

Utilising the Phenomenon of Centrifugal Force in Jujitsu Training

by Christopher Morris

Introduction

The great English scientist, Sir Isaac Newton was born in 1643 and died in 1727. During his lifetime, he studied many aspects of nature and proposed answers to the puzzles that confronted him. The focus of his attention was the manner in which the Earth circled around other celestial masses in the universe, and more importantly why each did not run into the other. Using these thoughts as a basis of further study, he narrowed his thinking a little closer to home by examining similar instances on Earth. From all his philosophising, he espoused three “Laws of Nature” -



First Law: A body at rest remains at rest, and a body in motion continues to move at a constant velocity unless acted upon by an external force.

That is, a body of mass in a stationary position remains motionless unless some force is applied to move it. Equally, a body of mass in motion will continue to move in the same direction unless a force is applied to change its direction or rate of movement. This is more commonly referred to as the force of Inertia.

Second Law: A force acting on a body of mass gives it acceleration which is in the direction of the force and is inversely proportional to the mass.

That is, force (F) equals mass (m) times acceleration(a), or: **$F = ma$**

Third Law: Whenever a body exerts a force on another body, the latter exerts a force of equal magnitude and in the opposite direction on the former.

This statement gave rise to the theory of jet propulsion. That is, “to every action there is an equal and opposite reaction”.

These *Laws of Nature* have received further attention by succeeding scientists. One significant result is the philosophical expansion of the phenomena known as “Centrifugal Force”, and its equal and opposite “Centripetal Force”.

Centrifugal Force

Centrifugal Force is felt by a body swinging in a circle around an axis.



A classic example of this is on a merry-go-round, where a rider feels the sensation of being flung towards the outside of the ride. A further sensation that exists is if the ride were to be sped up, a feeling of uneasiness would exist whereby the rider experiences the sensation of being flung off. Another factor which is often overlooked is the size of the rider. The larger the

mass of the rider, the greater the force pushing the rider to the outside of the ride; hence, the more uneasiness that is experienced.

It is a scientific fact that a child (of small size) is more stable on a merry-go-round than is a larger sized adult.

At the same time, the equal and opposite *Centripetal Force* is acting in an endeavour to have the riders remain in situ on the merry-go-round.

If we examine a situation where a ball is attached to a piece of string and swung around the head, two forces act upon that ball. The centripetal force transmitted by the string pulls in on the ball to keep it in its circular path, while the centrifugal force transmitted by the string pulls outward on its point of attachment at the centre of the path.

Centrifugal Force may be increased by increasing either:

- (1) the speed of rotation,
- (2) the mass of the body, or
- (3) the radius, which is the distance of the body from the centre of the curve.

Increasing either the mass or the radius increases the centrifugal force proportionally. But, increasing the speed of rotation, increases it in proportion to the square of the speed; that is, an increase in speed of 10 times, say from 10 to 100 revolutions per minute, increases the centrifugal force by a factor of 100. Centrifugal force is expressed as a multiple of g, the symbol for normal gravitational force (strictly speaking, the acceleration due to gravity). That is, Centrifugal Force (F) equals mass (m) times speed squared (v^2) times radius (r), or: $F = mv^2 r$

In simple terms, the quicker the speed of rotation, the more centrifugal force that is created.

Jujitsu Application

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All Jujitsu techniques may be traced back to some scientific bases. Within the Kyushin Ryu Jujitsu curriculum, it is essential that participants demonstrate skill in several areas, including *Atemi Waza* (striking techniques) and *Nage Waza* (throwing techniques).

The scientific theory of centrifugal force may be applied to many Jujitsu techniques, and several of them are now examined.

Atemi Waza:

The application of centrifugal force is exemplified in the skills associated with *Ushiro Zuki* (Rear Punch):

When dealing with an aggressor during the application of *Ushiro Zuki*, the defender pivots around to the aggressor's left front corner, momentarily positions himself and then rapidly applies a quick turning of the body while stretching out with a closed fist towards the target area of choice, i.e. the aggressor's solar plexus. It is this quick turning movement of the defender's body that applies the theory of centrifugal force. This action has been referred to as *Rotational Momentum*. When applying the mathematical equation of centrifugal force, it follows that a very powerful blow may be applied if the defender is a person of large size (mass). However, more importantly, significant force is generated if the defender executed the quick turning movement of his body in a faster motion. As the speed of the turn is increased, it increases the force applied squared (v^2). That is, the quicker the turn, the more powerful is the blow delivered.



A rapid movement into position by the defender allows for an even quicker turning of the body, with the application of centrifugal force to deliver a powerful blow to the solar plexus

In a combat situation where one participant is decisively larger than the other, it may be assumed that the larger participant may be able to deliver a devastating blow because of his size (mass) and physical strength. However, by applying the principles of centrifugal force, the smaller participant may be able to equal or better that force by executing a quicker turning movement of the body in the delivery of the blow.

Nage Waza:

In the case of an aggressor endeavouring to move in a forward direction to deliver a punch to the head, a defender may decide to utilise the throwing technique of *Sasae Tsurikomi Ashi* (Prop Drawing Ankle). In so doing, the control of the aggressor is greatly assisted by the quick turning action of the defender's body. The quicker the turn in the action of the throw, the quicker the aggressor will be thrown to the ground. Once again, centrifugal force is being applied.

As dictated by Sir Isaac Newton's first principle, when a body of mass is proceeding in a straight line, that body will continue unless interrupted by the application of an external force. Therefore, when performing the technique, it is important to apply a forward pull with the throwing arm. This action by the defender will encourage the aggressor's body to continue in the same direction as intended, but the application of the centrifugal force will take over at the decisive time to complete the throw.



Blocking the punch to the head, then continuing the aggressor's forward movement, with the defender turning into Sasae Tsurikomi Ashi



The defender turns rapidly to apply centrifugal force in the action of the throw

Conclusion

Many studies have been undertaken regarding the application of scientific theories within martial arts. Perhaps the most significant of these are *The Secrets of Judo* by Takagaki and Sharp, and *Ten Principles of Small Circle Jujitsu* by Professor Wally Jay. In each of these publications, the authors have examined the movements of each technique and made reference to a scientific basis for each of the integral skills.



These studies assist greatly in understanding the various techniques, but more importantly provide an invaluable aid to examining ways to enhance the techniques. After all, it is usually assumed that a good big man will always defeat a good small man. However, as a small man will always be more agile and able to move faster than a large man, the application of centrifugal force, for example, may provide the medium for success by the smaller man. This was certainly demonstrated by the now famous American actor and martial artist Chuck Norris who, in the late 1960s became the first light-weight to win the coveted All-American Karate Title. And then he backed up the next year and won it again!

Imagine if Sir Isaac Newton was a martial artist!!



Acknowledgements:

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