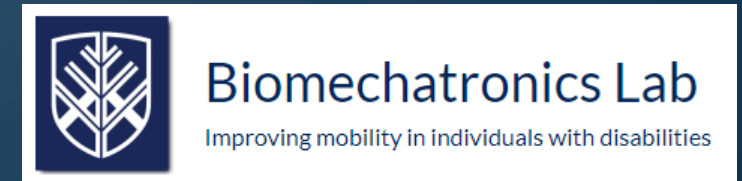


DESIGN AND FABRICATION OF A ROBOTIC KNEE EXOSKELETON

BY: HANNAH RENTSCHLER

MENTOR: DR. ZACHARY LERNER

NORTHERN ARIZONA UNIVERSITY



INTRODUCTION

- Wearable robotic exoskeletons augment human joint motion
- Exoskeletons can be passive or active
- Can be single or multiple joint systems



<https://www.nwf.org/Educational-Resources/Wildlife-Guide/Invertebrates/Blue-Crab>



https://www.roboticsbusinessreview.com/health-medical/exoskeleton_startup_cyberdyne_surges_in_trading_debut



<https://newatlas.com/unpowered-ankle-exoskeleton-walking-efficiency/36847/>

INTRODUCTION

- Applications:
 - Work environments
 - Military use
 - Restoring loss of mobility
 - Space environments
 - Physical Therapy



<https://www.extremetech.com/extreme/191959-the-fortis-exoskeleton-let-you-lift-heavy-tools-indefinitely-and-its-unpowered>



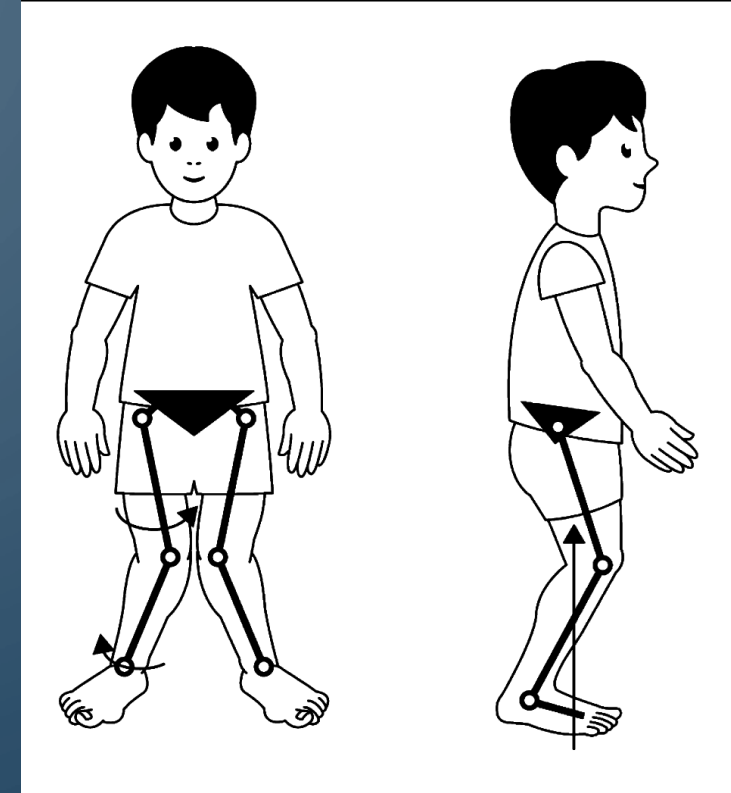
https://www.nasa.gov/offices/oct/home/feature_exoskeleton.html



<https://gizmodo.com/i-understand-this-is-an-early-version-but-i-can-see-one-1756999672>

PROJECT FOCUS

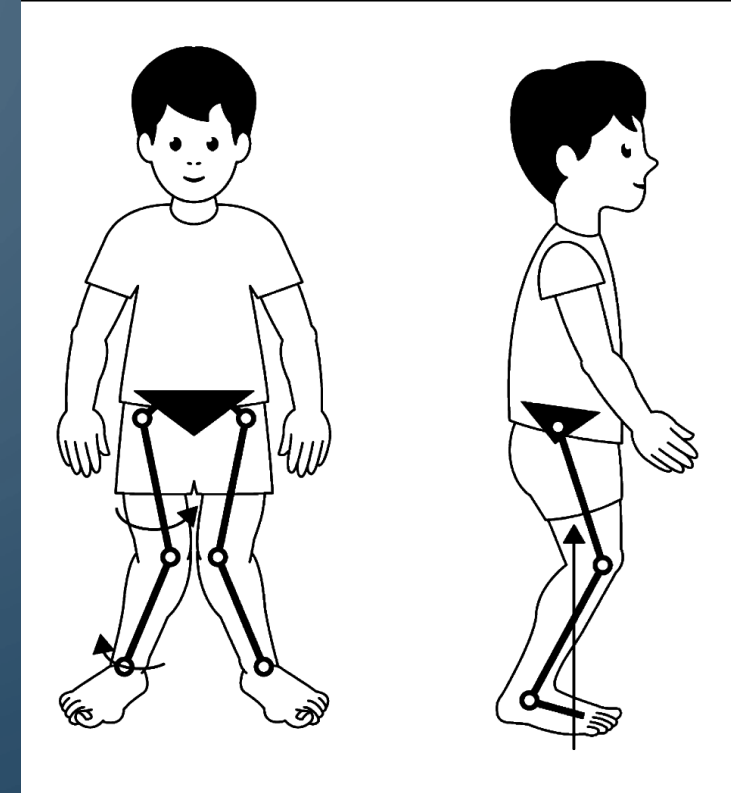
- Cerebral palsy
 - Often results in motor impairments
 - Reduce mobility and stability
 - Increase the energy cost of transport
- Crouch gait
 - Excessive knee flexion
 - Can lead to knee pain and degradation



<https://jamanetwork.com/journals/jamaneurology/fullarticle/1151825>

PROJECT FOCUS

- Cerebral palsy
 - Often results in motor impairments
 - Reduce mobility and stability
 - Increase the energy cost of transport
- Crouch gait
 - Excessive knee flexion
 - Can lead to knee pain and degradation



<https://jamanetwork.com/journals/jamaneurology/fullarticle/1151825>

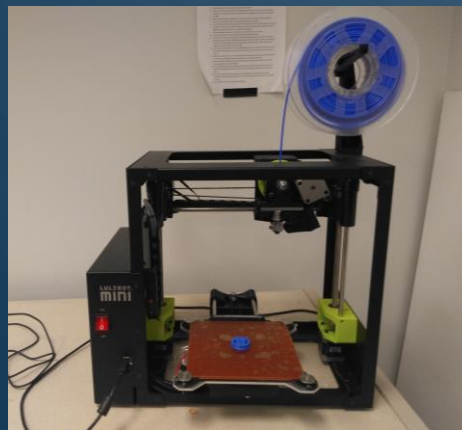
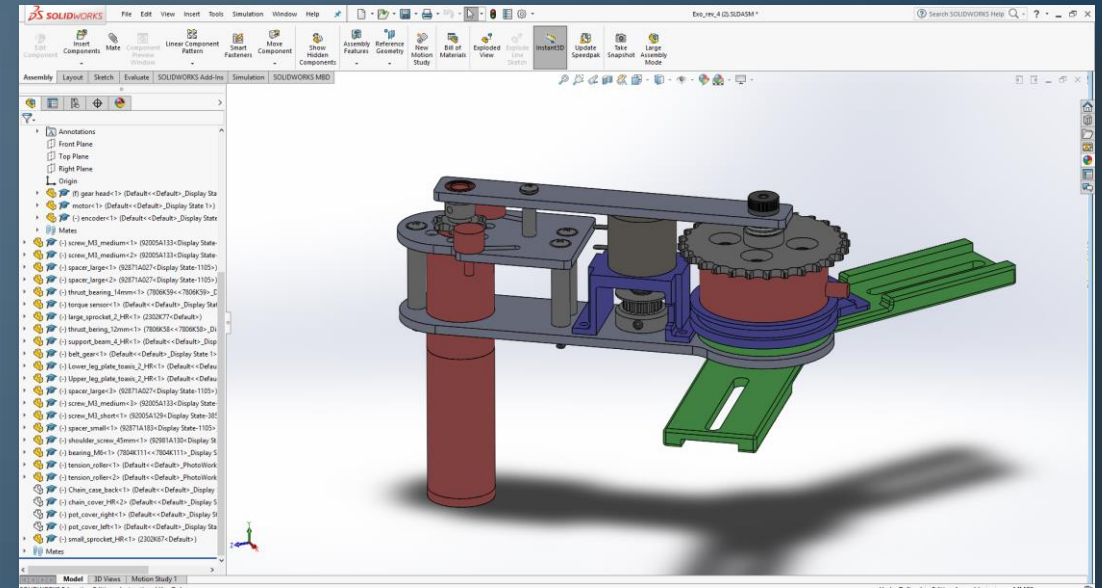
Need a way to extend the knee during walking

PROJECT GOALS

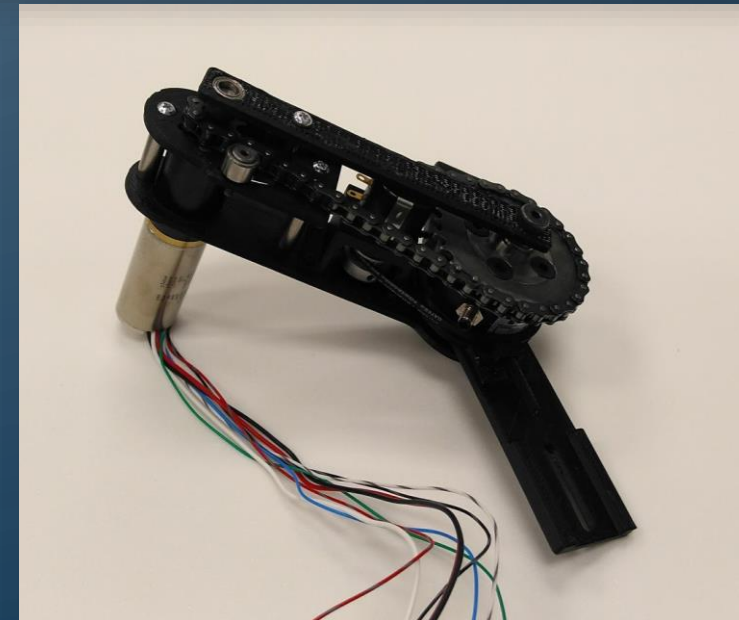
- To provide resistance/assistance about the knee joint
- To design, build, assemble, and test a knee exoskeleton:
 - Compact/light weight
 - Incorporate sensor to retrieve knee flexion
 - Customizable orthotics

METHODS

- SolidWorks
- Rapid prototyping using 3D printing



Lulzbot Mini



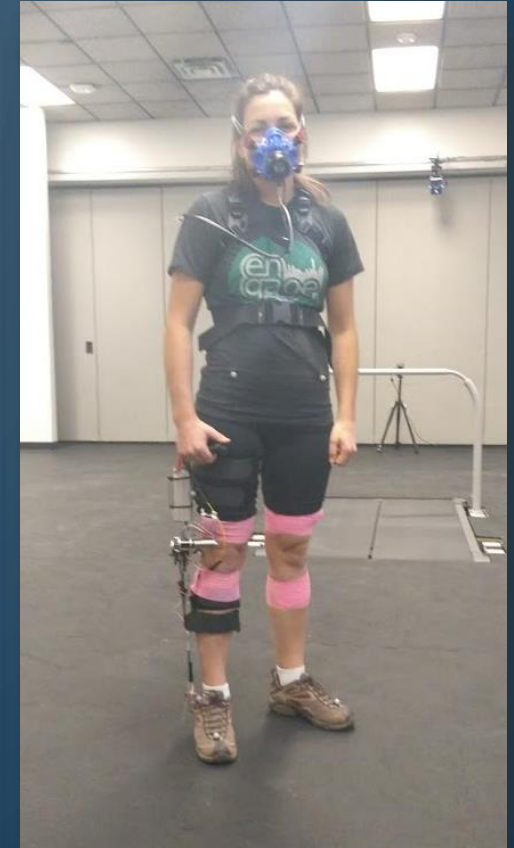
METHODS

- Other prototyping methods
- Tested using Vicon motion capture system



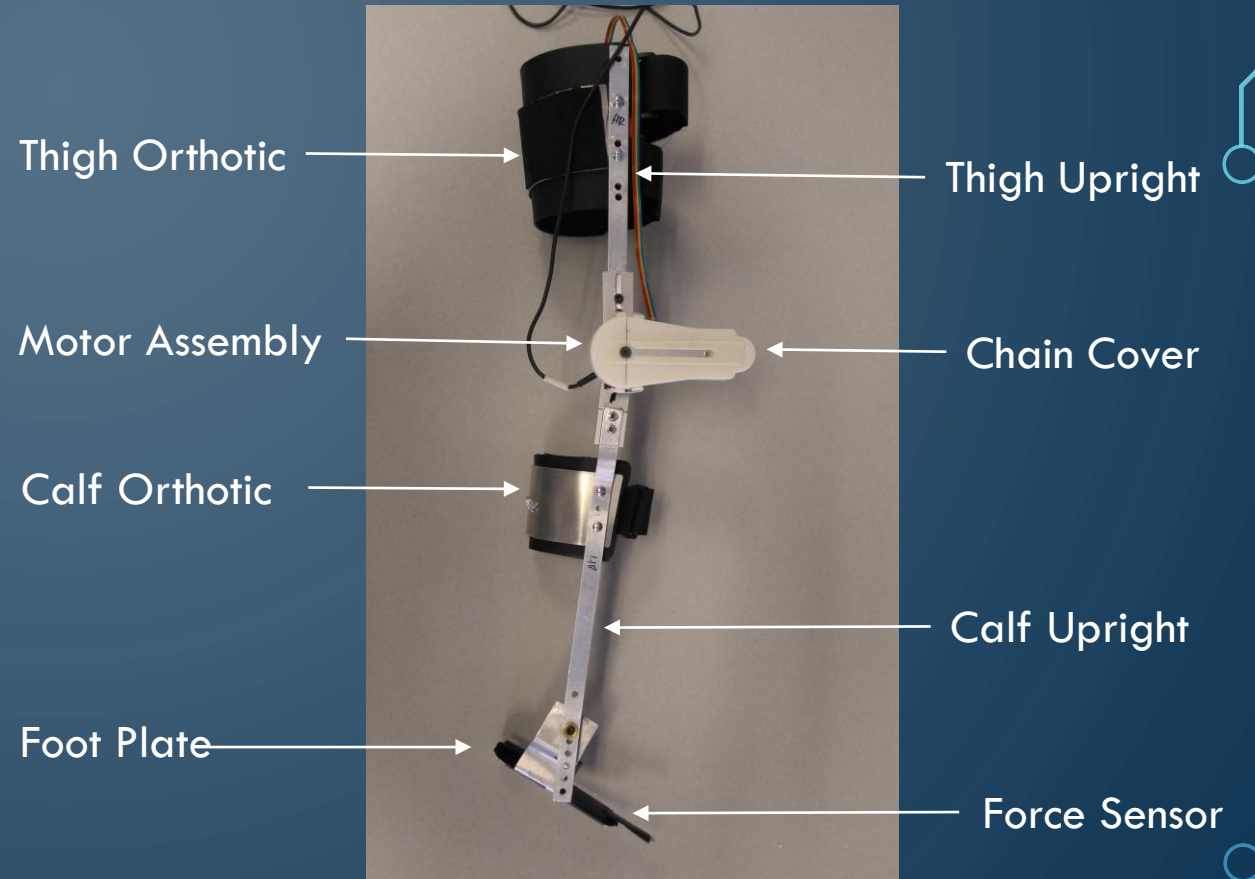
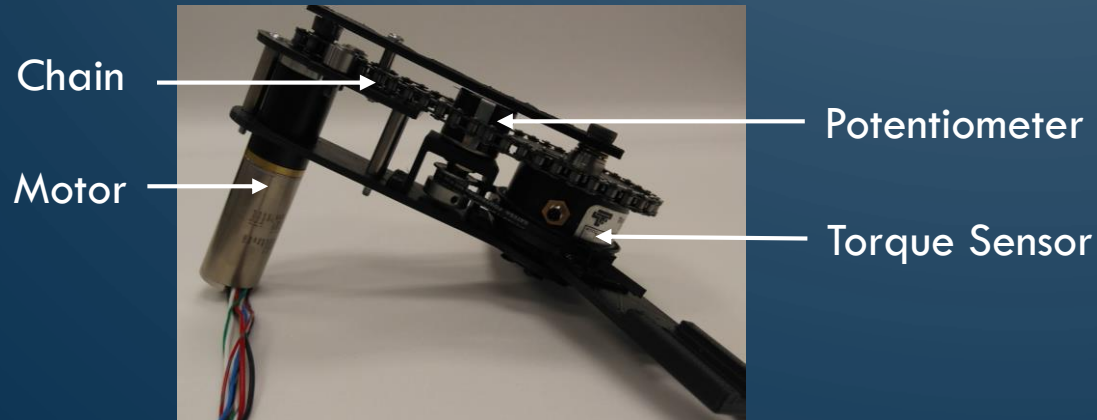
RESULTS

- Fully functioning exoskeleton
- Lighter and more compact
- Testing proved that the system functions as intended



RESULTS

- Integrated potentiometer
- Chain cover
- Customizable orthotics



CONCLUSION

- This system will be used in future exoskeleton studies
 - Biofeedback
 - Adaptive control
 - Long term use
- Will assist in exoskeleton development



ACKNOWLEDGMENTS



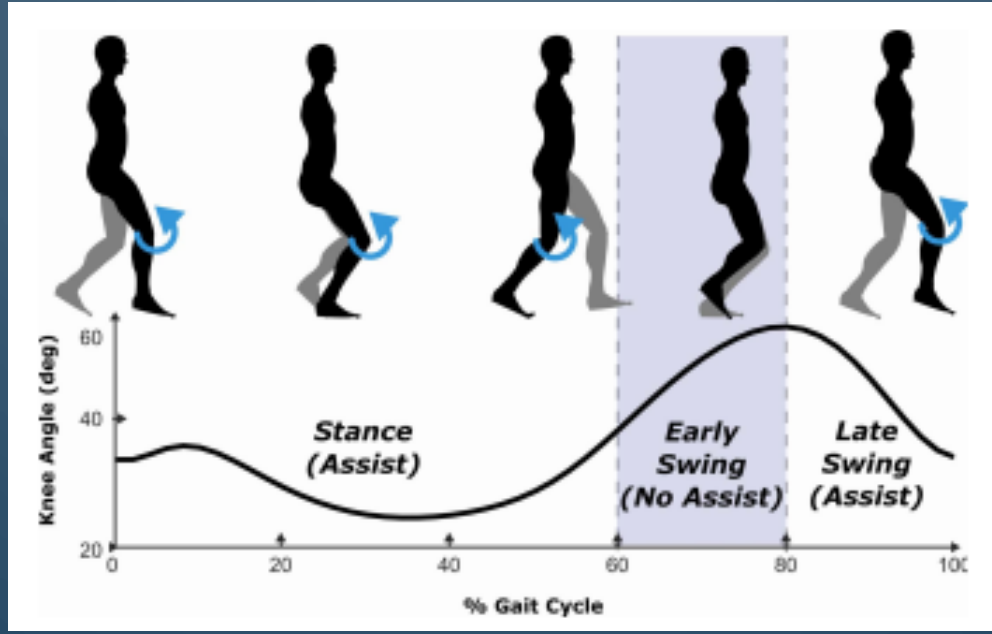
- Dr. Zachary Lerner
 - The NASA Space Grant Internship Program
 - Northern Arizona University
- 
- 

REFERENCES

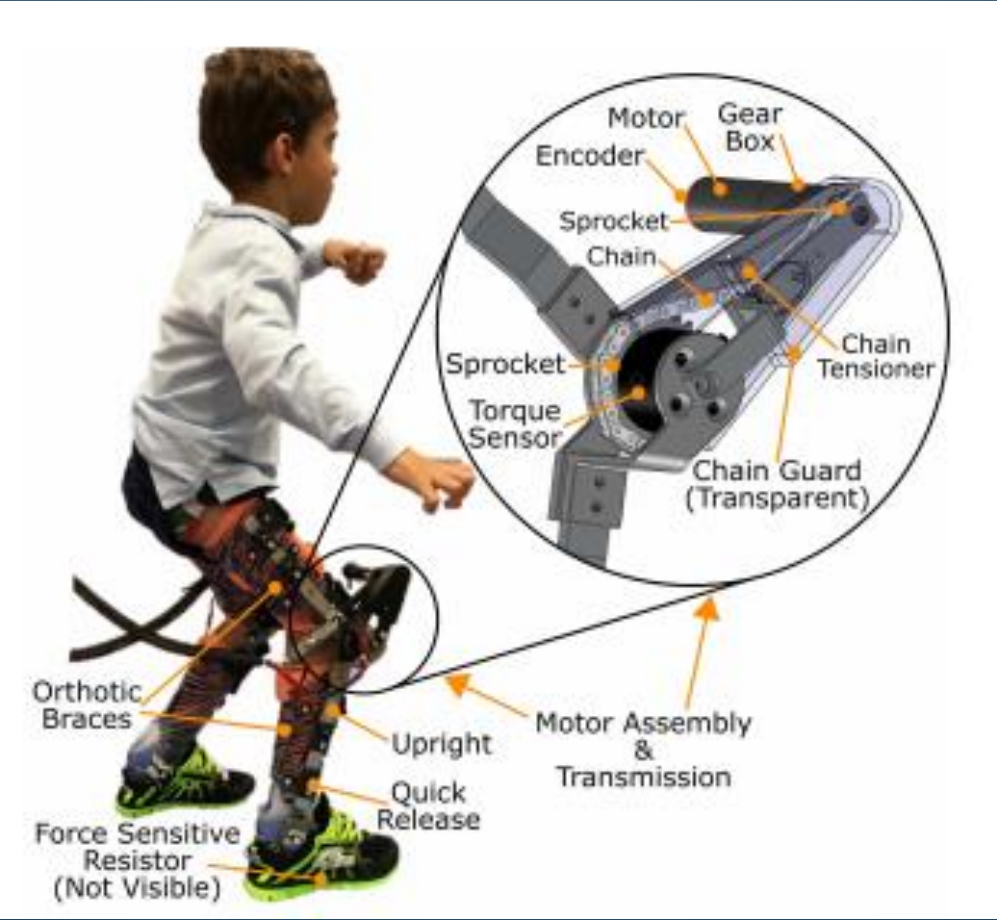
- [1] A. J. Young and Daniel P. Ferris. (2017, February). "State of the Art and Future Directions for Lower Limb Robotic Exoskeletons". [Online]. 25 (2), pp. 171-182. Available: ["http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7393837"](http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7393837) [March 3, 2018].
- [2] D. Prindle. "Without using any power, this leg-mounted exoskeleton makes walking more efficient." Internet: <https://www.digitaltrends.com/cool-tech/leg-mounted-exoskeleton/> , April 3, 2015 [March 2, 2018].
- [3] RBR Staff. "Exoskeleton Startup Cyberdyne Surges in Trading Debut." Internet: <https://www.roboticsbusinessreview.com/health-medical/exoskeleton-startup-cyberdyne-surges-in-trading-debut/> March 26, 2014 [March 5, 2018].
- [4] L. Hall. "NASA's Ironman-Like Exoskeleton Could Give Astronauts, Paraplegics Improved Mobility and Strength." https://www.nasa.gov/offices/oct/home/feature_exoskeleton.html, Aug. 7, 2017 [March 2, 2018].
- [5] Z. F. Lerner et al. (2017, June). "A Robotic Exoskeleton for Treatment Of Crouch Gait in Children With Cerebral Palsy: Design and Initial Application". [Online]. 25(6), pp. 650-659. Available: <https://drive.google.com/file/d/0B5Yp2M3LufwGWHFJNDZftUZQSDQ/view> [October 9, 2017].

The image features a dark blue background with white, stylized circuit board traces in the corners. These traces consist of straight lines that bend at right angles and terminate in small circles, resembling electronic components or nodes. The traces are located in the top-left, top-right, bottom-left, and bottom-right corners, framing the central text.

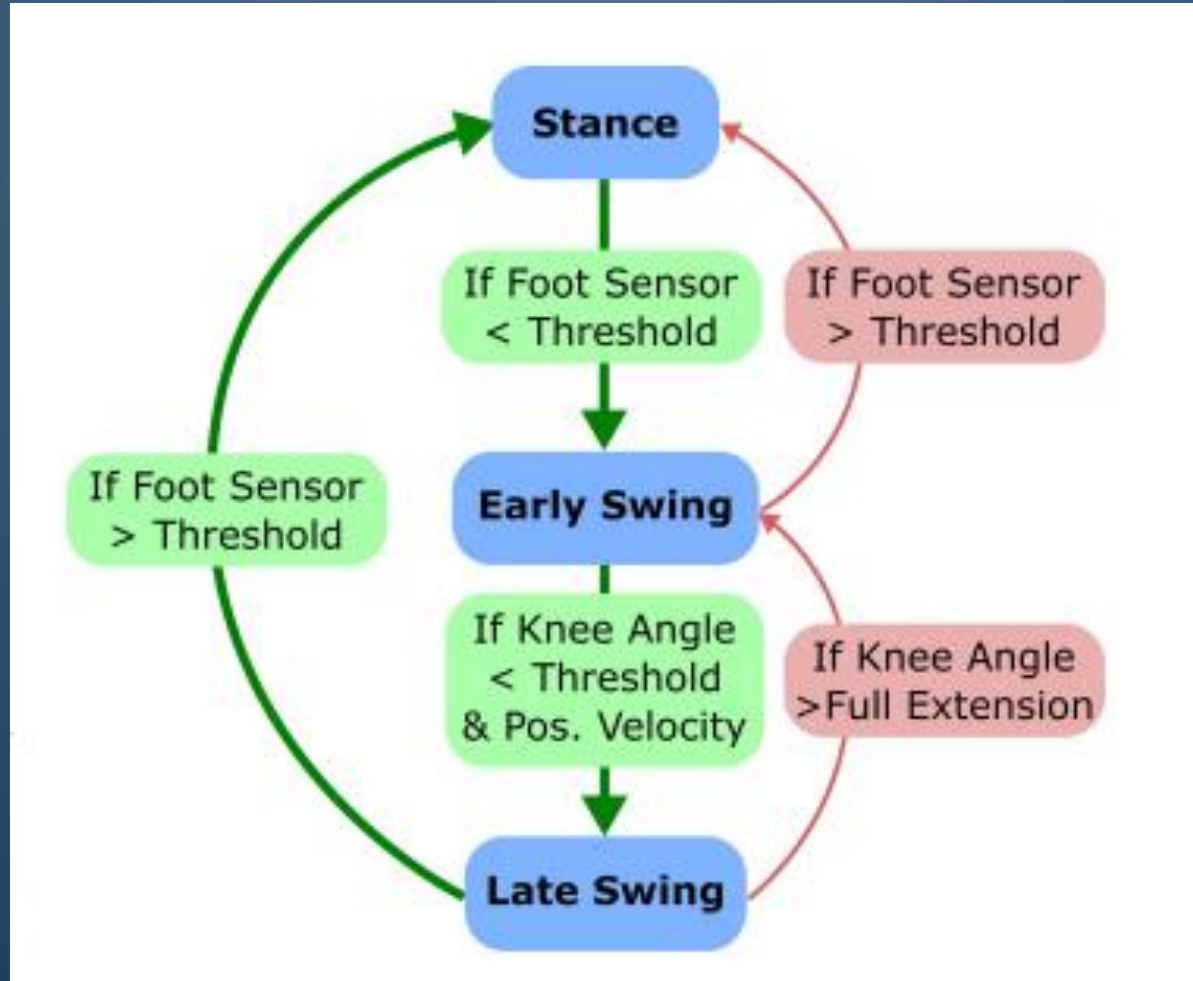
QUESTIONS?



<https://drive.google.com/file/d/0B5Yp2M3LufwGWHFJNDZftUZQSDQ/view>



<https://drive.google.com/file/d/0B5Yp2M3LufwGWHFJNDZfTUZQSDQ/view>



<https://drive.google.com/file/d/0B5Yp2M3LufwGWHFJNDZftUZQSDQ/view>