TheHotCorner

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Pitch Design is Here to Stay

What are *you* doing about it?

For ages, pitching coaches have talked about mechanics, command and control. Then came velocity and they threw out all the old adages. Today, it seems like everyone wants velo first, and then everything else as well. I am here to say that things are about to change again!

The advent of equipment like the Rapsodo Pitching camera and all that comes out of them is changing the game and doing it fast. It's giving coaches new insights that only data analytics can bring. Eyes don't see everything, especially at high speeds.

I know there are coaches and pitchers out there that have already jumped all over this and are winning more games because of it. But—at the moment—they are few and far between. Having said that, I believe those that learn and adopt the new technology will rise to the top of the game.

The new information isn't necessarily going to help you throw harder and it can't make you throw strikes. You still have to continue to train and develop those abilities. However, the information can be used to help pitchers become better at their craft. And I mean a *lot* better.

Folks are calling this "pitch design". Seems like a worthy name, but it's just as much about refinement and development as it is about design. To me the word "design" implies a plan to show the function of something before it's assembled. I believe, first and foremost, this new area is about pitch refinement and improvement, and then design. We can design new pitches all day long, but first let's evaluate a pitcher's existing stuff and see where he can improve.

About a year ago we purchased a Rapsodo Pitching camera system. Honestly, we had no idea how it worked. The information coming out of it was overwhelming and confusing. Although some of this information has been available to varying degrees in the pro ranks, there was no pre-existing playbook or manual on ball movement. So our pitching coach Robbie Aviles and I dug in. Robbie—who reached Triple-A in the Indians' system during a seven-year pro career—brought the in-depth pitching knowledge and given my engineering degree from 30 years ago, I learned the science and physics behind it. Together we hacked the code.

Pitching coaches talk about movement often. We've all heard it, but until recently it was based on what coaches could see with their eyes. Unfortunately, the eyes only give you a small piece of the story. For example, for a pitching coach, a 4-seam and 2-seam might look like they are moving just fine. But our data shows that 9 out of 10 pitchers' 4-seams and 2-seams move with little to no differentiation. They're basically the same pitch, even though they're gripped differently. It's really no one's fault. A pitcher can't throw both pitches at the same time, so comparing them previously was impossible—until now!

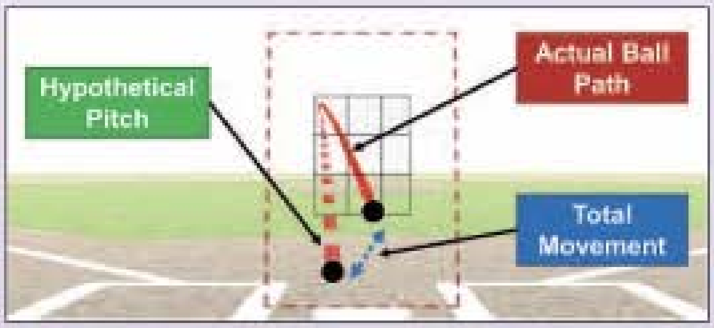
This article is a bit of a crash course on the science of ball movement (also commonly referred to as the "break"). It's the type of article you would have previously seen in sabermetrics journals, but times are changing, and all those topics are coming into the mainstream. The basic concepts and terms that I am about to review are just as important as velo and mechanics and they're all about what I call the "point of release".

Basic Concepts and Terms

In order to understand pitching data, you need to have a good understanding of a few basic concepts, including:

- Ball Movement (not the old definition)
- Magnus Force
- Different Types of Spin
- Gyro Spin
- Spin Axis
- True Spin and Spin Efficiency

Ball Movement – A deviation from a baseball's trajectory from the time it's released until it crosses home plate. This deviation or movement is mathematically measured against a "hypothetical" pitch (we call a gyro ball) that doesn't move at all. Here is an image that should help explain it a little better.

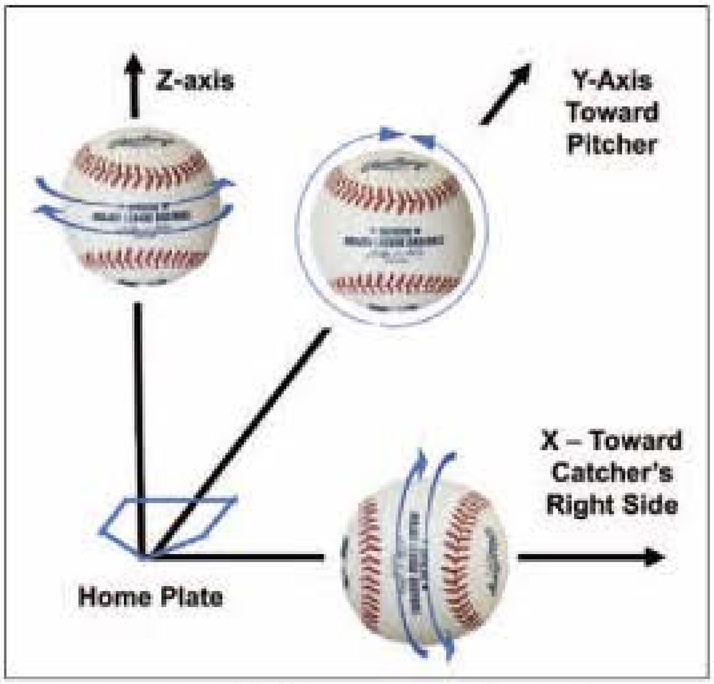


Magnus Force is basically what creates the deviation from a baseball's expected path by creating what everyone refers to as "movement." It is a phenomenon associated with a spinning baseball that drags air faster towards one side as it reaches home plate. This in turn creates a difference in pressure that moves the baseball in the direction of the lower-pressure side. For example, the backspin of a fastball:

- Increases air pressure under the ball
- Reduces air pressure above the ball
- Creates a Magnus Force that puts an upward movement pressure on the ball

Don't misunderstand me, the ball still falls due to gravity. It just falls a little slower.

Different Types of Spin – A baseball on its way to home plate can spin along all 3 different axes (x- y- or z-axis) at any given moment and each has their own impact on ball movement:

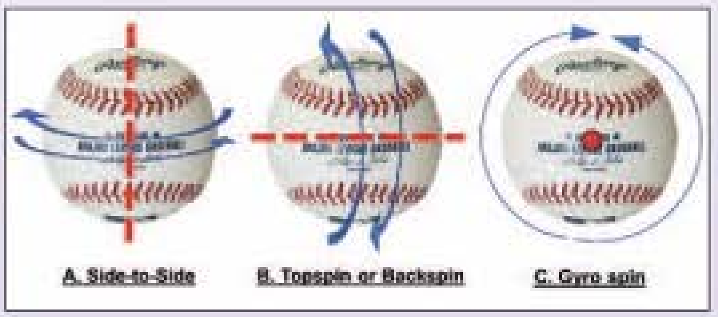


1. Z-axis: Lateral ball movement, side-to-side along the z-axis.

2. X-axis: Up or down movement, topspin or back-spin along the x-axis.

3. Y-axis: Gyro spin, like a football, along the y-axis (between catcher and pitcher). Gyro spin generates *no* movement (reviewed below).

A baseball could spin along one or all three axes at the same time and its ultimate direction of movement is dependent on the net amount of spin along the three axes. Although, rarely is a baseball spinning 100% along a single axis, the images below provide a visual of each specific type of spin along each axis (in red):



Gyro Spin – It might surprise you, but all spin is not alike, as some of the spin creates movement and some of it doesn't. For example, in the image above:

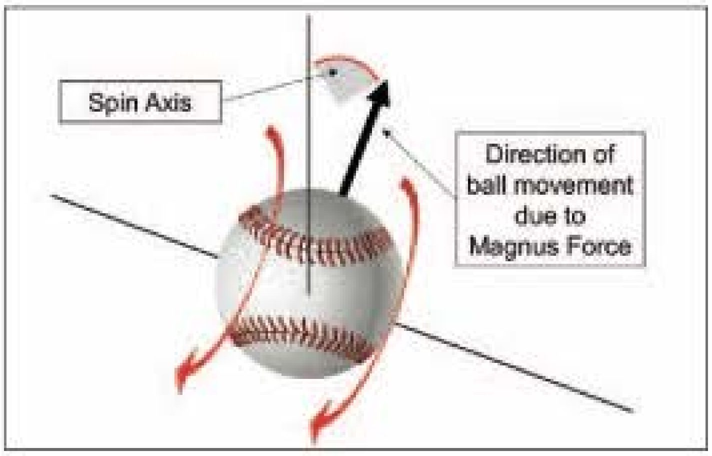
A. The baseball on the left spinning along the vertical dashed red line, will have movement to the left or right, as Magnus Force pulls it in one direction or the other.

B. The baseball in the middle, will have movement up or down.

C. The baseball on the right (with gyro spin), will have no Magnus Force and no "movement" in any particular direction.

Spin Axis – Although a baseball could be spinning in multiple directions at one time, generally, one of those directions is the most dominant and where the net amount of Magnus Force will direct the ball. Measuring the axis of the ball along that direction is what's referred to as the Spin Axis.

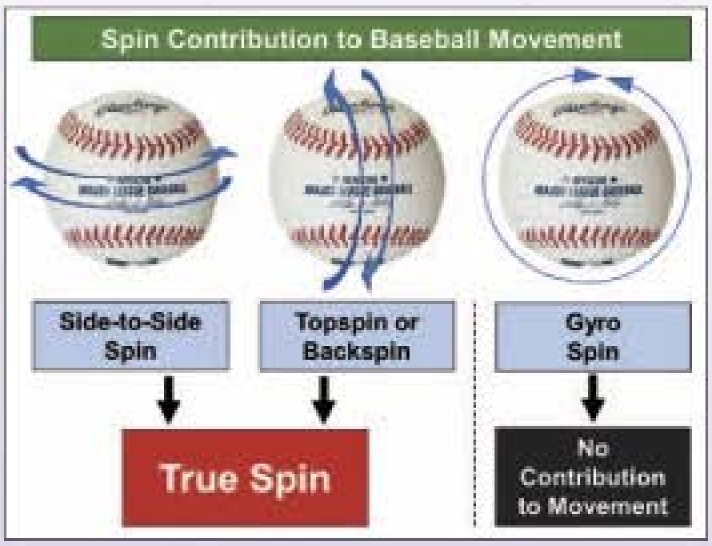
Spin axis, or tilt as some call it, is 100% correlated with the direction of ball movement. If you want to move the ball in a certain direction you have to tilt the spin axis in that direction. Learning how to shape the spin axis is the essence of pitch design.



True (Useful) Spin and Spin Efficiency – True Spin reflects only the components of spin that contribute to movement (basically A and B only). In simple terms, a fastball may have a total spin rate of 2,000 rpm along all 3 different axes. However, if 500 rpm of that total is gyro spin (y-axis), we remove that component to get a True Spin of 1,500 rpm.

This is also sometimes listed as Spin Efficiency Percentage which in this case would be 75% (1,500 / 2,000). These are simply measurements of the amount of spin that contributes to a ball's movement. Here is an image that might clarify things a bit:

Different types of pitches are expected to have different percentages of Spin Efficiency. A high percentage



isn't necessarily bad or good. Certain pitch types are expected to have a high percentage, while others are expected to have a lot less. For example, a typical MLB fastball will likely have a Spin Efficiency of 95-100%, while a slider might be in the 20-35% range.

Where Does the Amount and Direction of Movement Come From?

There are two major components to ball movement: the amount of movement and the direction of movement. Here are the contributors to each:

- Amount of movement ("break")
  - Velocity
  - Amount of True Spin
- Direction of movement
  - Spin Axis

Continues

Pitch Design

Continued

If you spend enough time watching high speed video from the point of release, you'll realize that spin axis is highly correlated with the initial grip, the finger placement and pressure points on the ball at the point of release. Arm slot, elbow flexion and wrist position also play a role, but the final point of contact with the fingers mostly shapes the ultimate spin axis at the point of release.

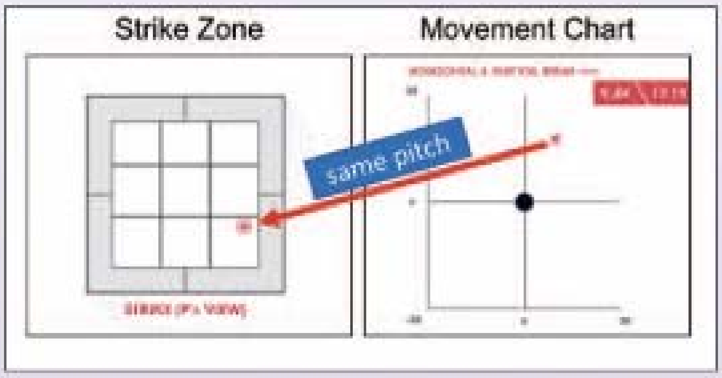
4-seam Fastball Example

Let's review a typical 4-seam fastball pitch from a righty pitcher's viewpoint with the following metrics:

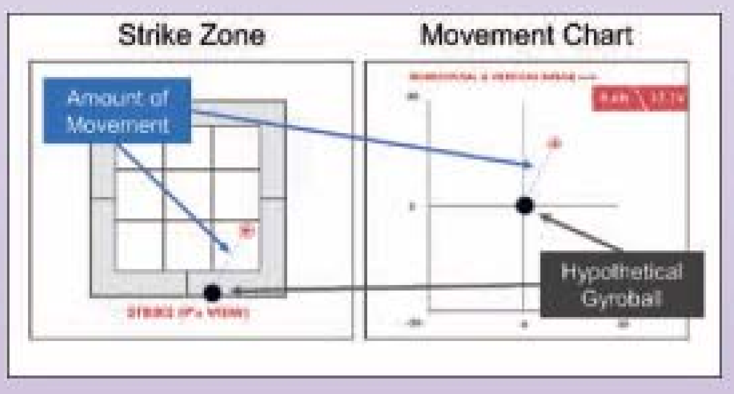
- Pitch Type: 4-seam FB
- Velo: 82.4 mph
- Total Spin (x- y- and z-axes): 1,959 rpm
  True Spin (x- and z-axes only): 1,806 rpm
- Spin Efficiency (True Spin / Total Spin): 92%
- Horizontal Break: +9.4" vs. dead center on movement chart below
- Vertical Break: +17.1" vs. dead center on movement chart below
- Spin Axis: 00:58 minutes (just shy of 1 o'clock)

Strike Zones vs. Movement Charts - The following charts demonstrate a strike zone and a movement chart side-by-side. These two are often confused. The chart on the left is what we've all seen many times. The chart on the right is about ball movement only. Said differently, it explains how the ball moves vs. a hypothetical gyro ball (black dot) at dead center of the chart. It has nothing to do with the strike zone on the left.

Basically, this baseball crossed the plate in the lower right-hand corner of the strike zone (left), but it moved up and in on a righty hitter, 9.4" horizontally and 17.1" vertically (right).



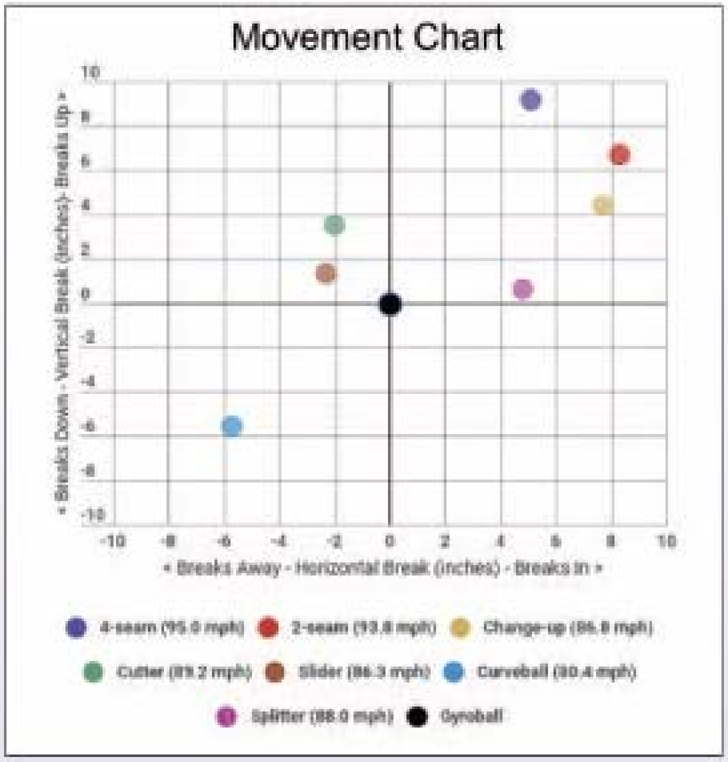
Now let's overlay them a little and try to make more sense of it. For comparison, the charts below show the movement in dashed blue line on both charts for clarification. As you can see, without the movement this ball would have ended below the strike zone.



What is Relative Movement?

A lot of pitching folks talk about the real value in pitching data to be in the spin rate numbers. You often hear so and so has a curveball with a 3,000-rpm spin rate, or a fastball with 2,800 rpm spin rate. Although it's all great info, the most relevant information in the data is in the movement numbers and the spin axis. When you look at how elite pitchers move the ball, you quickly realize that their success is as much in their ability to tunnel pitches and move the ball well, as anything else.

The chart we reviewed earlier is a typical pattern for a 4-seam fastball coming from a righty pitcher, up and in. Now, let's look at a dozen elite MLB pitchers collectively and how they move their various pitches. You can see why they're elite.



These guys move the ball exceptionally well. This gives them the ability to "tunnel" their pitches with great deception. The best pitchers have very distinct movement patterns from pitch-to-pitch. I call this "Relative Movement" and if you want to go far in this craft you should work towards creating similarly distinct movement patterns from pitch-to-pitch.

At the highest levels of the game, the teams with the most advanced data analytics efforts are training their pitchers to not only separate their movement patterns but telling them exactly where they want a certain pitch to hit on the movement chart. Why? Because they already know hitters have difficulty with that type of movement. Think about that for a second and let it sink in!

The punch line here is that movement is the result of everything that comes before it. If you don't know "why" and "how" your various pitches are moving, then you might want to learn and find out.

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