To AJKA-International
AJKA-I of PA
Instructor Trainee's Report #10

Subject: **"Explanation of Body Shifting in Accordance with the Principles of Dynamics"**

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Martial Arts are widely known as the method of teaching self-defense. Most people who hear the words Karate, Judo, and Kung Fu think of images of Asian temples or spiritual practices that are thought to strengthen the mind and body and spirit. Actually, it is physics that is the true power behind Martial Arts strength. Sir Isaac Newton's Three Laws of Motion explains why experienced Martial Artists can demonstrate power and ease of movement in the performance of their art.

Newton's First Law of Motion: *An object in any state of motion (including rest) will remain unchanged in that state (which means that those at rest will remain at rest) unless some unbalanced force is acting.*

This Law of Inertia applies directly to stances learned in karate. Before a karate-ka can effectively deliver powerful strikes and blocks they must develop a strong foundation of stability for standing and moving around (See Report #5 Stances in Karate). Newton's First Law teaches the karate-ka that once a firm position is obtained it will not be broken without the presence of an unbalancing force. A karate-ka will not move from their position; unless it is necessary.

Stances and stepping techniques are designed to give the karate-ka the maximum ability to function without risk of being overrun by an opponent. Master Nakayama stated, "[t]he ability to counter an attack, under any circumstances, depends largely on the maintenance of correct form. For techniques to be fast, accurate, and smoothly executed, they must be launched from a strong and stable base."[1] Furthermore, once a technique is launched it will continue forward until acted upon by an unbalanced force. If the target cannot move or block, it will be hit.

Newton's Second Law of Motion: *The relationship between an object's mass (m), its acceleration (a), and the applied force (F) is F = ma. Acceleration and force are vectors in this law; the direction of the force vector is the same as the direction of the acceleration vector.*

*Karate-ka*s (knowingly or unknowingly) use this formula to deliver the most powerful strikes and kicks possible. When a martial artists attempts to use his or her entire body weight to deliver a punch or a kick they are applying the Second Law of Motion to the technique.

The idea is that the faster a person can move and the more mass behind the punch, the harder the strike will hit its target. Accomplished karate-kas can demonstrate the power

[1] Nakayama, Masatoshi Best Karate, Fundamentals New York: Kodansha Int. LTD. 1978

of striking techniques and characterize the effects of hitting an opponent by showing the effects of well delivered physics to wood or stone. Master Nakayama describes a reverse punch:

> Lower the hips and rotate them with good timing, utilizing fully the power that comes from straightening the back leg, and driving it into the floor. The stance must be stable and the hips always on an even keel. The pelvis, and hence the center of gravity, shifts slightly forward. A punch with the hips even a little to the rear will not be effective. The power transmitted from the leg and hips to the chest, shoulders and arm accelerates, but for this to be true, the body and limbs must be solidly joined together, like an iron rod and a steel plate. This depends on the muscles working in harmony and tensing powerfully in the same instant.[2]

Newton's Third Law of Motion: *Whenever two objects interact; the force exerted on one object is equal in size and opposite in direction to the force exerted on the other object.*[3]

This Third Law can be directly applied to blocking techniques. In the event of an oncoming attack a karate-ka is trained to block or hit the offending strike in an attempt to move it out of harm's way. For example: if a reverse punch is moving quickly toward a karate-ka's head, he or she must understand that to remove the threat of injury the punch must be diverted from its original path. By attacking the incoming punch with a block the attacking arm will be forced to move in a direction away from the defender. When the force of the upward block meets the opponents striking arm a situation of opposing forces comes into play. The attacking arm is moved in the opposite direction of the block resulting in the defender's head not being hit. If the incoming attack is not blocked the defender will receive the full effect of the attack. The resulting damage will be directly related to the attacker's ability to apply Newton's second law.

For every martial artist to develop the maximum power possible they must apply all three of Newton's Laws to each of their techniques. These Laws provide the foundation for all Martial Arts physical techniques. Without an appreciation of the science that makes martial arts effective, the spiritual side of training alone will not produce the necessary power. Each movement will only be copied and imitated, not fully developed.

Besides Physics a karate-ka must also understand the concept of "base of support" with regard to stability and mobility. A base of support is defined as "the area within an outline of all ground contact points". When standing, we typically have two feet in contact with the ground. If our feet are close together, we feel less stable than when our feet are spread apart. Increasing the distance between the feet increases what is termed

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[2] Nakayama, Masatoshi Best Karate, Fundamentals. New York: Kodansha Intl. LTD. 1978

[3] Tillery, Bill, Enger, Eldon, and Ross, Frederick. Integrated Science. New York : McGraw Hill

our **base of support.** In situations of pending contact, we try to enhance our **stability**; when we want to move quickly, we try to increase our **mobility**. Five factors determine our level of stability and mobility[4]:

1. *Size of the base of support in the direction of force or impending force.* Increasing the size of the base of support increases stability. In preparation for an impact, we tend to spread our feet apart. Merely increasing the size of your base of support will not necessarily make you more stable. The increase must be made in the direction of force or impending force.
2. *Height of the center of gravity above the base of support:* As you lower your center of gravity, or decrease your height you improve your stability. Conversely, by standing up or raising your center of gravity you decrease stability.
3. *Location of the center of gravity projection within the base of support:* If your center of gravity moves outside the base of support, you become unstable and may fall over. When the center of gravity projection lies at or near the center of the base of support you are more stable than when the projection lies near the edge of the base of support.
4. *Body mass or body weight:* A body's mass (or weight) contributes to stability. Heavier bodies are harder to move and are more stable. Lighter bodies are moved more easily and are less stable, but are more mobile.
5. *Friction:* The amount of frictional resistance at the interface between the ground and any contact points contributes to stability and mobility.

In summary, **high stability** (low mobility) is characterized by a large base of support, a low center of gravity, a center of gravity projection within the base of support, a large body mass, and high friction at the ground interface. **Low stability** (high mobility), in contrast, occurs with a small base of support, a high center of gravity, a center of gravity projection near the edge of the base of support, a small body mass, and low friction. Both are equally important in karate depending on what you are doing and trying to accomplish.

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4 *Dynatomy: Dynamic Human Anatomy* by William C. Whiting, PhD, and Stuart Rugg, PhD. 2012