

# The world's most difficult exercise

by Brian Walpole

*Gymnastics today is arguably one of the most physically and technically demanding endeavours in sport and has a reputation of needing dedication above and beyond the realms of normal sporting commitment. Proficiency requires huge amounts of strength, skill and technical ability. One particular exercise has well-deserved prominence within the discipline – despite defying the laws of mathematics. Here we offer some insights into the mystery of the Iron Cross.*

Having appeared in its earliest form at the inaugural modern Olympic Games, artistic gymnastics emerged as an official Olympic event in 1952 and has been included in the games ever since. The first gymnastics World Championships was hosted in 1962 and today there are numerous high-profile national and international gymnastics events, the most important on any current athlete's timetable being the 2012 London Olympics.

## Awe and confusion

Those of us who have dabbled in the dark arts of gymnastics, or even half-heartedly attempted a handstand at some point in our lives, are familiar with the debilitating effects of gravity on the uncoordinated limbs of the average human. Bearing this in mind, it is only natural that you may have been subject to acute feelings of awe and confusion as an elite gymnast lowers himself into what seems an impossible feat of human strength while performing the Iron Cross on the Rings apparatus.

The Iron Cross, also called the Still Rings Cross, is an incredibly difficult skill, requiring immense shoulder joint stability and astonishing levels of strength in shoulder adduction [1]. Due to the upper body strength requirement of this move, it is only performed by males in competition and, although there has been mention of females using the Rings for conditioning during training, there is currently a lack of data in the literature to confirm this.

## Ways to practise

Like most skills performed on the Rings, the Iron Cross involves equalling or overcoming body weight, and there are several means of practising this particular skill in a modified manner – through the use of pulleys, elastic tubing, a partner, or modified apparatus – in order to build up to the full move. A gymnast must only hold the Iron Cross for 2 seconds in order to receive credit for the move, though Zak Kerkoulas, an American gymnastics coach, has taken this to a whole new level with an Iron Cross Guinness World Record of 39.23 seconds in 2010.

## A mathematical conundrum

If you were to refer to various physics forums and ask the opinions of physicists who do not study the human form, you will see diagrams depicting the Cosine Law (Figure 1) and applying it to describe the strength

### THE HARD SCIENCE



Figure 1. The Cosine Law

According to this law, as the string XY becomes straight, the vector Z becomes infinite. If this law is applied to the Iron Cross, it creates a mathematical absurdity as it does not consider that there are also rotational forces acting on the body when performing the Iron Cross. Our physiological design is incredibly functional, allowing us to overcome huge forces and perform feats of incredible athleticism with the correct preparation and training.



needed to perform the Iron Cross. Their prediction would be that this move would tear each of the limbs straight from the shoulder. Why? Because when you apply this law to the human body without taking into consideration the body's complex and intricate design, it creates a mathematical absurdity. The Cosine Law does not take in to account the torque (force – see below\*) that comes into play, but only calculates the downward force that would be needed with the arms horizontal. Based on this law, the force needed would be infinite, thus making the move impossible for any human to perform.

### A whole-body endeavour

However, any decent national level gymnast would be able to prove otherwise on a Sunday morning Rings session after a good breakfast and a rigorous warm-up. In order to hold the Iron Cross, it makes sense that you need to produce enough force/torque to overcome the weight of

\* **Torque** is a measure of how much a force, acting on an object, causes that object to rotate.

the body and hold in a static or isometric contraction. This is confirmed by research conducted in 2007 on elite and amateur-level gymnasts (see Key research panel). The main muscles involved when performing the move are the large shoulder adductors on the back (latissimus dorsi) and chest (pectoralis major), with the upper back muscles (scapular retractors and depressors) also incredibly important to stabilise the scapula and depress the shoulder girdle. The shoulder muscles will help to provide dynamic and isometric stability while the muscles of the upper arm and forearm are also vital components, to lock out the elbow and wrist. All the key stabilisers around the hips are also hugely important to stop the pendulum effect and keep the body still. In summation, all muscles of the body are called upon for this extreme exercise and any energy leaks or imbalances will hinder the move.

### Built over time

Performance Specialist James Finn, who works in Beijing, China with the male Chinese Olympics gymnastic team, explained, 'although incredible amounts of strength and stability are needed, the movement is very skill based and has to consistently develop based upon their weight and age over time; and is a movement that is developed over several years'. James agrees with the premise that gymnasts are among the world's most dedicated athletes and that this move deservedly carries the title of the world's most difficult exercise.

To see this move performed with the grace and finesse of a seasoned professional, we only have to look at one of our primate relatives – the chimpanzee. Interestingly though, chimpanzees have a large advantage over humans in this respect, because their biceps muscle has a longer lever arm. With this in mind, do not make the mistake of arm wrestling with an adult chimp – challenge him to a game of poker instead.

### References

1. Rozin EU. The influence of anthropometric parameters on successful learning in gymnastics. *Yessis Review Soviet Phys Educ Sports*, 1974, **9**, 16–21.
2. Dunlavy JK, Sands WA, McNeal JR *et al.* Strength performance assessment in a simulated men's gymnastics still rings cross. *J Sports Sci Medicine*, 2007, **6**, 93–97.

### Brian Walpole

*Managing Director, Love Fitness Education, London, UK*

Email: [brian@lovefitnesseducation.com](mailto:brian@lovefitnesseducation.com)



### Key research

A study conducted in 2007 [2], looking at the force needed to perform the Iron Cross, found that gymnasts with a bodyweight average of 66kg were able to perform the Iron Cross effectively when they produced a combined arm force of 654 Newtons or 66.7kg downwards at the wrist on a force plate, with arms parallel with the floor while suspended.