Mathematics in Baseball

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Baseball

- Fun facts
- The physics of a curve ball
- Reaction Time of a pitch
- Calculating statistics
- The physics of hitting (torque)

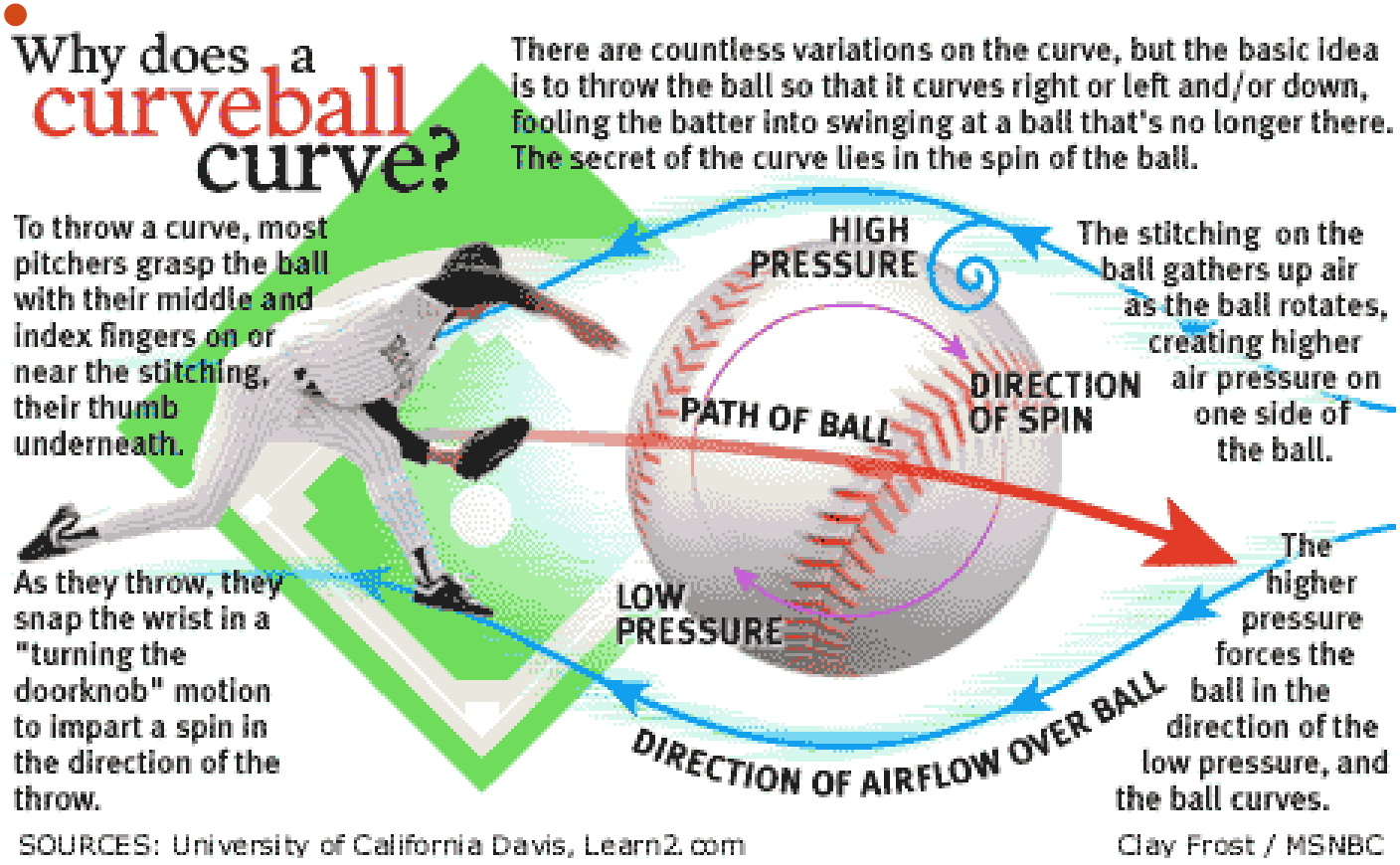
Fun Facts

- A ball that would travel 400 feet in "normal" conditions goes:
  - 6 ft. farther if the altitude is 1,000 ft. higher
  - 4 ft. farther if the air is 10 degrees warmer
  - 4 ft. farther if the ball is 10 degrees warmer
  - 3.5 ft. farther if the pitcher throws the ball 5 mph faster
  - 30 ft. farther if struck with an aluminum bat

Curveball

- A curveball has top spin
- High air pressure at top
- Low air pressure at bottom
- High velocity puts stress on the air flowing around the bottom of the ball (making the ball break away from its original path)
- Avg. Major league fastball 92 mph
- Avg. Curveball 75 mph

Curveball


Why does a curveball curve?
There are countless variations on the curve, but the basic idea is to throw the ball so that it curves right or left and/or down, fooling the batter into swinging at a ball that's no longer there. The secret of the curve lies in the spin of the ball.
To throw a curve, most pitchers grasp the ball with their middle and index fingers on or near the stitching, their thumb underneath.
As they throw, they snap the wrist in a "turning the doorknob" motion to impart a spin in the direction of the throw.
HIGH PRESSURE
The stitching on the ball gathers up air as the ball rotates, creating higher air pressure on one side of the ball.
PATH OF BALL
DIRECTION OF SPIN
LOW PRESSURE
The higher pressure forces the ball in the direction of the low pressure, and the ball curves.
DIRECTION OF AIRFLOW OVER BALL
SOURCES: University of California Davis, Learn2.com
Clay Frost / MSNBC

Calculating Statistics

- Batting Avg. **Hits/At-bats**
- Slugging % **Total Bases/At-bats**
- Stolen Base % **Successions/Attempts**
- On-Base % **(hits + walks + hits by pitch) / (at-bats + walks + hits by pitch + sacrifice flies)**
- ERA (other slide)

Stats(ERA)

- (Earned Runs X 9) / Total number of innings pitched

  - EXAMPLE

A pitcher goes 5 innings and gives up 3 earned runs. We take the earned runs x 9 which gives us 27. We then divide this by the innings pitched 27 divided by 5 = 5.40.

2.00 ERA considered an "Ace" Pitcher

3.00-3.50	Good
4.00-5.00	Average
<5.00	Struggling

Reaction Time

90 **miles** / 1 **hour** * 1 **hour** / 60 **minutes** * 1 **minute** / 60 **seconds** * 5280 **feet** / 1 **mile**

132 **feet** / 1 **second** = 60 **feet** / x **seconds**

Hitting

- Hitting a baseball is one of the hardest things to do in sports. Hitting a round object with another round object is not an easy task.

Hitting (torque)

- The best hitters in the world are able to develop a great deal of torque. This is what determines how hard the ball is hit.

$$T = Iw$$

I= is the moment of inertia for the bat/arm combination

w= is the angular velocity of the bat/arm combination…i.e. how fast the bat is swung

http://quantummoxie.wordpress.com

"Hitting a baseball is a lot like hammering a nail."

The nail isn't moving.

The torque generated on the bat tells you the bat speed, and the act of actually hitting is more appropriately analyzed as a collision. Assuming a constant torque, not choking up (or choking down) is appropriate if you can generate sufficient bat speed and contact the ball while it's over the plate by doing so. Those are the adjustments that dictate whether one should choke up or not — compensation for a bat that's too heavy. I've never heard it to be a mechanism for adjusting which part of the bat contacts the ball.

Sports Science

- http://www.youtube.com/watch?v=y9CEuJ5e2cM