Dynamic Balance & Stability as it Pertains to the Pitching Motion

By Dan Galaz at Galaz Baseball Technologies © 2019

Introduction

Throwing a baseball with more velocity is the goal of any player to get to the highest level. However, the science to achieve those goals depends on a proper interpretation of the governing laws of that discipline while applying them correctly. For example, the laws of mechanics is a branch of physics that addresses bodies that accelerate due to forces or torques exerted on them and how they respond while in **static** or **dynamic equilibrium (balance)**. Also, how well or poorly bodies translate or rotate (or both) corresponding to where the body's **center of gravity (CG)** is located when a force is exerted. On the other hand, **stability** has to do with how efficiently a moving body system can withstand the applied forces without losing control or how well the system can transmit forces to other objects. In this case, how well a pitcher can transfer energy to the ball efficiently. Throughout this material, **balance** means the same as **dynamic balance**.

Balance and Stability

Balance and **stability (B&S)** having to do with human movement are sometimes used interchangeably but have different meanings.

"Suppose somebody is shooting a cannon from a canoe. The canoe may be balanced; it may even remain balanced while the cannon is on board. The canoe, however, does not have the stability to remain in its position when the cannon is fired. In a similar manner, our bodies need a stable base in order to be able to produce force in a manner that is effective. If your body is more stable, you are able to shift more weight or produce more force in a more efficient and effective manner." ***Chris Slaviero****, Author, Practice Principal at Physio Inq South Penrith.*

Improving performance from the standpoint of how well the pitcher utilizes his surroundings to produce maximum forces and how well he can efficiently transfer those forces to the ball. More specifically, **balance** is the ability of the pitcher to keep the CG within an optimum location of the **base of support (BoS)** while maintaining good throwing posture, and **stability** is essential for improving performance and preventing injury. Therefore, the whole premise of **B&S** is to improve performance and avoid injury of the pitcher simultaneously. From this, the pitcher must maintain an excellent athletic posture throughout the entire pitching motion (PM). Consequently, It is impossible to improve performance and prevent injury when a pitcher has poor **B&S**.

Pitching experts talk about creating more power, energy, momentum, and velocity without implementing **B&S physics**. It should be the first goal and a prerequisite to increasing forces or torques to increase velocity, and most importantly, reduce the risk of injury. Trying to increase velocity while in poor **B&S** is one of the leading causes of injury due to poor throwing posture and is not being dealt with, not even at the major league level. If the pitcher is out of sound throwing posture, the arm must do most of the work to accelerate and decelerate the ball.

The approach to addressing **B&S** is two-fold, first from a strength & conditioning standpoint and second from a qualitative motion analysis perspective. The strength & conditioning specialist deals with improving **B&S** through the specificity of training pertaining to the unique sequential motion of the pitcher. The movement specialist's task is to improve the efficiency of movement to, first and foremost, detect injury mechanisms while simultaneously dealing with accuracy and velocity issues. There is a misconception that preventing injury, improving accuracy, and increasing velocity cannot be dealt with simultaneously. It most certainly can.

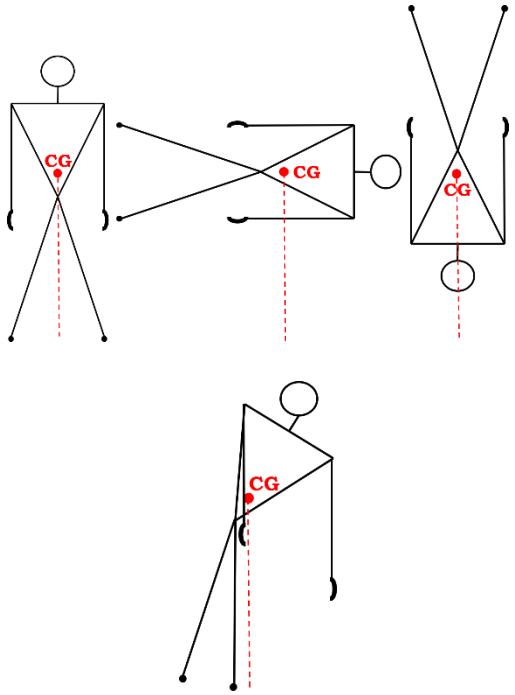
This material demonstrates the essence of sound **B&S**. To communicate this concept

properly, there must be an understanding of how to improve **B&S**.

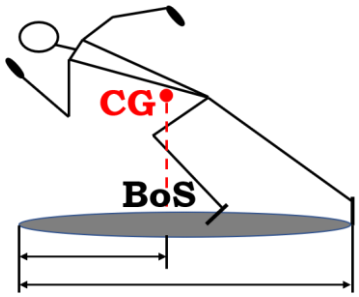
How to Improves B&S

To demonstrate how to improve **B&S**, the terminology to communicate this concept must be developed.

Gravity is the force that attracts an athlete's body with mass to the center of the earth, and **CG** is the theoretical balance point (moves as the body moves and can be outside the body depending on the movement) of the athlete's body without a tendency to rotate or tip over. Also, the center around where the body can rotate freely in all directions. In the first three images shown below, the **CG** is positioned where the body cannot rotate or tip over unless the **CG** moves outside the body, which can only happen if the upper body leans left or right, as shown in the last image. The second and third images illustrate that the **CG** is the center or axis of rotation of the body is to rotate freely in any direction.



Since the **CG** is an imaginary point in space that moves outside the body corresponding to the direction of motion, in the case of a runner, the athlete moves the **CG** to the left side of the **BoS** to move in that direction. The **BoS** is the shaded area underneath the runner's body, as shown below.



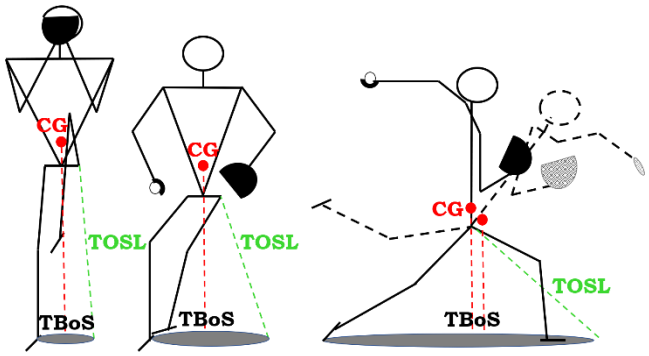
Therefore, in athletics, the **CG** is positioned in a certain way to optimize the required movement. The **CG** acts in the direction of gravity perfectly plumb down to the center of the earth regardless of the orientation of the athlete's body. Therefore, irrespective of the position of the body, the **CG** always points straight down. So the athlete's objective is to position the **CG** in an optimum location beneath the body to accomplish their ultimate goal. Also, lowering the **CG** helps stabilize the athlete before starting. So depending on the athlete's task, he moves the **CG** forward, middle, or the back of the **BoS**.

As mentioned earlier, the idea of applying **B&S** is an essential element for improving pitching performance while reducing the chances of injury. **B&S** work together to ensure that a pitcher can control his body's equilibrium throughout the PM. Although closely related, some use them interchangeably, but they differ in their meaning. **Balance** is the pitcher maintaining his equilibrium while not fighting gravity, letting gravity be the pitcher's friend as the **CG** stays as centered as possible on the **BoS** from the start of the PM to just before the push of the back leg to the landing of the front foot. In comparison to **stability**, the pitcher contends with a disruption of his equilibrium as he propels himself forward due to the force production from the push of the back leg. While maintaining **stability**, similar to **balance**, the pitcher is still trying to keep his **CG** centered while maintaining his trajectory toward home. It can be said that **stability** helps **balance**. In other words, if the pitcher has good **stability**, he has better **balance**.

When referring to the **B&S** of the pitcher, this is equivalent to denoting **PDP**, used going forward instead of **B&S** unless alluding to one or the other individually. Also, when **PDP** is mentioned, **CG** must be considered as central to the **BoS** as possible, as mentioned earlier about **B&S**. **PDP**, sound or poor, determines each movement the pitcher makes, which means the body automatically compensates for any postural deficiencies.

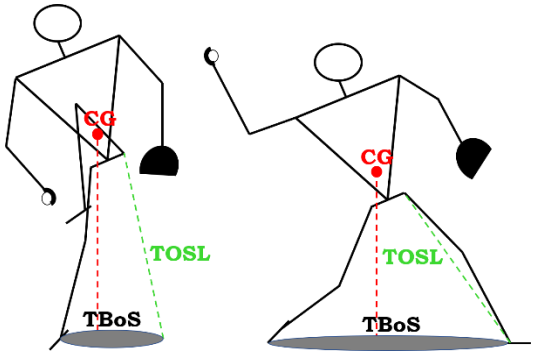
Applying a force or torque must be made with a good **BoS** and proper throwing posture to increase velocity safely. Thus, producing a force or torque while in a poor posture increases the risk of injury to the shoulder and elbow joint, which requires these two joints to absorb most of the acceleration and deceleration loads.

The following images illustrate how adequate **balance** is maintained throughout the PM. Per the definition of **balance**, which stipulates: the pitcher is to control his equilibrium without fighting gravity depicted by the **CG** centered to the **BoS** from the start to just before the throw. There is a minimal to no **contralateral tilt** of the trunk (trunk leaning back during forward motion).



It is counterproductive to produce any force or torque when the **CG** is not somewhere near the middle of the **BoS**. **Stability** is also demonstrated by a green **theoretical opposite stability leg (TOSL)** that points out that if we assume where the front leg would land at each movement position, the **CG** would be centered on the **BoS**. This is called the **theoretical base of support (TBoS)** since the definition of **BoS** requires two feet on the ground. Since the pitcher has created momentum to where he is in the last image, that momentum continues up the kinetic chain from the front leg through the trunk to ball release more efficiently.

In the next series of two images, the pitcher starts his motion with a severe **contralateral trunk tilt**, which positions the **CG** left of the center of the **BoS**.

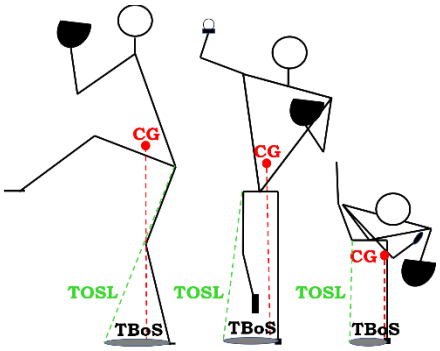


In the last images of the previous two series of pitcher movements, the **TOSL** became the theoretical opposite stability leg since the front foot hit the ground per the **BoS** definition. Also, the **TBoS** became the actual **BoS**, again, since the front foot hit the ground.

As mentioned earlier, the definition of **gravity** tells us that the **CG** location is an imaginary point in space that may or may not move outside the body per motion requirements. During the PM, awareness of where the **CG** is positioned is essential for pitching efficiency, and not much information is out there that implements this concept in pitching methodologies. Although command is an important skill to have, all pitchers covet more velocity. Improving velocity requires good foot alignment, and where the **CG** is located close to the middle of the **BoS** throughout the entire PM until release is vital. Therefore, it is essential that the **CG** does not lag too far behind the pitcher's centerline, and his centerline is pretty much the **CG** red line, as shown in the pitching sequence below.

A **CG** that lags too far behind the pitcher's centerline does not allow the total usage of the back leg drive. Therefore less energy is being put on the ball.

This notion can also be demonstrated from the front view – the difference in this view, the **CG** drifts toward the landing leg throughout the entire PM. The **CG** almost aligns with the landing foot, and for a good reason. Ideally, the front leg should line up with the back leg at landing if proper alignment is maintained for accuracy. Suppose the pitcher can land in this position shown in the last images below. In that case, he should be able to hold his balance over the front leg for 3 seconds or more. Holding this position for several seconds over the landing leg and pitching at full speed is a good indicator of adequated **PDP**. This concept is also illustrated in the last image of the pitching sequence across the page. Holding this position for 3 or more seconds during bullpens is an excellent drill to improve **PDP**.

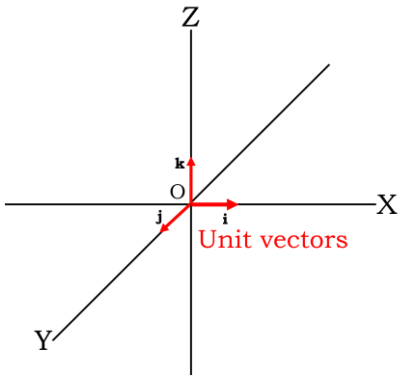


The ability of an athlete to control his **stability** as gravity acts on them is essential while maintaining **PDP** during movement, which means that if the **CG** stays within the **BoS**, preferably the center of the **TBoS**, **PDP** is supported.

<u>Keeping the CG on Target Improve accuracy and Velocity Simultaneously</u>

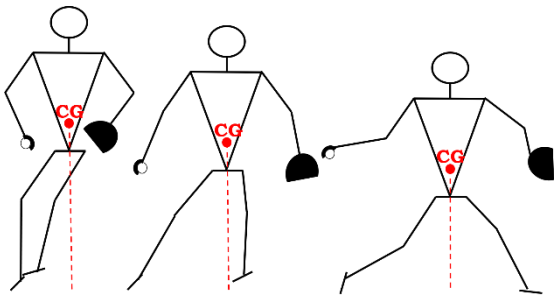
If the **CG** stays on the target from the first movement toward home until the landing of the front foot improves accuracy and velocity simultaneously. Proper alignment is vital for any sport that requires accuracy. Pitchers must have good alignment from the back foot to the front foot to command all sides of the strike zone. Without question, a **well-located fastball** is the best pitch in baseball. It should be evident that accuracy (since the distance to home plate is a vector [has magnitude & direction]) and velocity would be on the same direction unit vector since the pitcher's goal is to hit his target. Every vector has a direction unit vector **i**, **j**, and **k** associated with it in 3D space, as shown in the following image. Since distance ***d*** and velocity ***v*** have magnitude and direction, it makes sense that if accuracy improves, so does velocity. In this case, if the catcher is in the positive *x*-direction and pitcher is at the origin O, the direction of accuracy and velocity of the pitch has to hit the same target. Otherwise, if the pitcher strides toward the arm

side direction, both ***d*** and ***v*** have different unit vectors. If this is the case, both ***v*** and ***d*** are affected negatively. In other words, if the alignment with both feet is aimed arm side off-center and the pitch is throwing toward home plate, both accuracy and velocity are diminished. Put another way, if the pitcher strides offline, it means that the momentum of the pitch is going in two directions – the pitcher is striding toward the arm side, and the pitch is thrown toward home plate.

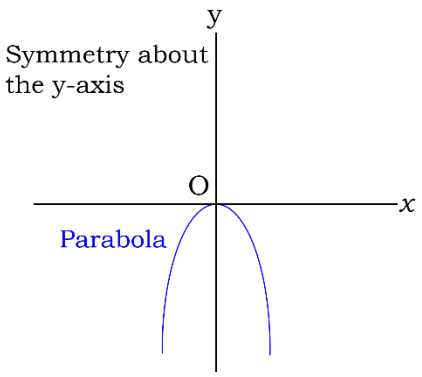


Symmetry of (SoM) & Synchronicity (SyoM) of Movement

SoM brings up the concept of **balance**. When a pitcher separates his hands and starts his stride, he starts his motion from a balanced position if he allows his extremities to move symmetrically, as shown below.



Notice how the arms and legs start to form an upside parabola, which is symmetric to the y-axis, as shown in the following image.



The pitcher's movements are not perfectly symmetric but help the body stay as balanced as possible before throwing the ball. Another essential concept is the **SyoM**. Synchronic movements also add to keeping the pitcher balanced throughout the motion. The **SyoM** starts as the pitcher lifts his lead leg and his hand from his waist. Once he gets his knee gets just above his waist and his hands about head high, he has just started his motion toward home plate. Therefore, these two types of movements work together to keep the pitcher **balance** throughout the motion.

Conclusion

PDP physics is a big part of pitching mechanics and is an essential component for pitching with accuracy and improving velocity. **PDP** has to do with how well the **CG** stays centered to the **BoS** three-dimensionally. When an athlete is in motion, it is vital that the **CG** is as close to the **BoS** as possible to efficiently transfer maximum momentum up the kinetic chain and back to the ground. Not covered in this material but crucial, forces that travel up the kinetic chain must also be redirected to the ground properly to protect the shoulder and elbow from injury.