Sine Wave in ITF Taekwon-Do

Suzanne Patterson

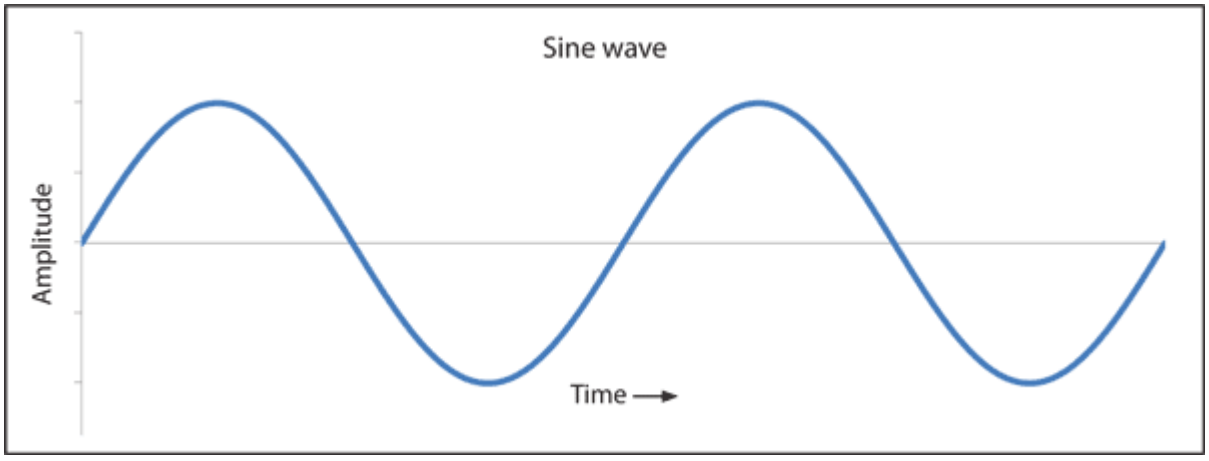
2 November 2016

Sine Wave

1.0 What is a Sine Wave?

A sine wave is a repetitive change or motion which, when plotted as a graph, has the same shape as the sine function. In other words, it is an s-shaped, smooth wave that oscillates above and below zero. This wave pattern occurs often in nature, including ocean waves, earthquake waves sound waves, and light waves.

Figure 1: Mathematical sine wave



2.0 Sine wave in ITF Taekwon-Do

Sine wave is a unique movement present in ITF Taekwon-Do and is said to contribute to the utilisation of mass in order to facilitate a powerful technique which is delivered with maximum force. Sine wave is recognised by 3 phases: a slight lowering (Phase 1), raising (phase 2) and lowering of (Phase 3) the body, or simply "down-up-down". The 3 phases should be performed in continuous fashion without stopping. In essence this means utilising knee spring which provides power and harmony to the motion[1]. Power is enhanced by maximising the movement of body mass and generating kinetic energy. Through sine wave there is also greater control over movements enabling changes in direction and transition from one movement to another[2].

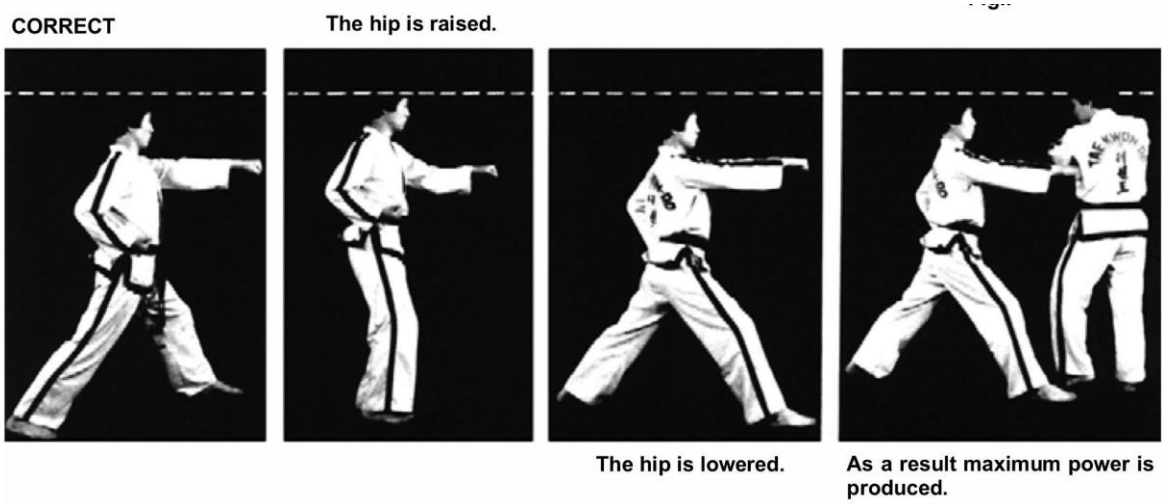
[1] Bos, Marano, Trajtenberg. *The Art of Taekwon-Do ITF (2013)*
[2] http://www.tkdimpact.co.uk/sine-wave

Sine wave motion is not always an ever present feature in the sense that every technique should conform to a single down-up-down movement. There are numerous ways of stepping and moving with varying levels or sine wave or even the absence of sine wave. In patterns the sine wave motion itself is often modified eg. for connecting motion, continuous motion, slow motion, and fast motion. Then there are the foot shifting motions where no sine wave motion is performed or when raising up from a lower stance to a higher straight legged stance (eg. walking stance to close stance or vertical stance) where it would be difficult to create sine wave.

The technical principles of ITF Taekwon-Do; the *Theory of Power* and *Training Secrets*, refer to the sine wave motion peripherally. The sine wave motion is not itself even a separate principle listed in the *Theory of Power* or *Training Secrets*. The first introduction of sine wave in the Encyclopaedia (condensed version)[3] is under the discussion on the eighth training secret in which it states "To create a sine wave during the movement by utilizing the knee spring properly".

The *Theory of Power* then introduces discussion on the utilisation of mass and how to "increase body weight by utilising springing action of the knee". In other words raising the hip at the beginning of the movement (to create potential energy) and lowering the hip at the moment of impact to drop the body into the movement (create kinetic energy) as shown in Figure 2 below.

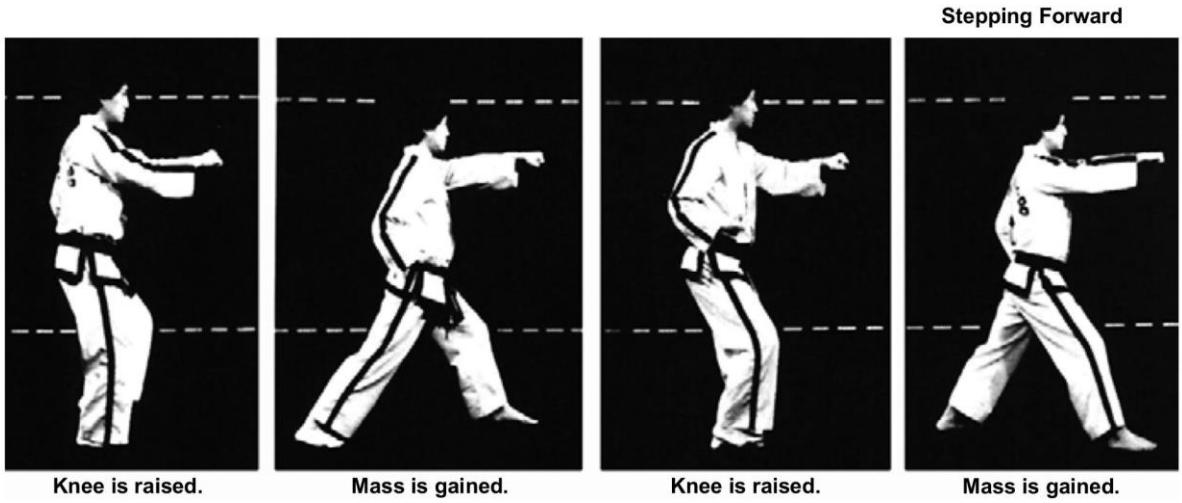
Figure 2: Theory of Power "Hip raising"



[3] Choi (1999),Taekwon-Do

And then the principle is discussed further in the coordination of hip and fist during forwards and backwards stepping in which the importance of knee spring is emphasised as shown in Figure 3 below.

Figure 3: Stepping and knee spring



3.0 What actually happens during a sine wave?

The following discussion is for walking stance fore fist punch only in order to keep in line with the illustration of figures 2 and 3 above.

3.1 Phase 1 'The Down'

During the first phase the body drops slightly down and forward by flexion of the knee and hips. The large muscles surrounding the hip and knee joint (glutes, quadriceps, hamstrings) become eccentrically loaded whilst the upper body relaxes and the arms come into a neutral and more relaxed position to create room for backwards motion required to prepare for a punch.

3.2 Phase 2 'The Up'

Phase 2 sees the body begin to rapidly raise up by extending the knee and hip joint through contraction of the large muscles surrounding the hip and knee. The knee must not straighten fully, otherwise a 'saw tooth' wave is produced. The arms remain relaxed and begin to prepare for the punch, with one forward and one pulling back towards the hip.

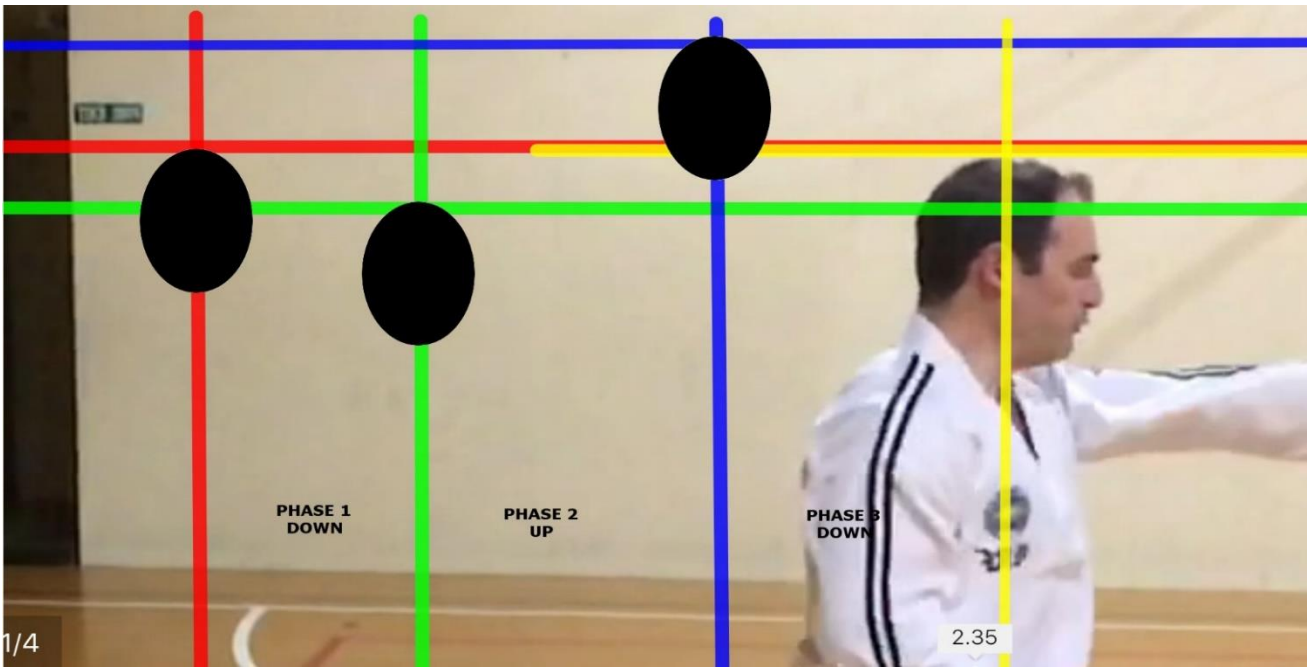
3.3 Phase 3 'The Down'

Once the apex of the technique (top of the sine wave) has been reached, the body begins to rapidly drop down in another eccentric contraction of the leg and hip muscles. The arms begin to accelerate into the punch and the other back to the hip. At the end of the movement the muscles suddenly are contracted to stop all motion and the abdomen is tensed with a sharp exhalation.

3.4 Real Time Sine Wave

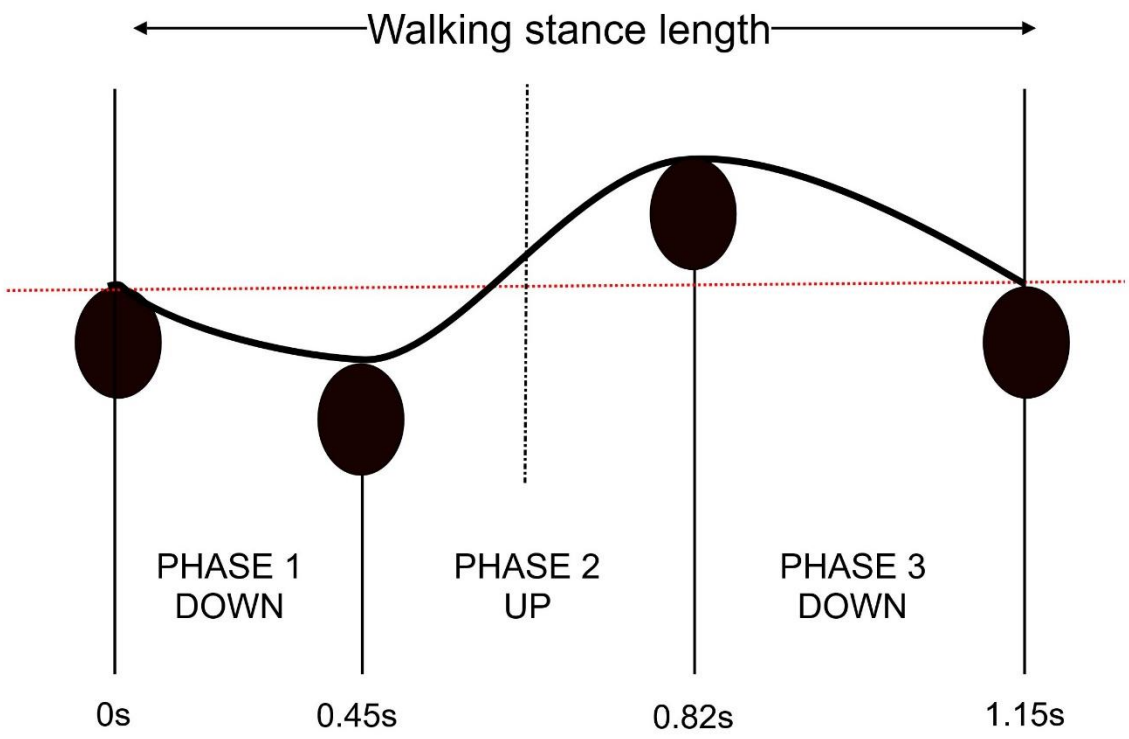
We know that a sine wave in mathematical terms is several symmetrical bell shaped curves as shown in Figure 1. But what does a sine wave really look like in Taekwon-Do application? A practitioner was recorded in slow motion performing a walking stance punch. The recording was stopped when the head position was at its lowest point (end of phase 1), the highest point (end of phase 2) and when the punch was executed (phase 3). The time was noted for each phase and an average was taken over 5 punches.[4]

Figure 4: Real time screen shot



[4] Not statistically valid as the sample size is too small and it is only one practitioner's performance of a walking stance punch.

Figure 5: Depiction of real time sine wave



	TIME	HORIZONTAL DISTANCE TRAVELLED* (STANCE LENGTH)	VERTICAL DISTANCE TRAVELLED *
Phase 1	0.45 seconds	6.29	1.81
Phase 2	0.37 seconds	8.42	5.21
Phase 3	0.33 seconds	8.49	3.25
TOTAL	1.15 seconds	23.20	N/A

* Arbitrary unit

	% OF TIME	% OF STANCE LENGTH
Phase 1	39	27
Phase 2	32	36
Phase 3	29	37

What do these numbers mean?

1. The downward phase (phase 1) takes the longest to complete, yet it is the shortest phase in terms of horizontal distance travelled. Here the body is relaxing and only a small amount of forward propulsion occurs.
2. In the downward phase (phase 1) the least vertical distance is travelled ie. the sine wave isn't as deep as it is tall.
3. When the apex of the sine wave is reached, 63% (close to 2/3) of the technique has been performed. No surprises there!
4. Phase 3, when the punch is delivered, is marginally the shortest to complete, which suggests that the body is dropping rapidly to cover approximately the same horizontal distance of phase 2 thereby maximising the movement of body mass and generating kinetic energy.

The lift phase happens with the help of a powerful contraction of the muscles in the legs and hips to raise the body up with the assistance of reaction force from the floor. The *Theory of Power* teaches us that Power = ½ x Mass x Velocity^2. So with regard to point 4 above, we move with sine wave to generate maximum speed and utilisation of mass and deliver a technique with devastating power.

It is important to recognise that the analysis above is anecdotal and far from scientific as it was produced from only a few repetitions and from only one practitioner! Its purpose was to demonstrate an approximation of the sine wave curve and how it is not a symmetrical curve.

4.0 Why do we sine wave?

According to the ITF Technical Committee, sine wave movement "…provides power and harmony to the motion" and that "the main goal of sine wave movement is to generate speed"[5]. Whilst it is generally accepted that the purpose of sine wave in Taekwon-Do is to generate maximum force using scientific principles, I wish to discuss the following 2 alternative reasons, which are not as widely discussed, as to why the General may have developed sine wave and incorporated it into Taekwon-Do.

1. Creates a unique point of difference from other styles
2. Implements oriental 'wave' philosophies (an alternative view)

4.1 Creates a unique point of difference from other styles.

In the 1950's karate was practiced in Korea, sometimes it was known as Tang Su Do or Kong Su Do[6]. General Choi was staunch nationalist and he wanted a new name for the martial art

[5] Bos, Marano, Trajtenberg. *The Art of Taekwon-Do ITF (2013)*
[6] http://www.taekwondoitf.org/our-history/#our-history

he was teaching to his troops in the army. Although in the 1960's the General began creating new patterns, the Shotokan kata were commonly practiced and the Korean form which was becoming 'Taekwon-Do' was virtually transplanted Shotokan. The 1965 version of the Encyclopaedia even contains these Shotokan kata. Prior to the 1970's it is hard to see technical differences when looking at pictures of Karate and Taekwon-Do, as shown below with a pressing and pushing block. Even the Taekwon-Do dobok was still very much like a Karate gi.

Figure 6: 'Pushing block' from Shotokan Karate[7]

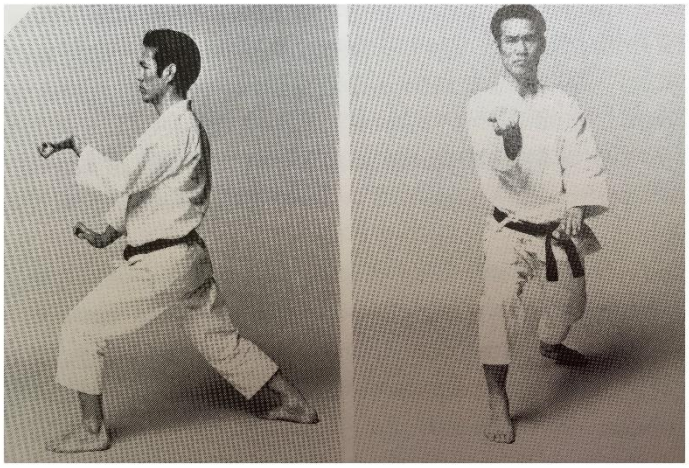
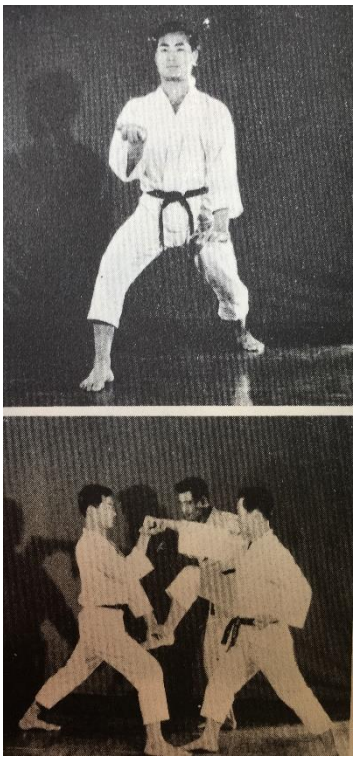


Figure 7: Pressing block from Taekwon-Do 1965[8]



After Korea was liberated from Japan in 1945, General Choi rapidly moved to create a national martial art for his country, one that was superior and different to Karate. During his military service he gained knowledge of physics and began to apply this to his Korean Karate. By 1965 the Theory of Power was added to the text and became the core of Taekwon-Do's 'scientific' status, whilst other martial arts focused on using hip twist.

[7] *Karate-Do Kyohan: The Master Text,* Gichin Funakoshi, 1973
[8] *Taekwon-Do: The Art of Self Defence,* Choi Hong Hi, 1965

4.2 Incorporates oriental 'wave' philosophies

It could be viewed that sine wave is one manifestation of a great principle found in many martial arts known as the wave or circle principle which is derived from the Taoist concept of yin and yang in which two seemingly opposite or contrary forces may actually be complementary and interconnected and has no sharp edges or rigid corners, just like a circle. It may also represent notions harmony between hard and soft, offensive and defensive, push and pull and so forth. The wave principle is characterised by relaxation and motions that move along curves or circles rather than in rigid straight lines. When sine wave motion is applied to Taekwon-Do movements, the practitioner is taught to keep the wave smooth (not saw toothed[9] as explained in the encyclopaedia) and natural and to avoid jerky motions.

In Korean philosophy the two elements are heaven and earth (Chon-Ji) and are known as Eum-Yang, rather than Yin and Yang. They are often represented as a red (heaven) and blue (earth), and together the form the "Taegeuk". Taeguek means "supreme ultimate". This is most commonly represented in the South Korean flag.

Figure 8: Taegeuk

Figure 9: South Korean Flag

5.0 Conclusion

Sine wave is an important principle which helps practitioners perform techniques with maximum power and force. It is a component of the theory of power, one of the defining principles of ITF Taekwon-Do which sets it apart from other martial arts, in particular to the Shotokan style of Karate in which Taekwon-Do has its origins. It could be said that sine wave is the signature of Taekwon-Do.

[9] Choi (1999),Taekwon-Do, (Page 322)

6.0 References

Choi, Hong Hi (1965). *The Art of Self Defence.*

Choi, Hong Hi (1999). *Taekwon-Do (5th Edition).*

Bos, Marano, Trajtenberg *(2013). The Art of Taekwon-Do ITF.*

Funakoshi, Gichin (1973). *Karate-Do Kyohan: The Master Text.*

http://www.tkdimpact.co.uk/sine-wave

http://www.taekwondoitf.org/our-history/#our-history