A course long term project, A Biomechanical Analysis of The Gymnastics Cartwheel, was completed during lab portion of KIN 417 Analysis of Movement. This project required the comprehension and utilization of various biomechanical principles that were taught in the lecture course. The unique aspect of this project is the capability to scientifically analyze the performance of the gymnastics cartwheel using the Dartfish Motion Analysis Software. This software is the latest and most sophisticated computer video analysis software that is used by teachers, coaches, physical therapists and sports medicine specialists. It is used to detect errors in a person’s movement, calculate angles, times, distances, velocities and provide feedback using the drawing tools and media book. Stephen F. Austin State University is among an elite group of universities in the United States that utilize this sophisticated software.

The performer is filmed holding a scaling rod for the computer program to accurately describe distance.

### Methods

A videotape of the gymnastics cartwheel was created and imported into the Dartfish Motion Analysis computer program following strict instructions. The performance was critically analyzed by utilizing the drawing tools. (See pictures) and conclusions were drawn using biomechanical principles and personal knowledge.

Results were provided to the performer by utilizing the drawing tools to illustrate errors and producing a DVD media book.

1. The purple angle indicates that an angle of 90 degrees was not maintained. A larger split allows for a more controlled and smooth lunge-out.
2. The picture of the arms indicates that they are still bent in the middle of the split making control difficult. A solid base of support is important.

**Biomechanical Principle** (Range of Motion): High levels of joint Range of Motion and Flexibility are important in performing gymnastics skills. In this particular phase of the cartwheel, good hip flexibility is needed for hip joint abduction of at least 90 degrees. The performer is lacking the ROM and flexibility as shown by the measured angle.

1. The red marker is once again showing that the foot is not pointed.
2. The yellow arrow is showing that the back leg is bent. In this position he is using the back leg as compensation.
3. The angle that the hips make is too acute. This will make it harder to bring his chest up to finish the movement.

**Biomechanical Principle** (Levers): The body is acting as a first class lever. The left leg is the fulcrum, the back leg is the resistance arm and the chest and arms are the effort arm. The further away the effort arm is from the fulcrum: the easier it is to lift the load. Depicted above, the fulcrum (left leg) was placed too close to the arms and hands. This will make it more difficult and require more effort to lift up the upper body.

1. The blue arrow shows that his back is not in line with the back leg.
2. The red arrow shows which direction his chest needs to move. This position will make the cartwheel short and more difficult to perform.
3. The green angle shows the angle at the waist. The correct angle should be an obtuse angle ranging from 115 to 130 degrees.

**Biomechanical Principle** (Moment of Inertia): In this phase of the cartwheel there should be slight knee and hip flexion. With this slight degree of flexion, there is a decrease of rotational inertia that allows the performer to maintain a straight line from his arms to his back leg. The performer has too much flexion at his hips causing him to have too much rotational inertia.

1. The red horizontal lines shows that the performers knee is correctly bent over the front foot.
2. The blue arrow points to the right arm to show that it is bent as the performers hand reaches the ground. It should remain straight to support the body going into the cartwheel.

### Summary

The Dartfish Motion Analysis Software enabled the investigator to more efficiently view the performers movements using a sound scientific basis. Evaluation and critique of the performer’s movement using this software will provide the performer with more detailed feedback for improvement. A DVD media book was given to the performer as a resource for instruction and training to improve their gymnastics cartwheel.