Countless number of people suffer from joint injury and require surgery. In postoperative therapy, the goal is to reteach the joints the correct range of motion. Continuous passive motion (CPM) devices are used for this purpose. Currently, these devices typically only range over one degree of freedom and are fixed in a stationary position. The purpose of this undergraduate senior design project is to focus on these two disadvantages and redesign the CPM device to be both portable and multi-axial for the elbow joint.

The muscles targeted in this device are the biceps and triceps. These muscles only produce force when contracting.

**EXTENSION AND FLEXION:**
Biceps raise the forearm towards the upper arm while triceps pull the forearm away from the upper arm. As the arm is raised from the 180° extension position, the muscle fiber length increases thus increasing the force exerted from the biceps increases until it reaches a maximum at about 90° flexion.

**SUPINATION AND PRONATION**
There are four muscles used to supinate and pronate about the forearm. Pronator muscles are made up of the pronator teres and the pronator quadratus. Supination is achieved by using the supinator muscle and the biceps. To rehabilitate the elbow, we are primarily concerned with the biceps (supination).

**TORQUE CALCULATIONS:**
\[ T = F_d \]
In order to move the arm about the elbow, torque was calculated. Calculations were made assuming known averages: arm weight 3.5lbs, average arm length 30cm, average maximum voluntary muscle contraction of the biceps 20.74N and for the triceps 14.31N. To lower the about of torque needed to move the arm, gravity was negated by supporting the arm during the exercise.

\[ T_{flexion} = (20.74 \times 4\text{cm}) = 82.96 \text{ Ncm} \]
\[ T_{extension} = (14.31N \times 1.5\text{cm}) = 21.465 \text{ Ncm} \]

**INTEGRATION OF TWO BRACES**
The integration of the Progress Plus and the Bledsoe T-check braces was completed for the base of the design.

**MOTOR**
The motor specifications were selected due to the CPM device needing enough torque to move the arm but also at a slow speed to reduce possible injury. The motor selected is the Tetrix brushless, DC motor that runs off 12 V with 154 rpm. Has a load torque of 3.9 kg-cm and current of 0.914 A.

**FUTURE WORK**
Though our design has proved this technology is available, further optimization of all components is needed to fully develop the device. With more funding and greater interdisciplinary skills, a second prototype would be produced and steps for marketing of the device would begin.