SUMMARY AND CONCLUSIONS

In conclusion, both the K2 and K3 subjects' results of the kinematic and gait performance evaluations did not fully support the hypotheses stated at the beginning of this practicum report. Hypothesis 1 stated that K2 subjects will show benefits to their kinematics and gait performance when wearing a K3 prosthetic foot in comparison to their K2 performance. Of the two K2 subjects, one showed a net improvement in gait symmetry performance when wearing the K3 prosthetic foot, while the other showed a minor decrease in gait symmetry performance. Additionally, AOPA08 showed an improved kinematic performance with the K3 prosthetic foot, while AOPA11 demonstrated a decreased kinematic performance. Within the limitations of this practicum, it is difficult to discern why or how this result was achieved. This could be due to an individual's period of acclimatization; i.e., one person may find switching prosthetics to be an easily adaptable experience, whereas another may experience a degree of difficulty in adapting to a new foot. Hypothesis 2 stated that K3 subjects will show detriments to their kinematics and gait performance while wearing a K2 prosthetic foot. Of the K3 subjects, all showed a net improvement in gait performance when wearing the K2 foot. This result is also hard to quantify in terms of the hypotheses and limitations of this report. As mentioned in the beginning of this report, gait is cyclical by nature and requires symmetrical movements from both legs in order to be successful. If subjects had displayed large disturbances to their symmetry, then their gait would have suffered and they may not have even been able to walk successfully.

Limitations. The main limitation of this internship practicum is the study's sample size. Currently only two K2 subjects and four K3 subjects have fully completed the study, and the parent protocol aims to enroll up to 40 subjects from each K-level category. Additionally, this internship practicum only focuses on a select few of the outcome measures when evaluating gait

performance. An analysis that encompasses all gait parameters, including moments and powers, could produce results that better illuminate and clarify the relationship between functional performance and prosthetic K-level and may produce statistically significant results that could support the research hypotheses.

Additionally, it is conceivable that a lower level prosthetic is more restrictive of movement by nature (Agrawal et al., 2013), thus reducing gait symmetry artificially rather than as a true product of performance. In the same vein, higher level prosthetics allow for a higher degree of free motion (Agrawal et al., 2013), which may serve to artificially increase gait asymmetry. Subjects will have been highly acclimated to the parameters of their original K-level foot, and due to the short duration of the data collection, may not have fully adjusted to the new foot. Thus, the data assembled above may not be a true representation of a subject's performance in their opposite K-level foot condition.

Furthermore, this practicum report only examines the first visit of each subject. Under the parent protocol, there are two study visits per participant and a short two-week randomization period wherein subjects will be randomized to wear a foot at or opposite their K-level in order to determine any acute effects of changing prosthetic functional level. It is possible that after the two-week period in the opposite foot, subjects may display an acute and significant change to gait and kinematic performance.

Future Research. As this internship practicum is adapted from a currently ongoing study protocol, the future of this research is still being explored. The parent protocol has ongoing recruitment efforts and is still in the process of running subjects through the complete protocol. Furthermore, the scope of that protocol aims to encompass additional outcome measures determined by balance tasks, quality of life surveys, and additional walking tasks. As a full

picture of the study's results becomes known, I expect a more accurate depiction of the relationship between a K2/K3 subject's performance in their native foot and a foot of the opposite level will become apparent. When and if such a relationship is discovered, I also expect that future research will look into examining a longer term relationship to support the theory between increased functional gait performance and wearing a higher K-level prosthetic.

At the heart of this research is the attempt to define and illustrate a relationship between a subject's performance with one K-level against the other. It attempts to demonstrate that the design limitations of a lower level prosthetic device translate into a measurable hard cap on a person's mobility and performance. If such a relationship is established, and a certain K-level of prosthetic equals a certain degree of maximum performance, then it may be possible that the current K-level system could be hindering the rehabilitation potential of our amputees. A K2-level device will only allow a patient to rehabilitate to the maximum degree of motion the device permits, even if the individual has potential to do more.

CHAPTER III

INTERNSHIP SITE AND INTERNSHIP EXPERIENCE

My research internship practicum was completed at the Human Movement Performance Lab located in the Center for Bio-Health at the University of North Texas Health Science Center. The Human Movement Performance Lab is a multi-department and multi-disciplinary lab, working with patient populations such as Parkinsons disease, amputees, children on the Autism spectrum, and balance in elderly populations. I worked with Dr. Rita Patterson, who served as both my on-site mentor and major professor.

During my internship in the Human Movement Performance (HMP) Lab, I participated in a wide variety of tasks both related to research management and conducting research protocols. I worked very closely with Cheryl Glosup and Lindsay Appleby-Keeton, the two Project Coordinators in the lab in order to learn all that goes on from a management standpoint. I was involved in protocol writing, preparing studies for full board review, expedited, and exempt protocols, document editing, updating and making changes to protocols during continuing review periods and more. From the very initial stages of preparing a research protocol from a grant to closing out a study for data analysis only, I had a little bit of experience for every stage of research across a wide number of different protocols. I helped prepare and collect Conflict of Interest and CITI certifications, as well as even conduct an internal audit of study records to make sure everything was stored properly and up to code.

On the other hand, I also had the opportunity to be involved in every stage of conducting a research protocol in the HMP. I was added as a Key Personnel on several studies so that I could physically interact with subjects and help conduct study visits. I had the opportunity to

experience wearing the same form-fitting clothes and having the reflective markers affixed, just like the study subjects do, and even helped pilot a few different upcoming study protocols. I learned about the CAREN system and how the cameras track the reflective markers in order to create a 3-D computer model. I learned how the Cortex program is used to track the markers and ensure there's appropriate spatial information for each marker at all times. I also learned how to further process the Cortex spatial data with the GOAT tool, which takes that information, makes calculations, and then outputs several kinematic and gait outcome measures for analysis.

Additionally, during my internship, I was tasked with creating multiple graphing template tools that would help illustrate the outcome measures in a more visually-pleasing way. For the AOPA study, which was the parent protocol for my internship practicum, I created a graphing template that takes all 8 data collections of a subject and then graphs every possible comparison of the collections all at once. Each comparison is graphed on its own tab, and the specific information relevant to that comparison is automatically printed out on each tab. I was able to adapt this graphing tool for the Heel Lift study, which only has 4 data collection points, and create another template for that study.

APPENDIX A
INTERNSHIP JOURNAL

Tuesday, May 31st, 2016

AM:

- Reviewed IRB example forms in order to get a better feel for the IRB process
- Observed demonstration of Cortex, V-Gait, D-flow, application of markers, applying harness/girdle, and demonstration of motion-capture system integration in use.
- Reviewed Pilot Grant Proposal for: Functional Performance and Evaluation of Dynamic Response Feet (K2/K3)
- Reviewed Introduction to Gait ppt for more background information on

PM:

- Spoke with Dr. Patterson about where to go on own practicum report.
- Reviewed Impact of Dynamic Response Prosthetic Feet on Functional performance and Quality of Life presentation pdf
- Brainstormed different ways to analyze data for practicum project, ex: Determine how to analyze 2K/3K classifications, 1st week vs 2nd week, moving between categories.

Wednesday, June 1st, 2016

AM:

- Attended lab meeting in the morning, discussing status of ongoing and future projects
- Discussed being added to current research protocols, adding self to IRB processing, going to meet with Cheryl later to go over IRB procedures, with potential to observe/practice informed consent procedure, and possible off-site data collection opportunity
- Observed troubleshooting with Cortex, D-flow, and GOAT creating static ghost markers when trying to export a Cortex file into GOAT

PM:

- Worked on research proposal presentation for 6/6 committee meeting
- Worked on preliminary analysis of sample gait data to determine best way to visually represent it, in terms of type of graph type, axis markings, labeling styles, etc.
- Observed more troubleshooting with the D-flow software and V-gait treadmill not properly adjusting and applying pitch during use

Thursday, June 2nd, 2016

AM:

- Observed calibration and start-up procedures for the motion-capture camera systems
- Worked on drafting research proposal
- Worked on committee meeting presentation

PM:

- Did additional research on the tools used in the lab to better understand them, including Cortex, D-flow, V-gait and CAREN systems
- Several students came in to the lab in the afternoon to help Amanda practice the Cortex software and D-flow. They got dressed in the fitted clothes and the markers were applied on the fixed points.
- Finally gained access to the PROJECTS folder. Started looking through all of the IRB paperwork for the AOPA data to familiarize myself with the research
- Still having issues with my ID badge not unlocking doors despite receiving a green confirmation light, went to police department for help. Keycard employee was not in, so I will contact Shanika Covington, (817) 735-5040 extension 5040.
Shanika.Covington@unthsc.edu for more help.

Friday, June 3rd, 2016

Out sick.

Monday, June 6th, 2016

AM:

- Held committee meeting with Dr. Patterson, Dr. Bugnariu, Dr. Rosales, and Dr. Gwartz to discuss research practicum project in CBH 470 conference room.
- Got Degree Plan and Advisory Committee documents signed, will scan to make copies before sending to Carla Johnson.
- Sat in on Glove and cerebral palsy project meeting with Dr. Mahdi Haghshenas-Jaryani, a developer of the REHAB glove. Dr. Patterson used her hand as a preliminary model, applying markers to each joint in the hand to get better data for the model. She wore a silicone tube above her index finger that had a wire running through it; when given current, it would flex and relax the index finger for the subject. Most of the morning was spent trying to recalibrate and refocus the cameras, because some of the markers were "blinking", disappearing and re-appearing when trying to motion-capture.

PM:

- The Glove team met again after lunch and this time we worked on marking up Dr. Patterson's pinky finger for more mo-cap measurements. Discussed trimming the width of the silicone finger so that all fingers could be monitored at once with markers. In the current design, the markers would clash and hit each other.
- Will meet with Dr. Haghshenas-Jaryani again on Monday the 20th to have Amanda model the silicone fingers and the REHAB glove itself to test time on/off and more validity testing.
- Finished reviewing the articles that the AOPA study grant proposal (topic of my research practicum) was justified with.
- Began working on formal Research Proposal due at the end of the month, starting with the one to two paragraph summary.

Tuesday, June 7th, 2016

AM:

- Continued to work on formal Research Proposal by drafting the Problem/Hypothesis and Significance portions.
- Downloaded and installed EndNote to facilitate citations and reference list construction for thesis and proposal. Started using EndNote to begin writing the Background section of the proposal, which requires a review of the literature supporting the hypothesis.
- Helped Amanda practice the protocol for the AOPA study by acting as a subject. I changed into the provided spandex and had the markers applied to the landmark positions across my body. I then got to climb onto the V-gait instrumented treadmill and see how the VR environment worked first hand. I completed a static and dynamic pose so that the markers could be identified, and then did a brief 15 second walk that was recorded.

PM:

- Worked with Cheryl on IRB for the Cerebral Palsy Glove study. We went through the various study related documents such as informed consent, protocol synopsis, and phone script and checked for clerical errors. Our main objective was making sure that the language and terminology remained consistent across all documents, which can be a huge task when you consider the sheer volume of written information an entire research study comprises. We also made sure to change from third person to second person when describing the study procedures on the informed consent and wherever else necessary (ie changing “the subject will be asked to do X” to “you will be asked to do X”. This task took the entire afternoon, and we still did not finish.

Wednesday, June 8th, 2016

AM:

- Came in early to continue working with Cheryl on the IRB for Cerebral Palsy Glove study. We continued to work on nailing out the small differences between the control consent form and the treatment consent form.
- A participant for the PREFER study came in around 10:00AM and I observed that study’s protocols. The study focuses on postural control and balance, so the participant was tested on their ability to rise from a chair without aid of the armrests, walk a certain distance, then turn around and return to the chair. In addition, the participant was tested on their ability to step forward, shuffle to the sides, and step backwards. Timing of these tasks was a big factor, as multiple trials were recorded.
- After those tasks, the participant changed into form-fitting spandex and was affixed with a harness and the reflective markers used for motion-capture. Once on the treadmill, they were tested on their ability to regain their balance after the treadmill ran and then abruptly stopped to simulate falling or slipping. This was done at two different speeds in order to simulate different intensity disruptions in balance.

PM:

- A second participant of the PREFER study came in during the afternoon just after the lunch break. As it was the same study, the same procedures were followed with the

physical tests, reflective markers, and motion-capture. The whole process takes about two and a half to three hours per participant.

- Continued to assist Cheryl with working on the CP Glove study IRB documents. When the day ended, we had compiled a short list of questions that we wanted to verify with Dr. Patterson before making sweeping changes to the protocol and other documents.

Thursday, June 9th, 2016

AM:

- Cheryl and I each reviewed the IRB documents on our own computers, with the hopes that they will be ready by Friday to submit for pre-review. By working separately as we finely looked for small details to correct, like font, margins, spacing and type size, we hoped to be able to more accurately pick up on anything the other might have missed. Since this study involves children, we had to be sure to correct tenses and pronoun usage as sometimes document would be referring to a parent/legal guardian and other times the subject themselves. The use of the 'Track Changes' feature made seeing what edits had been made and what the original looked like made the editing/reviewing process a whole lot easier to manage.

PM:

- Cheryl and I reconvened in the afternoon and went over the changes each of us made together. It took the entire afternoon, but we nearly finished checking every document in order to make it ready for the pre-review. There were a couple of things we still needed to check on the HIPAA forms that Cheryl was going to look into.

Friday, June 10th, 2016

With permission from Dr. Patterson, I took this day off so that I could complete travel arrangements to attend a family member's funeral.

Monday, June 13th 2016

AM & PM:

- I spent all of today working on my formal research proposal and nearly finished all of it aside from the Background and Significance section. My goal is to have it completely done by the end of the week so that I can give the committee 2 full weeks to review it before the deadline. I also plan to ask Dr. Patterson to give me some preliminary feedback on the rough draft before I send it out.

Tuesday, June 14th 2016

AM:

- I continued to work on my Research proposal, refining the background section and methodology to remove repetitive or non-pertinent information.

- The IRB pre-review for the Glove CP study came back, so Cheryl and I worked to implement those recommended changes into the protocol and all study-related documents.
- Last Friday was Carolyn's last day in the lab, so there was a Farewell Party for Carolyn held during lunch. We went to Piranha Killer Sushi and wished her the best of luck in PT school.

PM:

- After coming back from the Farewell Party, Cheryl and I finished continued work on the Glove CP pre-review modifications. This took most of the afternoon, but we were able to finish around 4:00.
- From 4:00-5:00 I resumed work on my research proposal.

Wednesday, June 15th 2016

AM:

- I attended the bimonthly Lab meeting and listened in on the status of various staff members and their projects. We discussed adding my name to Key Personnel for the AOPA and RLC studies so that I can assist in the data collection process.
- More work on the proposal, this time adding to the Limitations section and double/triple checking the citation style and reference list.

PM:

- I finally finished my research proposal in the afternoon, and asked Dr. Patterson if she could give me some feedback on it before I have to submit it to the rest of the committee. While waiting on this, I read up on Dr. Miller's RLC balance study that I am going to help out with in the future in order to get a heads up on the protocol and what to expect.

Thursday, June 16th 2016

AM:

- This morning we received a grant for a new AOA study, so I will really get the chance to see how the IRB side of things goes right from the start.
- I worked again with Cheryl to make a final sweep of the Glove CP study documents for any remaining errors or inconsistencies. Most of the edits made were about format and spacing rather than content. We will reconvene after lunch to compare the edits we made.
- I received feedback from Dr. Patterson on the draft of the my research proposal, and will work on making changes and improvements so that it will be ready to submit to the committee ideally by Monday the 20th.

PM:

- I met with Cheryl in her office and finished up the edits on the Glove CP documents so that they're ready for submission to the IRB. Tomorrow we will work on getting all the documents printed and ready. We need the original IRB application signed, 6 clean packets with the IRB application attached, a copy of CITI and COI for every key personnel, a copy of the PI's CV, and several copies of the grant application for a Full Board Review.
- I made a few additional edits to my research proposal and expanded the background information sections as per Dr. Patterson's recommendations. I still have a fair amount of revising to do, but I should be able to finish by the weekend.

Friday, June 17th 2016

AM:

- First thing in the morning I started to collate and put together the IRB packets for the Glove CP study. 6 copies of each key document, and a single copy of CITI and COI for key personnel, a single copy of the PI's CV, and several copies of the grant application. I compiled all that I could alone, because certain documents required color printing which is only available in Cheryl's office. I will wait till she is finished working with Amanda and Mahdi setting up in the lab for the Glove study to continue.
- There was a good deal of trouble trying to set up the cameras for the Glove study. The cameras kept diverging and there was trouble trying to properly calibrate the space.

PM:

- After coming back from lunch, Cheryl and I assembled the final copies of the packets for the Glove CP study. Everything looked good, so the only thing we have left is to double check the IRB application and it should be ready to submit by Monday. I also had a chance to visit the UNTHSC IRB office when I accompanied Cheryl to drop off an "Addition to Key Personnel" form for a sacral study.
- Cheryl met with Amanda, Mahdi, and Dr. Patterson to work more on the Glove preparations for Monday. I half-observed, half-worked on finishing up edits on the research proposal. I plan to give it some more thought over the weekend, and then send it out to the committee so they have ample time to review it before the deadline at the end of the month/beginning of July.

Monday June 20th, 2016

AM:

- First thing this morning I sent my edited research proposal to the rest of the Advisory Committee for review. There's a little under two weeks until the deadline (June 30th), at which time I will submit the proposal form with the committee's evaluation and signatures to the Graduate office.

- There was additional Glove testing this morning with Amanda as the hand model. Despite having done the calibration on Friday afternoon, there was still some jittering/switching of the markers in Cortex, so we needed to re-calibrate.
- Met with Steven to discuss collaborating on creating the excel templates for the AOPA study and more
- The IRB initial submission for the Glove CP study was completed, so Cheryl and I turned this in completely to the office downstairs.

PM:

- Helped Amanda, Cheryl, and Mahdi practice data collection with Cortex by helping tape down markers to make the process go more quickly. There was a strange issue with the loadout file not running things appropriately, so a good deal of time was spent troubleshooting what the problem might be. Mahdi eventually found an old backup copy of the same file that worked, so somehow the current file was changed.
- Met with Lindsay to draft memo about TROM and to fill out the continuing review. Enrollment, intervention, and study follow-up are complete, so the study is going to data analysis only.

Tuesday June 21st, 2016

AM:

- In the morning I met with Cheryl and we began working on the protocol for the new AOA Parkinson's study. We adapted various wordings from the grant and free-wrote other parts in order to fill out the protocol template.

PM:

- I began work on creating a UNTHSC Daily News advertisement that will run for the AOA Parkinson's study.
- Met with Lindsay and Cheryl to work on updating Key Personnel changes and the associated CITI/COI's, ie removing previous students, adding myself to the AOPA and RLC studies, etc.
- Went to the Wellness Fair with Lindsay, Amanda, and Cheryl down in the MET. They had free biometric screenings, chair massages and tables for campus organizations such as Toastmasters and the Community Garden. They also had therapy dogs to play with and plenty of freebies like note pads, pens, magnets and jar openers.

Wednesday June 22nd, 2016

AM:

- I resumed work on the UNTHSC Daily News advertisement for the AOA Parkinsons study, updating the parts about participation and compensation, and the age ranges.

- I drafted an ‘Addition of Key Personnel’ memo to the IRB that will function to add me to the studies discussed earlier at the lab meeting
- I completed the Research Conflict of Interest (RCOI) training and filled out regular Conflict of Interest (COI) forms to attach to the memo.
- I helped Gabriella practice administering/proctoring the motor skills assessment for VMIB by pretending to be a participant. It involved various tasks like fitting pegs into a board, threading string through a board, balancing on one foot, walking heel-to-toe, and throwing/catching a ball.

PM:

- I went with several members of the lab staff to the Grand Rounds lecture luncheon series held by UNTHSC. Today’s topic was low back pain research presented by Dr. John Licciardone, and he spoke about his study that compared OMT and ultrasound therapies on lower back pain relief and recovery.
- I spent the majority of the afternoon working on the AOA Parkinson’s study IRB documents. I added page numbers, looked for grammar errors, and tried to keep consistent phrasing of certain study-related terms.

Thursday June 23rd, 2016

AM:

- Got together with Cheryl and continued work on the AOA Parkinson’s study IRB documents

PM:

- I attended a post-award Grant meeting with Cheryl for the government funded Mentis study. The meeting went over PI roles and responsibilities, clarifications about budget and how costs/purchases/salaries should be handled, as well as other study matters. They emphasized the importance of logging hours so that when one of the key personnel is written as providing 15% of the work, they have put in at least that amount of time. This can be hard for any key personnel, as almost everyone working on a study also has other responsibilities they have to balance.
- Following the meeting, I helped Cheryl, Mahdi, Victoria, and Amanda practice data collection and Cortex use by assisting in putting on/taking off the reflective markers and taping them on/off.

Friday June 24th, 2016

AM:

- I to independently work on the IRB application for the AOA Parkinson study. I pieced together what information I could from the protocol and grant, and will fill out the rest in the coming weeks.
- I then got together with Cheryl and compared Tracked Changes notes to finish up the AOA Parkinson IRB. We are waiting to hear back from doctors Papa and Hensel, and then we can make some “final” adjustments.

PM:

- Worked on the IRB application some more
- Went with Cheryl down to the OMM/Family Medicine department in the MET to pick up the Progress Report. Desi was not there so we could not pick up the original, but we have the emailed signed version.
- Helped put new tape down to mark the camera locations in front of the treadmill.

Monday June 27th, 2016

AM:

- I received my committee’s evaluation of the research proposal. Now I have to collect their signatures, and attach a copy of the proposal to turn into the Graduate office. Still to do is to submit an IRB application for the study. I wasn’t sure what kind of application to fill out, so I emailed one of the IRB Office staff to ask for guidance. With Dr. Patterson’s signature, I now need to get Dr. Bugnariu and Dr. Rosales to sign and turn in before the deadline Thursday.
- I started working on an Excel sheet macro that will automatically select a range of values and create graphs based on that selection. I hope to use this tool in order to cut down time on data analysis when looking at gait data, as the excel sheets have 200,000+ data points each.

PM:

- Got a signature from Dr. Bugnariu on my research proposal evaluation sheet, all that’s left is Dr. Rosales
- Without knowing how many trials GOAT will spit out onto a data sheet, I’m not going to be able to use the same macro for every participant. If I had more of a computer science background, I might be able to figure it out, but I’m not familiar with the VBA coding language. This might be something to collaborate with Steven on.
- Instead, I’m going to try to create a template that takes a series of averages on the first sheet, and then auto-populates graphs on the second sheet. This will be a lot easier on me, as I don’t know the VBA coding language or computer science. I’ll still have to figure out how to get the data points averaged per section though.

Tuesday June 28th, 2016

AM:

- Continued working on the graphing template. I started creating the graphs that will auto-populate themselves when information is inputted. This assumes that I will have the averages somehow, but it is easier to complete this part first and tweak where the graphs look for their data later.
- I walked up the hill to the RES building and got Dr. Rosales's signature. I attached a copy of the proposal to the evaluation sheet and turned it in to the Graduate Office so that it can be filed.

PM:

- I continued working on the graphing template. For the sample data file I have, the template seems to be working fine. Copy+pasting the raw data into the first tab will automatically calculate the averages tab, and a graph is automatically drawn. However, these are static references and rely on the custom formatting and number of trials. In theory this idea should work, so I either need to get custom code written, or find an easier way to get the averages plotted. The next step will be look into GOAT (Gait Offline Analysis Tool) that is outputting the participant data to see if I can tweak how the data gets reported to an Excel sheet.

Wednesday June 29th, 2016

AM:

- I continued working on the graphic template to include more of the parameters listed in my research proposal.
- I accompanied Cheryl to go collect COI's in person from people we were unable to get in contact with over email. With those COI's in hand, we were ready to start preparing the packets for the Asthma continuing review. Since it was a continuing review, we prepared 6 packets total (1 master, 5 copies) and delivered them to the IRB office.

PM:

- After returning from lunch, I continued working on the template. I think I have figured out how I want the axis marks, grid lines, sizing and legend to be formatted.

Thursday June 30th, 2016

AM:

- I met with Cheryl this morning and went over the GRAIL/GOAT program to get a better feel for how the data is getting analyzed. When a data collection is completed, the files must be post-processed to fix missing or switched data markers in Cortex, and then

restreamed in GOAT/GRAIL where the numbers are crunched and can be exported into a usable format.

PM:

- I some of the student lab modules about Cortex and GRAIL/GOAT to get a better feel for the way the system as a whole works. I learned more about how the marker placement and designation within the system works, as well as the basic steps in running the program.

Friday July 1st, 2016

AM:

- I more in-depth observed Cheryl do post-processing on Cortex data, and the different troubleshooting methods you can use to fix the data. Sometimes markers just become unlabeled, and it's just a matter of telling Cortex what the marker name should be. Other times the marker can be missing completely, be switched with another marker, or a "ghost" marker could be throwing off the data. In these cases, there are a few options to solve the problem. Virtual markers use three other marker placements and an algorithm calculates where the marker ought to be based on its temporospatial relation to the three. The cubic method uses a cubic function and is only really used for small gaps of 4 frames or less. There's also a linear join method, but that one is only used in really rare instances.
- This experience combined with the other observations of data collection has given me a much better understanding of the way data is utilized and analyzed in the lab. Not only will this information be helpful towards understanding the way the lab operates, but also towards my thesis, as I can understand the step by step transformation rather than just the end product that GOAT/GRAIL spits out.

PM:

- In the afternoon I met with Cheryl and Lindsay and we prepared for an upcoming study audit. This involved making sure all the paperwork was in order, everything had been signed and dated, all the data was entered into the databases, and that everything was filed in the correct place. The whole process took about 2 and a half hours.

Monday July 4th, 2016

4th of July, UNTHSC Holiday

Tuesday July 5th, 2016

AM:

- This morning I worked on filling out and printing COI's for Sensory Conflict, Glove Stroke, Falls (Vibratory), Limb Loss, and TPTA Prefer studies. This comprised of making a separate document for each key personnel member, filling in their name and titles, and then printing them to be signed. For all the key personnel that work in the HMP lab, I will bring these to the Lab Meeting tomorrow to sign.
- In addition to creating COI's, I also checked and verified that every key personnel had a CITI training certificate on file and that it was still current.

PM:

- I spent the entire afternoon as a student observer of the July UNTHSC IRB meeting. This was an incredibly informative and eye-opening experience. The Board discussed continuing reviews of existing protocols, new applications for protocols, as well as violations and matters of research compliance. Continuing reviews were usually the quickest to deliberate on, as not many large changes are made aside from key personnel updates. For new protocols, they brought in the PI and the Board had a chance to ask any specific questions they had.
- I had to leave the room along with Dr. Bugnariu whenever an HMP lab study was brought to final discussions and votes, but otherwise I was able to witness the entire proceedings from start to finish.

Wednesday July 6th, 2016

AM:

- I attended the bimonthly lab meeting in the morning and listened to updates on what each lab member has been working on. I took the COI's I had prepared yesterday to the lab, as it is the best time to get all the staff in one place and get it down in one go. Some individuals on certain studies are either not HMP lab staff or non-UNTHSC affiliated, so their COI's will have to be emailed.
- Following the lab meeting, I met with Dr. Papa, Cheryl and Lindsay as we discussed what findings we had made during our own internal audit last week. This was in preparation for the IRB audit that is to occur next Monday, July 11th.

PM:

- I was tasked with preparing the Sensory Conflict study for the upcoming Continuing Review. For a Continuing Review, you need to submit 1 copy of the IRB Progress Report form, 6 compiled packets of the IRB-stamped protocol and each version of the consent form, 1 clean copy of the protocol and each version of the consent form, 6 copies of other study documents like questionnaires and advertisement flyers, and 1 copy of the conflict of interest (COI) form and current CITI certification per key personnel member.
- Most of the COI's for the Sensory Conflict study are signed, and all but one CITI certification are completed. Lindsay has the contact information for the remaining key

personnel, so she will email the remaining COI's and remind that one person of their CITI status.

- I spent the afternoon preparing and compiling the 6 stamped packets, as well as the clean consent and protocol. I also drafted the tracked changes version of the protocol that includes the key personnel modifications, as well as drafted the memo requesting and noting the modifications since the last IRB continuing review.

Thursday July 7th, 2016

AM:

- I finished up compiling the packets for the Sensory Conflict study. Just waiting on confirmation from Dr. Bugnariu about the study status (enrolling, data analysis only, closing), and if there are any other modifications to the protocol aside from key personnel before printing the tracked changes versions. After that, it should be ready to submit to the IRB.
- Dr. Patterson wanted some force plate data with a static and dynamic/walking trial to send to some colleagues. We markered up Amanda and used her as the body model for the data. Robert had to a bit of troubleshooting first and we Skyped in Motek, but that went on simultaneously as we put markers on.

PM:

- In the afternoon we had 2 TPTA (PREFER) study visits. Each visit lasted about 2 hours, and we collected data from standardized clinical tests as well as motion capture information. Since I have not yet been added to the protocol as a key personnel, I could only observe rather than assist. By the time the next study visit occurs, the Continuing Review for the study should have been approved and I'll be good to go.

Friday July 8th, 2016

AM:

- After hearing back from Dr. Bugnariu, the Sensory Conflict study will be moving to data analysis only. This was the last piece of information I needed to complete the progress report and the last changes to the protocol. I asked Lindsay to review the progress report and memo to make sure I'd remembered everything.
- We're still waiting on getting back some signed COI's as well as one current CITI certificate. When we finally get those in, I can just slip them into the packets and they'll be ready to walk down to the IRB office.

PM:

- In the afternoon I drafted the memo and progress report for the Limb Loss study while Cheryl worked on preparing the packets.

- I also started going back over the AOA Parkinsons study to check for grammar/spelling/spacing issues while we wait for Dr. Hensel's modifications. When we hear back from her, tracked changes should make it easy to compare the two versions and know where to place the edits.
- I've also been tasked to brainstorm a way to include a "stamp box" in the header or footer for IRB purposes. This way it gives them a uniform place to put the stamp, and makes it easier on us in the lab when formatting documents as there's already space set aside.
- Lindsay gave me a couple of tasks to work on for Dr. Miller's VMIB study, but I didn't have time to get around to them today. They will be first priority come next Monday morning.

Monday July 11th, 2016

AM:

- Starting with the task Lindsay gave me last Friday afternoon, I reviewed the VMIB documents for grammar, consistency, and terminology. Changed a few 'subjects' to participants and corrected a few pronouns when it came to informed consent of parent versus an autonomous participant, and made other miscellaneous edits to 8 documents in all.
- While this was going on, we also had an IRB audit of the TPTA Prefer study. This involves an auditor from the IRB coming into the lab space and reviewing all study related documents and electronic records to ensure that the protocol is being followed as stated. An auditor makes notes of when deviations from the stated protocol are made, and if applicable, when violations are made. The auditor will review the initial findings with the PI in case there are questions that they can answer right then and there, but ultimately they conduct another meeting at a later date to review the audit's total findings with the PI and Chair of the IRB. At that meeting recommendations and modifications deemed necessary are discussed in order to

PM:

- In the afternoon I drafted several versions of a document template for the IRB in order to standardize where they stamp. One top right corner box header version, one centered footer box version, and one version where the footer is a bit larger than normal dimensions to allow room for the stamp. A common feedback is that documents can get cluttered and leave little room for the stamp to be placed without overlap, so this was an attempt to fix that minor problem.
- I turned in the drafts to Lindsay and she sent them off to Dr. Miller to see which one she liked best to use on her protocols.

Tuesday July 12th, 2016

AM:

- I continued working on the AOA Parkinsons documents looking for grammar/formatting changes to make.
- Met with Dr. Patterson and went over the template I've made for the graphs and where to proceed from here. After speaking with her, I have a more concrete idea about where to go from here. I will be making three separate templates, one for raw data (per individual), one for averages (per individual), and one for averages per cohort.
- The key idea is that the templates will be able to look at and compare several different combinations of variables. You'll plug in the appropriate data on the first tab, and then the graphs will auto-populate. Ideally we will be able to compare Visit 1 vs 2, Prosthetic foot vs Sound foot, K2 foot vs K3 foot performance, and an individual's performance based on personal K-level.

PM:

- In the afternoon, Cheryl tasked me with updating some of the information on the AOA Parkinson. We removed one clinical balance test and added another, so there were several places in the documents that needed to be updated and changed.
- I also took this opportunity to add in the custom footer margins Cheryl created that specifically leave room for the IRB to have a consistent place to stamp.
- After this, I started work on making the Averages (per individual) template because I could adapt the prototype I'd been working on towards that. I will have to get in touch with Steve again about the raw data macro before I can work on that template.

Wednesday July 13th, 2016

AM & PM:

- I spent the overwhelming majority of the day working on getting the Averages template up and running. To begin, I made two tabs to plug the averaged data into that represent the two test conditions that will be compared. Across the top, I added boxes to add information like ID number, visit number, the participant's K-level and so-on. This information would be auto-populated in appropriate places throughout the template as well as on the graphs.
- On the graph tab itself, I created two separate tabs. One compares the Left and Right foot together for 1 condition (and L/R for the other condition next to it), while the other tab compares Left foot for both conditions (and R for both conditions next to it). This way the information can be visualized multiple ways and the relationships better understood.
- It will make it more apparent whether there are performance increases based on terrain (flat/incline), visit number, foot type, and so-on.

Thursday July 14th, 2016

AM:

- In the morning I continued working on the template. Each gait parameter gets its own graph, and there are four total different ways the graph should be drawn. Since there are also multiple sheets within an Excel doc, you also have to make sure the right tab and the right cell ranges are being referenced, otherwise the data might say one thing on the graph, but actually belong to a totally different parameter.

PM:

- In the afternoon, I attended the meeting that Cheryl and Dr. Patterson had with Dr. Hensel to go over the AOA Parkinson's study, as Dr. Hensel is the PI. She had several changes she wanted to make before we sent the study off to the IRB.
- After the meeting, I resumed work on the Average template.

Friday July 15th, 2016

AM:

- This morning I worked on collecting and printing the CITI's for Victoria's upcoming study. We had all but one CITI in our records, so this was a fairly easy task to complete.
- Following that, I continued working on the Averages template. I took a break from constructing all the graphs to tinker with graph sizing, formatting, and coloring.

PM:

- More work on the Averages template. I adjusted all the graphs I previously made to fit a standard size ratio, and then worked to create future graphs to match that so everything was uniform.

Monday July 18th, 2016

AM:

- I met with Steve this morning in person to fill him in on the status of the templates and what direction we were headed. He's going to write a code that will organize the individual raw data into a 3-D array, and the template ought to pull the data from the array and auto-populate graphs. This part needed code because there are a variable number of strides per participant per visit that GOAT/GRAIL accepts as usable, so you can't use static references like you can in the Averages template.
- We also met with Dr. Patterson so she could give us a better idea about the long-term goal and how the templates fit into that plan.

PM:

- Victoria's IRB submission was due today at 5PM, so I spent most of the afternoon working with her and Lindsay to get all of her documents last-minute proof-read, printed, and compiled into the 6 required packets.

Tuesday July 19th, 2016

AM:

- PREFER study visit
- I continued work on the templates.

PM:

- In the afternoon there was a new PREFER study visit. I indirectly assisted by helping move the rolling stairs into/out of position, and then passively observed the rest.

Wednesday July 20th, 2016

AM:

- I attended the bimonthly lab meeting this morning. I wasn't sure I had anything relevant to report so I initially did not make any announcements, but Dr. Patterson reminded me about the graphing templates I've been working on. If all goes according to plan, we should be able to use these templates on ANY study because all motion data is run through Cortex/GOAT/GRAIL.
- After the lab meeting, I started working on the templates again.

PM:

- I used the afternoon to finish up the Averages template to show Dr. B in the morning tomorrow. I made several different variations of the graphs output by changing the location of the legend and whether to use individual titles or not.
- I also ran a couple different analyses with the data we have right now in order to demonstrate how the template works.

Thursday July 21st, 2016

AM:

- This morning I met with Dr. Bugnariu and Dr. Patterson to go over the templates I was making for the AOPA study. I received feedback on the template's current state, as well as direction on how to proceed onward. It was decided the easiest thing to do would be to make a custom template for AOPA first, and then scale it back after it's complete for other studies.

- I will end up inputting all of the participant's data collections into the worksheet, and then have a tab for every possible permutation of the data.
- We also discussed adding an extra "baseline" measure to the Visit 1/2 comparisons that includes the person's original foot test. This will help determine the short and long term effects of switching feet, and for those randomized to wearing the same K-level, hopefully show that exposure to the protocol and lab has a minimal training/practice effect.

PM:

- I printed and compiled stamped copies of the Falls (vibratory) study for the upcoming Continuing Review.
- And then resumed work on the new Averages template.

Friday July 22nd, 2016

AM&PM:

- Today was a pure workday on the new Averages template. I created 8 tabs for all the data collections, and 12 tabs for every different permutation of the data
- I met with Dr. Patterson briefly to discuss my status as a CRM student. I've already submitted my proposal and committee evaluation before the deadline at the beginning of the month. Next week the Intent to Graduate form is due, and then the Intent to Defend form is due 30 days before the defense date. Dr. Patterson suggested I try to set a date at the end of October, beginning of November to allow for some breathing room in case there are extenuating circumstances.
- At the end of the day, I also helped Mahdi assess his code for the Eccentron by acting as a mock participant. This involved making eccentric muscle contractions on the machine up to a certain target force.

Monday July 25th, 2016

AM:

- I spent the morning working on the AOPA template.

PM:

- In the afternoon I was scheduled to participate in a mock run-through of the VMIB study to help Gabriela and Dr. Miller. I got suited and marked up, and we got about a quarter of the way through the protocol before we ran into issues with projectors not syncing up correctly and had to end it there.
- Afterwards I resumed work on the template.

Tuesday July 26th, 2016

AM:

- Spent the morning working on the template.

PM:

- Continued working on the template after lunch.
- I met with Dr. Patterson to verify what units the 2-D measurements used for length and time so I could label the graphs appropriately.

Wednesday July 27th, 2016

AM:

- Continued working on the template.
- I met with Dr. Patterson briefly to show her the design variations I had made for the 2-D measurements. She liked all of them for various reasons, so I consulted Dr. Bugnariu via email to see which she liked.
- For the purposes of manuscripts and such, Dr. Bugnariu liked the more traditional graph. I made this one the primary graph, and then at the bottom included the variant graphs just in case the other types were wanted in the future.

PM:

- More work on the template.

Thursday July 28th, 2016

AM&PM:

- I worked on the template all day. I've made good progress on the template this week, and finished 3 of the 16 total permutations.

Friday July 29th, 2016

AM:

- More work on the template this morning.

PM:

- I spent the majority of the afternoon working on the template again.
- I ran an errand with Cheryl over to EAD to pick up some data folders for an older study.

- In all, I finished 4 of the total 16 different permutations of the template this week. Progress is slow, but it's important that each tab get checked and double-checked if this template is going to be used repeatedly in the future. If one graph is using data from the wrong data collection tab then that graph will end up being misleading and/or useless.

Monday August 1st, 2016

AM&PM:

- Continued working on the template most of the day. Nearly finished now.
- Filed my Intent to Graduate form to the GSBS office. Now all that's left is to write my research thesis, schedule and file an Intent to Defend form for the thesis defense, and then the paperwork requirements for my CRM degree will be over.

Tuesday August 2nd, 2016

AM&PM:

- Continued working on the template. Only one permutation left, so I should be able to finish tomorrow morning after the lab meeting.
- I got in touch with Steve again today, he's still working on the Visual Basic code that will count and graph an Individual person's strides. Once he's finished with the code, I can then talk with him about graph designs so that they match what I've done with the Averages template.

Wednesday August 3rd, 2016

AM:

- Bimonthly lab meeting this morning. Today Dr. Yavuz's staff also met with us, so the entire HMP lab was together. In the future, we will meet altogether at the first meeting each month, and then the second meetings will be separate again.
- I reported about the progress I've been making on my template efforts.
- After the meeting, I continued working on the templates.

PM:

- I finished making the template for the last permutation. To be sure that everything is accurate before I start running actual data through it, I've decided to go through each tab and make sure each template is accurate and using the correct data set.

Thursday August 4th, 2016

Out sick.

Friday August 5th, 2016

Out sick.

Monday August 8th, 2016

AM:

- Continued working on checking the templates for accuracy.
- Met with Cheryl to go over some protocol wording, and then we also discussed GRAIL/GOAT and re-streaming. I looked at some of the data run with the new 3.2 version of the program, and it seems like some of the inconsistencies in measurements were fixed. Values of ankle rotation are no longer 9000 degrees, but a reasonable 7-12 range. We will have to re-run all the AOPA data in the new version, but that's not as huge a task as actually re-streaming.

PM:

- Sent out an email to my committee about scheduling a defense date. I'm aiming for the last week in October/first week in November to allow plenty of time before the deadline for corrections and/or rescheduling the defense in case something comes up.
- Continued checking the templates for accuracy.

Tuesday August 9th, 2016

AM:

- Started the morning by checking the templates for accuracy.
- Met briefly with Dr. Patterson to let her know what Cheryl and I found out about GRAIL/GOAT. After I finish checking the template, the next order of business will be to start running the AOPA data through the new 3.2 version of the software so I can have something to start writing my thesis with.
- I also met with Steve this morning about the individual template. The code he wrote will take any trimmed data file and graph the individual strides together based on leg and conditions like foot type or visit.

PM:

- I finished checking the templates for accuracy in the afternoon, and everything seems to be in order. However, a new challenge popped up in the form of comparing right and left legs. A positive value on the left leg rotation represents external rotation for that leg, but a positive value on the right leg represents internal rotation based on a right-hand ruled XYZ coordinate system.

- After speaking with Dr. Patterson, I will need to take another look at the data and make some design choices on positive/negative values and y-axis labels. For example, for rotation, I could use negative values to represent external rotation, and positive values as internal rotation. In that case, some of the values will need to be inverted (such as the left leg rotation) so that ALL positive values will indicate limbs performing the same kind of motion (external rotation in this case).

Wednesday August 10th, 2016

AM:

- After a lot of trial and error, I wrote some preliminary code in Visual Basic that will flip the sign values of whatever ranges I need so that positive values indicate one type of motion and negative values the opposite. Once I finish determining the directions I want the axis to represent, I can define what variables need their values switched. The end goal is to insert a 'Command Button' to the first tab of the worksheet that will perform all the necessary sign switches, and will be the last step a person has to take to prepare the graphs for use.
- After confirming that the code worked, I started working on orienting myself within the right-hand ruled XYZ coordinate planes. I then compared each variable to the coordinate plane to figure out what action the current positive/negative values indicated. From there, it was a matter of reconciling how I wanted to format the y-axis on the graphs and determining which variables needed to be flipped.

PM:

- After coming back from lunch, I continued working on the XYZ coordinate plane system. Having never worked with this sort of thing before, it took longer than expected. A lot of the movements were hard to model with myself, so I looked up different camera angles of people walking to figure out what axis of rotation each variable uses. Some, like trunk rotation or tilt, are fairly easy to figure out, but complex joints like the ankle are giving me a bunch of trouble.

Thursday August 11th, 2016

AM:

- I met with Dr. Patterson this morning to see if she could help me figure out what axis of rotation GRAIL/GOAT was using when it determined what motion constitutes the ankle variables. As it turns out, there's quite a bit of variability in what academics use. For example, researchers have used calcaneus relative to tibia, forefoot relative to calcaneus, and forefoot relative to tibia, which all generate different axis of rotation and thus create different kinematic graphing patterns. As a side note, we also discovered a journal article

about gait patterns with forward and backward perturbations that the lab might be useful for future research.

- Consulting the GRAIL/GOAT manual did not help, as it did not define what body markers were being used to describe the different ankle motions. Dr. Patterson suggested I search for examples of the different measurement methods and compare those to the shape of the AOPA data.
- When I work with Cheryl to re-run some of the data through GRAIL/GOAT, we will take a look at the program and see definitively which markers are being used for each kind of ankle variable.

PM:

- Comparing the AOPA data to online examples of kinematic norms is slightly more difficult than anticipated. Not only does the data have computing errors (like values of 9000 degrees of rotation), the fact that half of the measurements use a prosthetic leg means the graphing patterns are often skewed.
- To try to combat this, I'm going to plug in some of the GRAIL/GOAT 3.2 data Cheryl did for Heel Lift, as that data will more closely approximate "normal" gait patterns than prosthetic users will. This will also help shed some light on what reference markers are used on some of the trickier ankle movements, like abduction/adduction vs pronation.

Friday August 12th, 2016

AM:

- In the morning I worked on writing a VBA macro that would help rename some of the y-axis titles I had mislabeled. I didn't know enough to have the macro be fully automated and change everything at once, but it would rename whatever graph I had selected. I fixed all of the Moments with appropriate units (Nm/kg) as per what the GOAT manual has recorded.
- However, the renaming process ended up taking a lot longer than I anticipated. Perhaps because of my amateur coding ability, Excel froze up every other row of graphs, and crashed 3 times. After the first crash when I lost 5 tabs worth of changes, I had to start over and made sure to save my progress after each tab.
- I also took a break to start writing portions of my practicum report. I expanded a bit on the introduction and methods sections that I adapted from my proposal.

PM:

- I adapted the Moment graph renaming macro and made some minor changes so that I could rename the Power graphs with appropriate units as well (W/kg). Because of the same issues with Excel (freezing/crashing) that I experienced in the morning, it took pretty much the whole afternoon.

Monday August 15th, 2016

AM:

- Finished up the last 4 tabs of the axis title corrections for Powers variables.
- Looked at Steve's individual stride graphs and the VBA code, and then made notes to meet with Dr. Patterson later

PM:

- In the afternoon I met with Dr. Patterson to go over Steve's graphs
- Afterwards I e-mailed Steve back with the changes/questions we came up with. Most of the changes are aesthetic, like re-ordering the way the graphs get spit out to match the Averages template as well as sizing and labels.
- At Dr. Patterson's suggestion, I started looking for example graphs of kinematic norm graphs to help identifying which variables need to be inverted as per my efforts last week. I've also looked at the PDFs that GOAT generates as additional examples.

Tuesday August 16th, 2016

AM:

- This morning I decided to go to the library to continue working on writing my thesis. I continued where I left off last week on the Methods section. It's much quieter and easier to concentrate without all the things going on in the background with the lab.

PM:

- Continued looking for kinematic norms graphs. As noted last week, the ankle is particularly hard to find example graphs that match the same axis parameters that GOAT uses because there are a variety of methods to model an axis.

Wednesday August 17th, 2016

AM:

- I spent the morning in the library again working on a new literature review to help expand the introduction and background sections. I found a few articles I had not picked up on before, but I'm still determining where I can add them in.

PM:

- I plugged in some of the Heel lift data run through the new GOAT 3.2 and compared that to the work I've been doing to determine which values need to be inverted. It looks like

several of the variables have been adjusted to reflect positive values indicating the same type of motion (aka positive values meaning flexion), while other values still look like they need to be changed.

- I made a few adjustments to the VBA code that flips the sign values, and it should only change the variables needed under the new GOAT. I will still need to double-check the changes are accurate with a second data set, preferably the AOPA ones once Cheryl works out the issues her computer is having with GOAT.

Thursday August 18th, 2016

AM:

- Continued working on the Literature Review in the library.

PM:

- Lindsay and Cheryl gave me a new task that I can work on in the background, or during lull periods. They want me to go through all the studies we have and go into the protocols to see what we said about contacting participants for future studies. Some studies say we will keep this information in a database, while others might not specify, so they want me to make a record of what study says what. With that list, I should then double-check to verify that information is stored wherever the protocol says it is.
- Since there wasn't a whole lot more that I can do the Averages template without the AOPA data specifically, I went ahead and started working on this task.

Friday August 19th, 2016

AM:

- Worked on the abstract, acknowledgements, specific aims, and significance sections of the thesis in the library again.

PM:

- I spent the afternoon as a mock participant testing for Dr. Miller's VMIB study. Most of the issues that we encountered in the last testing had been fixed and we completed the majority of the protocol this time. There were still some weird things with the force plates registering forces besides the participant during a specific application, so we will probably test again next week or whenever they work out the problem.

Monday August 22nd, 2016

AM:

- Worked on the Internship Experience portion of my thesis with my impressions so far. I will update it as the deadline draws closer if anything changes.
- Also worked on the specific formatting and page numbering of the document. Some need to be labeled with roman numerals and some Arabic numerals, and there are a lot of spacing and font formats to adhere to as well.

PM:

- Worked on GOAT with Cheryl
- Started running AOPA csv (from Goat v3.2) through the Motek averages/SD template. Calculating the averages takes only 10-20 seconds, but when calculating the standard deviations Excel freezes up for 20-30 minutes each time.

Tuesday August 23rd, 2016

AM:

- Continued running AOPA csv through Averages/SD template made by Motek medical. The progress is extremely slow because of Excel freezing for long periods of time. Managed to process AOPA02 Visit 1 and half of Visit 2.*

PM:

- Processed AOPA02 second half of Visit 2 and part of AOPA05 Visit 1.*

Wednesday August 24th, 2016

AM:

- Finished the remaining data collections of AOPA05 Visit 1 and all of Visit 2.*

PM:

- Finished AOPA07 and AOPA11. With those complete, all of the current AOPA data has been run through Goat v3.2 and the averages and standard deviations have been calculated and saved.*

Thursday August 25^h, 2016

AM:

- Now that all the averages have been computed, I can start graphing each participant using the Averages template that I've been working on. I copy and paste the averages from the Motek Averages/SD template into the corresponding data collection tab on my template,

and the graphs are automatically generated. However, Excel still freezes up when I paste the values, so this step takes a while too.

- Started on transferring the AOPA02 Visit 1 averages values.*

PM:

- Transferred remaining AOPA02 Visit 1 and all of Visit 2 values.*

Friday August 26th, 2016

AM:

- Transferred AOPA05 V1 and one data collection from Visit 2.*

PM:

- I paused on transferring the AOPA data to take a look at the PDF report printouts that GOAT generates for each data collection. I compared the shape of the graphs as well as the axis titles to what I had worked out for myself, and found out that I had gotten a few variables wrong. I flipped the wrong side for pelvic obliquity, and a couple of variables didn't need their sign values (+/-) flipped to match the actual motion on the axis (extension/flexion).
- I had to go back and start changing the axis titles not only on the template, but also on the participants I'd already gotten through graphing.

**While Excel has been frozen this week, I've spent the wait time working on different parts of my thesis, secondary applications for medical school, or the task Lindsay and Cheryl gave me last week to catalogue what terminology and phrasing each study in the lab uses for contacting future participants, and then check to make sure that information is stored where the protocol says it is.

Monday August 29th, 2016

AM:

- Transferred AOPA05 Visit 2 and AOPA07 Visit 1.

PM:

- Met with Cheryl and Lindsay about working on IRB for some new studies. Cheryl sent me the grant for one of the proposals so I can familiarize myself with the protocol.
- Continued working on the patient recontacting task from last week.

Tuesday August 30th, 2016

AM:

- I met briefly with Dr. Patterson in the morning, and let her know about my progress.
- Transferred AOPA11 and that finished off the graphing templates. Next step is to start looking at the data and making comparisons.

PM:

- In the afternoon, Lindsay approached me with a new IRB task. She'd like me to create a protocol from scratch for Dr. Bugnariu's adult playground study proposal. I spent some time reading over the proposal several times so that I understood the study's aims and methods, and then got to work. When I'm finished, I'll send the draft back to Lindsay and Dr. Bugnariu and we'll collaborate more from there when Dr. B returns to the lab next week.

Wednesday August 31st, 2016

AM:

- I continued work on drafting the Motion Wellness adult playground protocol. Some portions, like the background and significance, can be taken straight from the proposal, but other parts need to be written from scratch.

PM:

- As I was finishing up the draft in the afternoon, I met with Lindsay to ask her a few questions about the study that weren't covered in the proposal. I learned that Dr.B wants it to be an expedited study, and that we intend to waive the need to consent, so I have changes to make in a couple places. Other things like desired sample size and inclusion/exclusion criteria Lindsay wasn't sure about, so we will have to wait till Dr.B gets back to correct those.

Thursday September 1st, 2016

AM:

- I made some last minute changes to the protocol and then sent it off to Lindsay and Dr. Bugnariu for review.
- I then started working on the Heel Lift task Dr. Patterson emailed me about last week. She wanted me to graph the Heel Lift data HL10 through HL18 using the Averages template I'd developed. Before I could do that, I had to make changes to the template; it was specifically set up to accept AOPA data.
- Mostly this involved renaming the data collection tabs to fit the Heel Lift protocol, as well as deleting certain info tabs (like Prosthetic Side and K-level) that were not

pertinent. Once everything was appropriately labeled for Heel Lift, I then began the process of transferring the Averages over and graphing.

- As with AOPA, Excel often freezes when copying the values over. Heel Lift only has half the number of data collections per participant as AOPA, so it's a bit faster in that regard, but also twice the number of total subjects.
- I transferred over and graphed HL10's averages.

PM:

- Transferred and graphed HL12 and 13's averages. HL11 needs to be restreamed again, so it got skipped over.

Friday September 2nd, 2016

AM:

- Transferred and graphed HL14 (only 2 collections valid), HL15 and half of HL16's averages.

PM:

- Transferred and graphed remaining half of HL16, HL17, and half of HL18's averages.

Monday September 5th, 2016

LABOR DAY HOLIDAY

Tuesday September 6th, 2016

AM:

- Finished the remaining half of HL18's averages graphs.
- Wrote an Instructions tab for both Heel Lift and AOPA templates to explain how to use them.
- Moved all of the AOPA and Heel Lift completed graphs over to the share drive.

PM:

- Met with Dr. Patterson to inform her of my progress and we discussed where to go from here. The next step is to compare the graphs side by side and look for patterns. Do any exist? Do they lend support for/against the aims of the study? There are 16 different permutations of a participant's data if they completed the study, so there are many different ways to look at the information. What makes the most sense at this point is K2 vs K3 for the first Visit, considering all participants have at least Visit 1, but only half have completed Visit 2.

- I will also consider creating the cohort template that averages all participants together. There are conceivably 4 different groups, K2 Right, K2 Left, K3 Right, and K3 Left, but since we only have 4 participants, I'm going to start off with just K2 vs K3 cohorts.

Wednesday September 7th, 2016

AM:

- In the morning we had the monthly lab meeting with the entire staff. I made announcements about my thesis progress and invited everyone to attend my thesis defense on October 31st. We have 3 birthdays in the lab this month (including my own), so we had breakfast tacos and Black Forest cake to celebrate all of us.
- Dr. Bugnariu and Dr. Patterson requested that I send them an update on the status of the data for the AOPA participants. Cheryl had already made good notes to that effect, so I made a few tiny updates and sent those out in an e-mail.
- Right after the meeting, we had PREFER08 Visit T1. I assisted with taping some of the markers, and then had an extra task assigned by Lindsay.
- Delivered red cups, tape measure, and stopwatch to Dr. Bugnariu's office for her Grand Rounds lecture during lunch. I will also attend the Grand Rounds lecture lunch and then afterwards ferry the lab tools back to CBH so that we can use them for the 1:00 PREFER participant appointment.

PM:

- Straight after the Grand Rounds ended, I headed back to CBH to bring back the lab tools and to assist with PREFER09 Visit T1.
- After the study visit, I got back to looking at the thesis data.

Thursday September 8th, 2016

AM:

- Assisted with PREFER10 Visit T1
- Started working on graphs of the deltas between study conditions. The easiest thing to look at first was Flat vs Incline of K2. Keeping in mind what each participant's original K-level is, we can compare the K-2 natural performance to that of the people wearing K2's for the first time to see whether a new foot type has a greater or lesser effect on performance on flat roads versus inclined roads.

PM:

- Continued working on graphing the K2 Flat vs Incline deltas.

- In the afternoon I met with Cheryl and we started to take a thorough look through the AOPA data. We compared notes on the IRB Progress reports, the study files, and the data collections to create an up-to-date list of the status of each participant. Some data was corrupted and could not be opened on the computer, some participants failed the screening process and never made it to the mo-cap portion, and some data was viable for only one visit.
- We also took this time as an opportunity to re-stream some of the data just to be sure, and Cheryl taught me the process. While she did the Cortex side of things, I handled the DFLOW computer and together we went step by step. We didn't end up finishing the restreaming process, so we had to re-schedule for another day.

Friday September 9th, 2016

AM:

- PREFER11 Visit T1
- I finished graphing the K2 Flat vs Incline deltas, and moved on to doing the K3 deltas for Flat vs Incline. Comparing these graphs to the K2 ones, I can then identify the immediate effects of moving from K2 to K3 or K3 to K2 on performance based on the size of the delta.

PM:

- Finished off graphing K3 Flat vs Incline deltas.
- Started graphing and comparing K2 Visit 1 vs Visit 2 deltas. Since one of the K-3 participants was randomized into wearing a K-2 foot for the two-week intermission period, this will be helpful in determining a longer-term effect of wearing a lower functional level foot. I can also compare these deltas against the K3 Visit 1 vs Visit 2 deltas that I will graph next to see if there are any increases/decreases in performance associated with returning to the participant's regular K3-level foot.

Monday September 12th, 2016

AM:

- Continued working on the K2 Visit 1 vs Visit 2 deltas.

PM:

- Finished K2 V1 vs V2, and started on K3 V1 vs V2 deltas.

Tuesday September 13th, 2016

AM:

- Continued working on K3 V1 vs V2 deltas.
- We also had a guest visitor, Dr. Richard Dewey from UT Southwestern. He came in and was introduced to all PI's and lab staff, and then given a small tour and demonstration. As Dr. Dewey's research is in Parkinson's disease, we showed him some of the PREFER protocol as related to falls using the treadmill to showcase the system. He was particularly interested in the VGAIT treadmill and how it could be used clinically as a form of standardization for testing patient mobility/gait/balance.
- After the lab tour, we all headed over to the library where Dr. Dewey would present a special lunch lecture titled "Parkinson Disease Biomarker Program: search for a disease-tracking clinical biomarker".

PM:

- After the lunch lecture, there was a meeting with the team that we've been collaborating with from UT Arlington on the Glove studies. They had a newer model of the glove and a matlab program that could be used to control the glove and record data.
- Continued working on K3 V1 vs V2 deltas.

Wednesday September 14th, 2016

AM:

- Finished the last of the K3 V1 vs V2 deltas. I can't think of any other useful change comparisons to make between the available data sets, so I'm going to switch to graphing the cohort all together on the same graph for each condition, i.e. V1_K2_Flat, V1_K2_Incline, V1_K3_Flat, etc.
- Started graphing the averages for V1_K2_Flat for all participants on a single Cohort chart. To do this I made a copy of the Deltas template, and then adjusted the relative references to look for tabs that said 'AOPAXX' instead of 'DELTA XX'. 89 graphs with four participants each time and 2 reference changes to make equals a lot of work.

PM:

- Finished adjusting the Cohort template and graphed all the V1_K2_Flat data for current data participants (AOPA's 2,5,7,11). Cheryl informed me that she had restreamed AOPA08 and that we would re-stream the rest of 11 and 12 tomorrow morning, so I had to adjust the cohort template.

Thursday September 15th, 2016

AM:

- In the morning I met with Cheryl and Robert to restream AOPA's 11 and 12. This is a tandem effort between Cortex and DFLOW in order to get the .mox files that GOAT uses to analyze the kinematic data.

- After we had the .mox files, we can load those into GOAT and it spits out PDF results as well as a .csv file that contains the raw data. With the new CSV's, Cheryl and I split up the task of plugging those into the Averages/Standard Deviations Excel calculator that freezes up because of the sheer volume of data points. With both of us working on the task, the total time spent frozen for one person was halved.

PM:

- In the afternoon I finished calculating the Averages and Standard Deviations for AOPA12 while Cheryl did 11. The first order of business was then running those new Averages through my Individual All Conditions graphing template before I started on the Deltas and Cohort templates again.
- Started adding AOPA08 and AOPA11 to the Cohort template.

Friday September 16th, 2016

AM&PM:

- Processed AOPA 11 V2 (K2/K3; Flat/Incline) and AOPA 12 V2 (K2/K3; Flat/Incline) through the Excel Averages template and my All Conditions graphing template. This took all day because Excel freezes when calculating averages and standard deviations in the Averages template, and again when copy+pasting that data into other spreadsheets.

Monday September 19th, 2016

AM:

- Started work on adding AOPA11/12 to the Cohort template. I have to go through every single graph and manually add references to AOPA11/12 data tabs, so it takes a long time to get them back up to speed.
- Once I have AOPA11/12 fully added, I can then copy and replicate the tab for a particular data collection (ie V1_K2_Flat) and then more quickly adjust the references all at once to reflect a different data collection (ie V2_K2_Flat). This saves a bit of time over manually selecting the ranges from each tab for each graph each time.

PM:

- Still working on AOPA11/12 on Cohort template.

Tuesday September 20th, 2016

AM:

- Switched to working on adding AOPA11/12 to the Deltas template. It's basically the same process as the Cohort template, but there are a few calculations that have to be done before it can be graphed. I can't use the same work as the Cohort template because the reference ranges are different and don't overlap nicely.

PM:

- Met with Dr. Patterson after a PREFER exercise visit and brought her up to speed on my progress. I wasn't sure where I should be proceeding with my analysis of the data, and she gave me feedback and advice on how to proceed. For example, she suggested I might include symmetry indices between sound and prosthetic legs as another indicator of performance in addition to the deltas.
- I participated as the body model for Victoria's piloting of the EHB study. We did several clinical tests for balance, coordination and walking speed, and then marked up. Victoria's study is looking at hearing loss and effects on balance, so she had prepared an audio track that simulates hearing loss. It has babble playing in the background, like you might hear in a busy restaurant, and the participant is supposed to listen for and repeat back simple sentences from a particular distinct voice. In addition, there were random perturbations similar to the ones done in PREFER that would interrupt/interfere with sentence reproduction.

Wednesday September 21st, 2016

AM:

- We had another lab meeting this morning. It was Cheryl's overall last lab meeting and marked the last day Lindsay is available in the lab before she leaves on her honeymoon. For the next two weeks, we will be down both Project Coordinators. Their responsibilities have been divided between the lab staff and myself. I've been briefed on the status of the upcoming Continuing Reviews and protocols that need to go in for October so that I can take care of a good bulk of the work for Lindsay before she comes back, and before the new hire for Cheryl's position comes in.
- I finally transferred all of my work to the share drive for easy access under the Student Projects folder. In there, I copied over the graphing templates I've designed for Heel Lift and AOPA, as well as all the completed graphs that I've done so far. All the graphs I've done for Heel Lift and AOPA were also uploaded to their respective projects folder under [Project Name][Participant ID]_Averages_All Conditions. The "All Conditions" nomenclature was added to differentiate the graphs I've made versus the ones already available on the share drive.

PM:

- I decided to switch to a faster but more inconvenient method of graphing the deltas. Rather than using one Excel file that has all the possible ways to graph the variables, it will only graph whatever two data sets per participant are put in. It opens up a lot of room

for error if I am not careful copying and pasting the right data set over, and it means I'll have to look in several places to compare all the data, but it saves time in that I don't have to manually adjust the reference ranges for each comparison.

- With this new method, I was able to finish up K2 Flat V1 vs V2, and then proceeded to graph the K3 Flat V1 vs V2, V1 Flat K2vsK3, and V1 Flat K3vsK2 combinations.

Thursday September 22nd, 2016

AM:

- Continued working on the deltas, and graphed V1 K2 Flat vs Incline and V1 K3 Flat vs Incline. That's all the most useful combinations of the data that I can think of, so I'm now looking for patterns in the data that are relevant to the hypothesis.
- Today for lunch the majority of the lab got together and celebrated Cheryl's departure from the lab by going to Milano's for lunch.

PM:

- After lunch, I came back and continued to look for patterns in the data.

Friday September 23rd, 2016

AM:

- Assisted in some restreaming of Heel Lift with Cheryl and Robert.
- Afterwards, I continued looking at the different Deltas. Dr. Patterson suggested I look at the knees and ankles, so I focused on that.
- I also helped Cheryl with formatting the data collection sheet for the Avazzia study. Microsoft Word was not cooperating very nicely, so it took quite a while to get the columns and spacing just right.

PM:

- I started graphing the absolute value of the Deltas as well to help see the magnitude of difference between two data sets. If K2 participants have a greater max magnitude of change compared to K3 participants for something like ankle flexion, and that magnitude is repeated when the K3 participant wears the K2 foot, then it lends credence to the part of the hypothesis that the K2 foot lowers a person's max functional ability.

Monday September 26th, 2016

AM:

- Continued working on graphing the absolute values of the Deltas for the change between Flat and Incline on K2 feet, change between K2 and K3 feet on Flat, and change between K2 and K3 feet on Incline.

PM:

- After graphing those things in the morning, I decided to work on splitting the graphs into a K2 group and a K3 group. This way it will be much easier to visually assess whether there might be a pattern in K2/K3 performance. So far, it seems like there aren't enough participants/data to make any solid conclusions.

Tuesday September 27th, 2016

AM:

- I started this morning calculating gait symmetry by subtracting right foot performance from left, and then taking the absolute value. The more asymmetrical, the higher the value will be. These are also different from deltas in that they only look at one data collection, ie V1_K2_Flat. Later on I can look at the deltas/change in symmetry from one collection to the other.

PM:

- After finishing up the template for Symmetry, I plugged in all the V1_K2_Flat data sets and looked at the data table. I found that the K2 participants had better gait symmetry than the K3 participants across the board in trunk rotation, and power of hip ab/adduction and ankle flexion. On the other hand, the K3 participants had better symmetry with respect to pelvic rotation, pelvic tilt, and knee rotation, despite wearing the unfamiliar K2 foot.
- After discovering that result, I decided to immediately start looking at the change in gait symmetry between a K2 and K3 foot performance on the Flat road. I found even more results this time, as the K2 participants had a smaller change in symmetry (and thus performance) in trunk flexion, trunk rotation, hip flexion, hip rotation, and ankle pronation. Similarly, they had smaller changes in symmetry in hip rotation and knee rotation moments, and ankle flexion power.
- At first glance, this seems to suggest to me that K2 participants have an easier time adjusting to the K3 foot as the maximal changes in the symmetry of their gait are lesser than the minimal changes in gait symmetry of the K3 participants. If this is true, then the reverse idea is supported that a K3 participant wearing a K2 foot could have a decrease in functional performance.

Wednesday September 28th, 2016

AM:

- With yesterday's results in mind, I worked on calculating the same K2 vs K3 comparison but during the second visit. This should be interesting because now the effects of the

short term randomization come into play, but also the fact that not every participant has completed their second study visit.

- After doing the calculation however, there were was only one variable, and it was again ankle flexion power. However, I don't find this result to be particularly compelling because there is only one K2 participant who has completed the study. The disappearance of matching results from the Visit 1 symmetry analysis could be for any number of reasons. Perhaps there was a training effect associated with K3 participants who wore the K2 foot for two weeks. Similarly, the K2 participant who completed the study was randomized to wear the K3 foot for two weeks, so perhaps their level of asymmetry normalized to the asymmetry of a regular K3 participant.

PM:

- I took a second look at the Visit 2 data and this time looked to see if the K2 participant had MORE max change in asymmetry than the K3 participant's max change, and found 19 variables where this was true. I'm not exactly sure what this implies at the moment.
- I moved back to regular symmetry comparisons and looked at the V2_K2_Flat data collection. In this instance, K3 participants had less symmetry than K2 participants in progression, hip ab/adduction, and knee ab/adduction moments, ankle flexion power, stance.swing, stride time, and swing time variables.
- This does not take into account randomizations yet. I will have to further analysis to see whether how the symmetry of K3 individuals randomized to wearing a K2 foot for two weeks compares to the symmetry of the K2 natural participant.

Thursday September 29th, 2016

AM:

- I started this morning looking at the randomizations and how that effected the level of symmetry during the second study visit. There was only one K3 participant who has completed the study with the K2 randomization, and there was no across the board conclusion that could be drawn. A handful of the variables showed increased symmetry, while others showed decreased symmetry, and some had relatively the same amount of symmetry as before.
- The K2 participant who completed the study showed decreased symmetry for most variables on the K2 foot. However, this participant was also randomized to the K3 group, so they had just spent two weeks wearing a K3 foot and were probably acclimated to a different gait.

PM:

- I worked on calculating the V1_K3_Flat and V2_K3_Flat symmetry comparisons.
- V1_K3_flat showed that K2 participants still showed more symmetry with trunk rotation, ankle flexion, and ankle pronation, as well as the knee rotation moment and ankle flexion power. This is despite the fact that the K3 participants are wearing their regular

prosthetics and the K2's are wearing a prosthetic outside their norm. I am not sure what conclusion to draw from this.

- On the flip side, K3 participants showed more symmetry with respect to knee rotation. In all other variables, there was overlap between the maximal asymmetry and minimal asymmetry of the K2 and K3 subcohorts.

Friday September 30th, 2016

AM:

- I started looking at the V2_K3_flat symmetry comparison that I calculated yesterday but didn't get a chance to look at.
- I found that the K2 participant, who was randomized to wearing a K3 foot for 2 weeks, showed more symmetry in hip flexion, hip rotation, ankle ab/adduction, and ankle pronation, in hip ab/adduction and knee ab/adduction moments, ankle pronation power, and stride length.
- Conversely, the K3 subcohort showed more symmetry in trunk tilt, pelvic tilt, knee ab/adduction, knee flexion, knee rotation, ankle flexion, progression, ankle flexion moment, hip ab/adduction and hip rotation power, stance.swing, stance.time, and swing.time.
- It's difficult to make a concrete assessment of why the K2 had better symmetry in some areas while the K3's had better symmetry in others. Some of this could be due to the K2 participant having worn the K3 foot for two weeks and gotten used to it, while two of the three K3 participants had a K2 foot randomization and when returning to the K3 foot, were not accustomed to its properties.

PM:

- The next step is to compare the visit 2 symmetries of K2's wearing K2's(0), K2's wearing K3's(1), K3's wearing K2's(2), and K3's wearing K3's(1). The results for this analysis were all over the place.
- For the V2_K2_Flat data collection, there were no K2 participants randomized to wearing the K2 foot for two weeks,
- K2 participants randomized to wearing the K3 had the most symmetry for variables progression, hip ab/adduction and knee ab/adduction moment, ankle flexion power, stance.swing, stride time and swing time.
- K3 participants randomized to wearing the K2 had the most symmetry for variables hip flexion, ankle ab/adduction, ankle rotation, and knee rotation moment.
- K3 participants randomized to wearing the K3 had the most symmetry for variables trunk rotation, pelvic obliquity, pelvic rotation, hip ab/adduction, knee rotation, ankle flexion, ankle pronation, stance time, and walking speed.
- The K3 naturals (K3 wearing K3 randomization) had the most number of variables with highest symmetry (8 variables), followed by the K2 wearing K3 randomization (7), and

then the K3 wearing K2 randomization (4). From a non-statistical and purely observational standpoint, this seems to suggest that there is a net benefit to gait symmetry from wearing the K3 class of prosthetic. However, this is limited by the fact that there are no K2 naturals that completed the study. There are still 22 variables in which no combination of personal classification and foot randomization produces overall better gait symmetry, so there is still plenty of room for the K2 naturals to produce better gait symmetry.

- The next step will be doing the same analysis with the V2_K3_flat data collection and seeing what results come up.

Monday October 3rd, 2016

AM&PM: Out Sick

Tuesday October 4th, 2016

AM:

- Looking at the V2_K3_Flat symmetry analysis, there were no K2 randomized to K2 feet participants
- The K2 randomized to K3 participant had the most symmetry in variables progression, hip ab/adduction and knee ab/adduction moments, ankle flexion and ankle pronation powers, stance.swing and stance time.
- The K3 randomized to K2 participants had the most symmetry in variables hip rotation, knee flexion, ankle ab/adduction, ankle flexion, ankle rotation, knee flexion and knee rotation moments, knee flexion power, and stride length.
- The K3 randomized to K3 participant had the most symmetry in variables trunk rotation, pelvic obliquity, pelvic tilt, knee rotation, ankle pronation, ankle flexion moment, and swing time.
- Again, this analysis is hampered by the fact that there are no K2 randomized to K2 participants to be absolutely sure, as there are 19 variables in which there no combination of personal classification and randomization hold the best gait symmetry.
- This time it was the K3 participants randomized to K2 who had the most symmetry variables (11), followed by a tie of K2 randomized to K3 (7) and K3 randomized to K3 (7). I would have expected the K3 naturals (K3 randomized to K3) to be the most symmetrical.
- PREFER13 T0 Study Visit

PM:

- For both K2 and K3 flat Visit 2 data collections, the K3 randomized to K3 had the most symmetry in trunk rotation, pelvic obliquity, knee rotation, and ankle pronation.

- K3 randomized to K2 had the most symmetry in ankle ab/adduction, and knee rotation moment.
- K2 randomized to K3 had the most symmetry in progression, hip ab/adduction and knee ab/adduction moments, and stance.swing.
- PREFER12 T0 Study Visit
- I met with Dr. Patterson at the very end of the day to share the results I had discovered last week. She gave more feedback and I have a slightly new direction to go in insofar as graphical results.

Wednesday October 5th, 2016

AM:

- Weekly lab meeting
- I started working on incorporating Dr. Patterson's feedback into my analysis. I reworked the Symmetry to include both sum totals and average totals, as well as graphed the symmetries all together. I also started to focus on the hip, knee, ankle flexion values and the 2-D kinematics.
- Unfortunately, some of the values for ankle flexion on AOPA02 and AOPA08 suffer from a problem encountered earlier, a gimbal lock that gives values of 17000 degrees of rotation which is way off.

PM:

- In the afternoon I loaded AOPA02 and AOPA08 into GOAT to see if I couldn't troubleshoot why those values were still being generated even when the new 3.2 version of GOAT seemed to fix them previously. There were no static ghost markers interfering with the analysis, nor were there any points where the ankle markers suddenly changed location.
- After some more digging, I found out that there's an option to reprocess the kinematic data when you first load a file. I chose this option and the values for ankle flexion seemed to be corrected, so I went ahead and did this for both data collections where this happened.

Thursday October 6th, 2016

AM:

- Because I reprocessed two of the data collections yesterday, that meant that I had to run the raw data file through the Motek averages and standard deviations calculator template again. It took approximately an hour and a half to get both of the data collections re-run and then inputted into the appropriate place in the files.
- With the newly corrected data collections in place, I re-did my symmetry analysis and found much more reasonable results. Now I'm looking to compare K2 vs K3

performances based on the level of asymmetry present, as well as the magnitude of change of symmetries between performances.

PM:

- PREFER04 T2 Visit took up most of the afternoon. I assisted with applying markers, being a spotter, resetting the foot placement parchment, and taking the markers off.

Friday October 7th, 2016

AM:

- In the morning Dr. Patterson and the rest of the staff made a presentation to an Insider Tour from the university about the HMP lab and all that we do here. She talked about each of the PI's area of expertise and ongoing research, and then we gave several demonstrations of some of the study protocol tasks. I demonstrated the bugs and birds scenario where a participant has to walk on the treadmill and then intercept bugs/birds that fly at them on the VR screen with their hands. There were also demonstrations of the shooting gallery ducks, Dr. Yavuz's cooling technology, and the eye-tracker glasses that Dr. Miller uses.
- Following the Insider Tour, I resumed working on the symmetry analysis.

PM:

- I created comparison graphs for all K2 performances, all K3 performances, all data collections together, and finally a change in performance graph. The change in performance graph shows the difference between the K2 and K3 performances, and whether which foot had more asymmetry or not.

Monday October 10th, 2016

AM:

- This morning I sent Dr. Patterson a final draft of my thesis. I'm still working on the data analysis and results, and I have more formatting to do once I'm satisfied with the body of content. However, I've been a bit lost as to what type of statistical analysis best fits my data. After speaking with Dr. Patterson, I have a much better reassurance that I was making the right decision to go with a paired t-test.

PM:

- I participated in the REHAB glove study as a control participant. First Dr. Bugnariu affixed the glove and we ran the collection several times. Whenever the glove was interrupted, we would reset and re-calibrate, and there goal was to get 15 minutes total of "intervention". Following that collection, the glove was removed and I answered a short questionnaire about my experience. Finally, they timed to see how long it would take for me to don/doff the glove alone.

- Following this, I continued working on my statistical analysis. I actually think that a two-way repeated measures ANOVA with replication might be more appropriate than a paired t-test so that I can also account for interaction between my outcome measures since they are all taken from different areas on the same leg.

Tuesday October 11th, 2016

AM:

- Continued working on my thesis draft. I finalized the statistics for the gait analysis and then ran them using Excel's data analysis feature. I then created tables in my word document and transferred over the results of the paired t-tests and the repeated measures ANOVA. From there, it was a matter of reporting the meaning of the statistics in standard format.
- We had a special goodbye lunch for Lindsay today at La Familia Mexican restaurant, as she will be leaving the lab later next week.

PM:

- I continued working on my thesis draft. I renamed a few of the figures in the results section to make it easier for the reader to understand whether I was talking about the K-level of the subject, or the K-level of the foot they were wearing.

Wednesday October 12th, 2016

AM:

- I expanded on multiple sections of my thesis, including more information about the K-level system and what each level represents, as well as more information about what walking and gait have to do with the project. This will help to further explain the background of the research to people not familiar with gait and kinematics.

PM:

- Lindsay asked me to look over the TC copy of the Rat protocol that she's been working on. I checked on grammar and syntax, and tried to make sure there weren't any glaring errors, but didn't find many things to change.
- I continued working on improving my thesis per Dr. Patterson's previous feedback.

Thursday October 13th, 2016

AM:

- I worked on reformatting the bibliography section of my thesis. I had previously used the numbering system when I had made the proposal, but then switched to APA style on accident when I was working on improving the thesis. Overall I like the format of the APA style better, so I decided to convert the whole document to that style.
- I also did a last minute literature search to see if I could find any more supporting evidence and background information to my thesis, but did not come up with anything directly related or not already stated.

PM:

- I met with Dr. Patterson to go over the feedback she had on my most recent draft. She suggested that I also report on some of the 2-D kinematics as well as the graphing template tools that I had created. There were also various other suggestions and word choice notes to go over. One major thing that she noticed was that I used the passive voice in the methods and procedures section. "Subjects will do X, data will be collected, etc." instead of "Subjects did do X, data was collected, etc."
- After the meeting, I went to work on gathering the 2-D kinematics together so I can add that to my results section. I won't be able to use the symmetry template that I'd already created because the 2-D kinematics are identical per leg.

Friday October 14th, 2016

AM:

- This morning we had an AOPA participant come in for his second visit and assisted where needed. This took the majority of the morning to do both the clinical tests and the balance tests on the treadmill.
- The whole lab had a working lunch meeting to discuss the upcoming ISPGR training school that we will be hosting in late November. Each PI will give a presentation session on their research and a short demonstration of a study protocol where attendees can volunteer. We will also have data already processed that attendees can attempt to analyze. I will be working with Dr. Patterson, Amanda Robert, and Julia to demonstrate motion analysis of large and small volumes, whole body vs hand and wrist kinematics.

PM:

- I worked on completing one last draft for Dr. Patterson to review. It has all the statistical analyses as well as the addition of the 2-D kinematics and other revisions per her feedback. I will attempt to make any further corrections as she gets back to me so that I can submit it to committee on Monday.

Monday October 17th, 2016

AM:

- Worked on the last touches to my thesis draft. I incorporated feedback from Dr. Patterson over the weekend, and now added several pictures to help illustrate the technology that helped me accomplish this project. In addition, I also added one final section about the graphing template tools that I've created to help analyze data for the parent AOPA protocol.
- I asked Julia for help with finalizing the formatting, as she had just completed CRM last December and I was struggling to make all the page numbers and formatting work. She had very helpful advice and was able to show me how to create separate numbering schemes so that the first section had roman numerals and the rest was labeled in regular Arabic numerals.

PM:

- Turned in thesis draft to my committee
- Helped make final edits to the Rat study and helped Lindsay and Julia prepare the packets to submit to the IRB review

Tuesday October 18th, 2016

AM:

- PREFER07 T2 Study Visit

PM:

- Worked on ppt for thesis defense

Wednesday October 19th, 2016

AM:

- Weekly lab meeting
- Worked on ppt for thesis defense
- Printed and scanned a COI for Don for PD Fatigue

PM:

- PD01 Study Visit

Thursday October 20th, 2016

AM:

- PD02 Study Visit

PM:

- Worked on ppt for thesis defense and began practice of speech/presentation

Friday October 21st, 2016

AM&PM:

- I decided to write out an outline of my thesis presentation to help make sure I hit all the points I wanted to on the slides. I plan to reference them as notes when needed, but I would like to have the entire presentation memorized before my defense.
- After I finished this, I continued practicing and memorizing the speech.

Monday October 24th, 2016

AM&PM:

- Practiced and rehearsed my thesis defense. Over the weekend I transitioned from looking at the speech I'd written to notecards, and I'm down to 25 cards.

Tuesday October 25th, 2016

AM:

- I went to a meeting with Lindsay along with several other HMP lab members. We discussed how Lindsay's responsibilities would be handled now that she would be working part-time and remotely from home.
- More thesis practice.

PM:

- Continued practicing my defense, down to 14 notecards now and the rest memorized.

Wednesday October 26th, 2016

AM:

- I made some last minute edits to my thesis defense presentation and practiced rehearsing it with Julia.
- I also met with Dr. Patterson afterwards to practice presenting to her and received feedback. We're going to meet again tomorrow after I work on incorporating her recommendations.

PM:

- I went to my CRM friend Phillip Escarsega's thesis defense in the afternoon. His presentation looked at the history, development, and usage of Statins and PCSK9 Inhibitors as treatments for managing patient cholesterol. This exposed me to what kind of atmosphere to expect from the defense, and gave me a few ideas on how I might improve my own presentation.
- I helped Gabriella refresh her knowledge of the WASI IQ test by serving as a mock subject for her to practice on, as she had a data collection coming up.
- I also assisted Victoria with testing her Hearing Loss audio files she's trying to validate for her research.
- In between and after each of these things, I continued working on my thesis presentation and incorporating feedback I've received.

Thursday October 27th, 2016

AM:

- I worked on finishing up the corrections, alterations and incorporation of feedback I've received from Dr. Patterson and others. I did some major reformatting of the flow and outline of my presentation, including creating new figures and tables to help simplify the data for an audience that might not have a huge background on the subject matter.

PM:

- We had a PD03 study visit scheduled, but the participant did not show up. Instead I worked on rehearsing my presentation.
- I met with Dr. Patterson one more time to show her the new reformatting and outline of my presentation. I redid the background section and included more information on the HMP lab as well as a more information on the outcome measures.

Friday October 28th, 2016

AM&PM:

- Continued practicing my presentation.
- Helped Lindsay and Julia with a few minor IRB tasks.
- Julia also recruited me to help print and compile the packets for the VMTD protocol initial submission and the VMIB modifications. VMTD required 6 copies of everything while VMIB only had 1 copy, and then we delivered those to the IRB office.

Monday October 31st, 2016

AM:

- This morning I finally defended my thesis with committee. I gave a public presentation of my research, answered public questions, and then met with my committee privately for the rest of the defense. The committee asked me several questions, and then I stepped out while they deliberated. My defense passed and I will be graduating with distinction with my masters!
- As my parents came into town to watch my defense, I introduced them to everyone at the lab and gave them a short tour of the lab.

PM:

- After lunch, I worked with Lindsay and Julia to help prepare answers to the list of pre-review questions and make the modifications the IRB requested for the Motor Function IHA study protocol and documents. The list was items A through R, so after making a change to one document, we then had to check every other document to make sure the language and information was consistent across study documents.

Tuesday November 1st, 2016

AM:

- Worked on making sure we had everything ready for the continuing review of the retrospective medical records study. As this research fell under expedited review, we only had to submit three clean copies of all study documents, in addition to one stamped copy and one tracked changes copy as well as the CITI and COI's.

PM:

- I worked with Julia to scan in the backlog of documents that Lindsay hadn't gotten around to yet. These included Board Action notifications, some COI's for upcoming studies, and CITI/RCOI's. There were probably about 30 documents that had to be scanned, saved and sorted, and then physically filed in the filing cabinet in Julia's office.
- Lindsay/Julia finally received the last CITI training from Dr. Miller's PT students, so we were able to file the Addition to Key Personnel for them for VMIB, RLCB, and VMTD.

Wednesday November 2nd, 2016

AM:

- This morning we had another bimonthly lab meeting. I brought donuts and kolaches for everyone as a way to express my thanks and gratitude for making my experience in the lab such a great one and for teaching me everything that made my thesis possible. We also ended up celebrating Vicki and Gabriella's birthdays, which added a chocolate cake to the mix.

- Afterwards, I went to watch Vicki's presentation on Tai Chi and Parkinson's Disease along with Julia and Dr. Bugnariu. It was really interesting to see that tai chi had significant improvement to symptoms compared to resistance training and a light stretching regiment.

PM:

- After lunch, Julia showed me how the research disbursement log and study funds records work. She also received the final COI she needed for the Sacral study, so we started getting the paperwork for that continuing review ready.
- We also submitted the Key Personnel addition, CITI, and COI for Dr. Bugnariu's PT student on the Vibratory Falls study.
- VMIB 013 study visit

Thursday November 3rd, 2016

AM&PM:

- I worked on making all the edits that Dr. Rosales had suggested in the library. They were pretty lengthy, so it took almost the entire day. I also had several changes of my own that I'd noticed, such as using the wrong wording and spacing issues.
- I also started working on the exit paperwork for graduation.
- I did a little bit of work on creating the symmetry template, but since I created it on PC, it wasn't playing nicely with my Mac and I had to stop progress.

Friday November 4th, 2016

AM:

- We had another Insider Tour this morning, and Dr. Miller was the "talking head". She explained about her research studies and demonstrated a few protocol tasks.
- We drafted a memo and submitted a modification for a certificate of completion for PREFER, as well as an update to the continuing review documents for RLC Balance, since key personnel modifications were made since we submitted it.

PM:

- Following lunch, Julia, Dr. Patterson and I restreamed the data for the ISGR conference coming up in a few weeks. We ran into a few technological hiccups along the way, and the entire process ran about 3 hours. Dr. Patterson wants me to run the data through my graphing template as well as the template I collaborated with Steven on way back in July.
- She would also like for me to create an Instruction sheet for what to do with mox files generated when restreaming through the GOAT data processing and ending with the data being entered into my template.

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