Application for Student Research Award, School of Science Summer Research Program, 2006

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Optimization of Baseball Swing Parameters for Three Levels of Play

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It is said that America's favorite pastime is baseball. It isn't surprising that there have been many investigations into baseball regarding how to optimize one's own performance and thus their team's success. The most prominent focus of research is in hitting because this is where runs can be earned and games are won. Several research groups have written papers about the biomechanics of the swing and the optimal parameters for hitting home runs. However, there has been little research into the biomechanics and optimal parameters of a softball swing. Due to the size of the ball and different pitch delivery, a softball swing will have many differences compared to the swing used in baseball.

The purpose of this research project is to evaluate some of the studies done by research groups in baseball and determine how they should be adapted to accurately describe a softball swing. As this is a very broad topic, I will focus my investigation on the optimal parameters needed to hit a softball the furthest distance. Hubbard et al[1] investigated a baseball swing in two parts. First they carried out an impact analysis of the ball and bat. The results provided them with the initial flight conditions of the ball allowing them to use a flight simulation, written in MATLAB, to determine the range of the ball. When analyzing the results, they found an optimum angle at which the hitter should undercut the ball to get the maximum distance

depending upon the pitch thrown. Furthermore, they concluded that one can hit a curveball farther than a fastball due to the difference in the ball's spin.

This project would adapt this procedure for a softball swing. The dynamic collision between the bat and softball would be analyzed using classical mechanics. The results from this analysis would them be the initial conditions for a flight simulation. The main purpose of this project would be to compare and contrast four flight characteristics of a baseball and softball: their pitched trajectories, pitched spins, batted trajectories, and batted spins. There are two obvious differences between baseball and softball: the size of the ball and the delivery of the ball. Thus there should be significant differences when comparing these four flight characteristics. Specifically, a new drag coefficient must be used in the flight simulation to account for the larger size of the softball. This will be measured experimentally. Furthermore, the underhand delivery used by a softball pitcher will change the trajectory of the softball as well as its spin. These parameters will be taken into account in the mechanical analysis of the swing. The batted trajectory and spin of the softball will be examined by using the MATLAB flight simulation.

The results from this simulation would then be compared to experimental results. By recording a subject's swing, we can determine the angle and initial velocity of the batted softball and then measure the range the ball travels. These measurements would be compared to the flight simulation results to determine whether an accurate model has been created.

With the exception of MATLAB software, the tools needed for this project are all readily available. Laboratory space with a computer, software to analyze video footage, subjects for the experimental portion of the project, and a digital video camera are all easily accessible. MATLAB can be purchased for $500.00 from Mathworks[2] directly.

Proposed Timeline:

Week 1: Review articles pertaining to biomechanical analyses of baseball swings

Week 2: Determine what changes need to made to Hubbard's model.

Week 3: Carryout mechanical analysis of the bat/ball collision.

Week 4: Have MATLAB flight simulation loaded and running on computer.

Week 5: Adapt MATLAB simulation to softball. Measure new drag coefficient.

Week 6: Run simulation.

Week 7: Analyze results and gather predictions for experimental trial.

Week 8: Film softball players and edit video.

Week 9: Compare experimental results to theoretical predictions.

Week 10: Write up results with suggestions for future changes.

References:

1. M. Hubbard, G. Sawicki, W. Stronge. "How to hit home runs: Optimum baseball bat swing parameters for maximum range trajectories." American Journal of Physics. 71, Nov. 2003 p.1152-1162.

2. See the Mathworks website: http://www.mathworks.com/store/default.do