Contents

CHAPTER SEVEN

Gait Analysis and Foot Balance

'Handsome is as handsome does' is a saying we all know. However, we are constantly reminded that good conformation is the key to good movement. What good conformation *is* exactly is hotly debated and, to a large extent, athletic conformation depends on the sporting discipline at which the horse is aimed.

For example, the long back of the Cleveland Bay horse would be considered to be a conformation weakness in a riding horse, but for a carriage horse (which is what the Cleveland Bay was bred for) it is a sought after trait because it improves the ability to pull weights and makes the horse less likely to sustain overreach injuries.

A straight hind leg is also frowned upon, but we know that a straight hind limb enables a greater stride frequency, so it is a benefit in the speed horse. So perhaps 'Handsome is as handsome does' is a good principle to bear in mind, and we should not discard a horse because he does not conform to some erratically researched rules. There are myriad books available dealing with conformation in detail; detail we will not go into here as this book relates only to function.

Athletic ability and good function in the horse is governed by the principle of levers. In moving animals, levers govern the movements of joints and the more efficient the levers, the more efficient the movement; and the principles of 'conformation' were derived from an ideal vision of equine levers. A lever is a rigid structure, fixed at a single point, to which two forces are applied at two different points. One force is 'resistance' and the other is 'effort'. The fixed point is known as the 'fulcrum'. There are three classes of levers, and the one that dominates movement of equine joints is a third-class lever where the resistance and the fulcrum are on opposite sides of the effort, colloquially known as the 'wheelbarrow'.

This lever system provides two important functions. Firstly it increases the effect of an applied force in much the same way as lifting the handles of a laden wheelbarrow makes moving the contents easier. The second function is to increase the speed or velocity of joint movement. Imagine you are picking up a mug of coffee. The weight of the mug is the resistance; the effort to pick it up is applied by your biceps muscle, and the fulcrum is the centre of rotation of your elbow joint. To follow this line would take us into the highly complex mathematical science of biomechanics, but this is also not the aim of this book. We hope to be able to deliver 'applied' biomechanics in such a way for you to appreciate the function of the horse, and use that knowledge to improve your horse's movement, posture and athleticism.

Gait analysis

In Chapters 2, 3 and 4 we listed the major muscles of movement and their functions, but in this chapter we will introduce the science of equine movement as quantified by gait analysis, and we thank our friend Russell Guire of Centaur Biomechanics for supplying the majority of the images you will see in this chapter. However, this is just a thumbnail sketch of the work that is being done in research into equine movement.

Interest into equine movement really began with the seminal work of Muybridge in 1887 which stimulated interest in the discipline with remarkable photographs of equine movement. Indeed it was Muybridge who first demonstrated using his photographs that in the gallop gait there was an actual moment of suspension when no feet were on the ground at all (Figure 7.1).

However, this brief flurry of research activity into equine movement ground swiftly to a halt when the general use of the horse was replaced by steam and motor power. The number and use of horses declined dramatically as man turned his attention to greater providers of horsepower.

A revival of interest began in the 1970s with the introduction of the concept of the sport horse and the advent of cheap computer power, and since that time the scientific discipline of equine locomotion has come of age.

For a long time expensive computerised gait analysis equipment could only be used in a laboratory setting with horses working on treadmills. Still much of the scientific work is conducted in locomotion laboratories with a

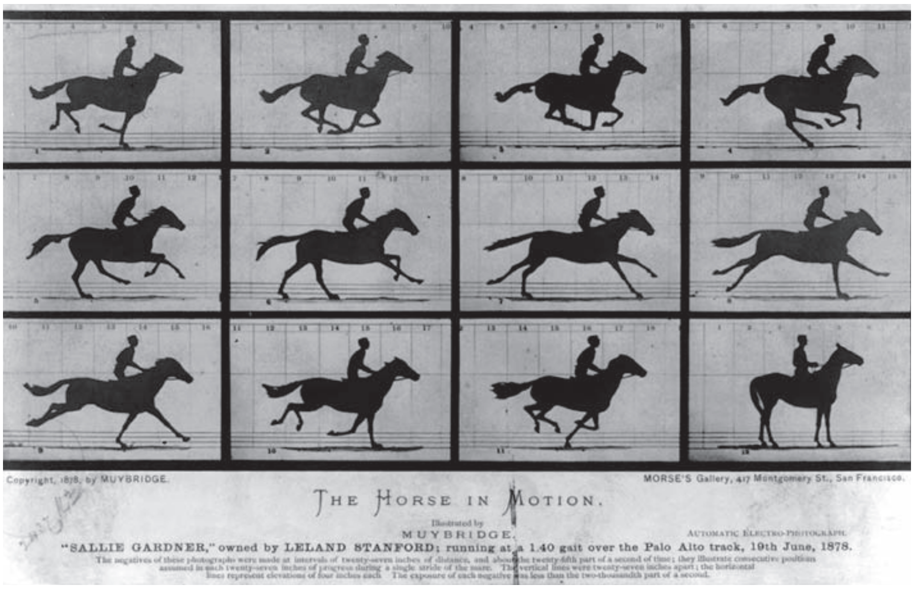

Figure 7.1 Muybridge's famous sequence of photos: The Horse in Motion.

three-dimensional system capturing up to 1000 frames of data per second which can be used for sophisticated analysis, and not generally available for commercial use with the average riding horse. Also, it is known that horses working on treadmills move differently from horses working over ground and comparisons to actual movement in athletic performance are difficult to extrapolate.

Other systems are available for general use outside the laboratory but these are only working in two dimensions so are unable to give the sophisticated data of the 3-D systems. The most easily available 2-D system used by the Centaur Biomechanics Team is the Quintic System (www.quintic.com). This bridges the gap between the laboratory-based limitations of a 3-D system as the data output is taken from a 2-D plane and mainly looks at the angular displacement of the joints. Two-dimensional analyses can also be carried out in the outdoor or competition environment therefore giving a better impression of an individual horse's movement. Indeed the Centaur Biomechanics Team were very busy taking data from horses competing in the 2012 Olympics for research purposes, and were responsible for the research behind the revolutionary Fairfax girth (see Chapter 6) which was widely acclaimed for giving Team GB Equine a competitive advantage.

For data collection, markers that can be tracked by computer are attached to the horse in standard, palpable anatomical landmarks (Photo 7.2). The camera captures up to 240 images per second, whereas the human brain can only process about 12 images per second. Computerised gait-analysis systems can, therefore, pinpoint even small errors or asymmetries in movement that could not be perceived by eye alone, thus detecting the

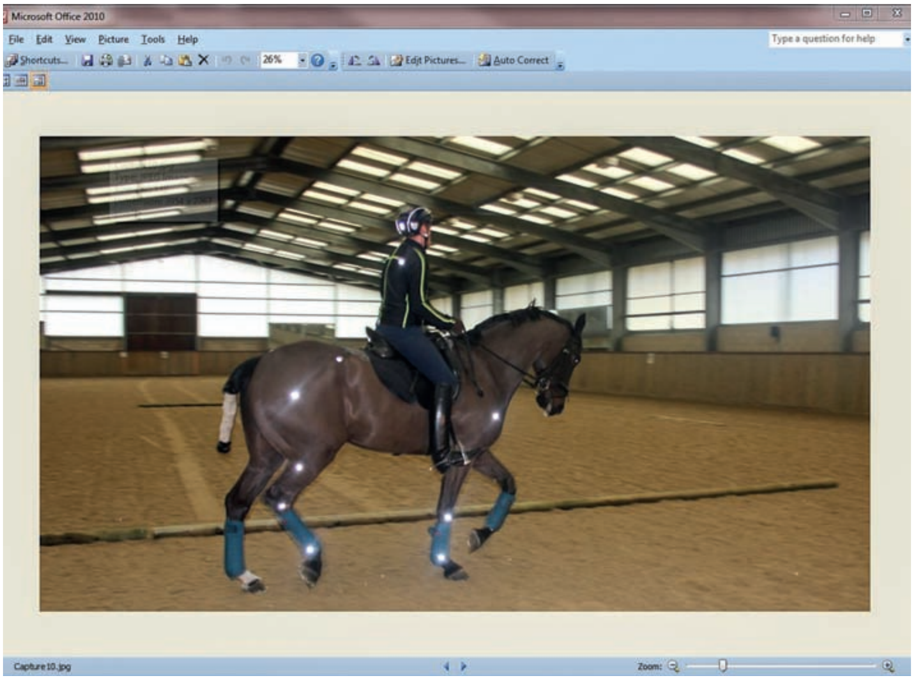

Photo 7.2 Standard anatomical marker placement for gait analysis.

so-called 'sub-clinical' lameness. In terms of the athletic horse, where correct dynamic and static posture are paramount, the ability of being able to pick up subtle asymmetries in movement is key to maintaining soundness and performance.

Even better, if the equine athlete has baseline movement data, against which his development can be monitored, this can be the basis for his athletic conditioning and physiotherapeutic support.

Gait analysis and movement issues

So what type of movement issues can the everyday horse rider, competitor or physiotherapist use gait analysis for, and how does it work?

As the horse moves, a video camera captures the movement of the markers applied to the horse and the system software digitises that movement so it can be analysed within minutes and displayed on a computer screen. The software effectively 'joins the dots' between the markers and displays specific segments of the horse's body. Photo 7.3 shows the segmented forelimb. One immediate visual effect is a demonstration of how the limb moves through time and space, as the markers are tracked through one stride (Photo 7.4). All markers can also be tracked by the system throughout one stride and visualised on screen (Figure 7.5).

There are obvious limitations to a 2-D system when compared with a 3-D system. Firstly, you do not get an impression of any simultaneous

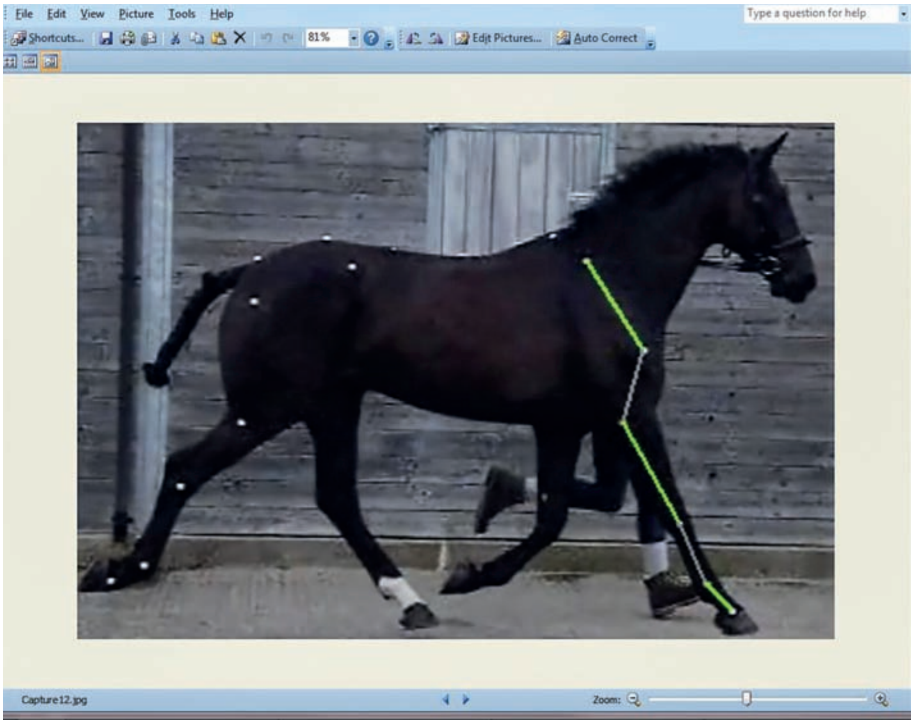

Photo 7.3 Computerised image of foreleg limb segments.

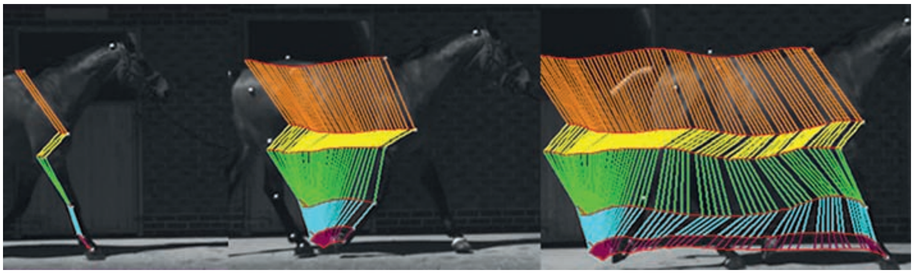

Photo 7.4 The computer software tracks the markers as the horse moves, to obtain a visual representation of how the limb moves throughout one stride. (Courtesy of www.quintic.com)

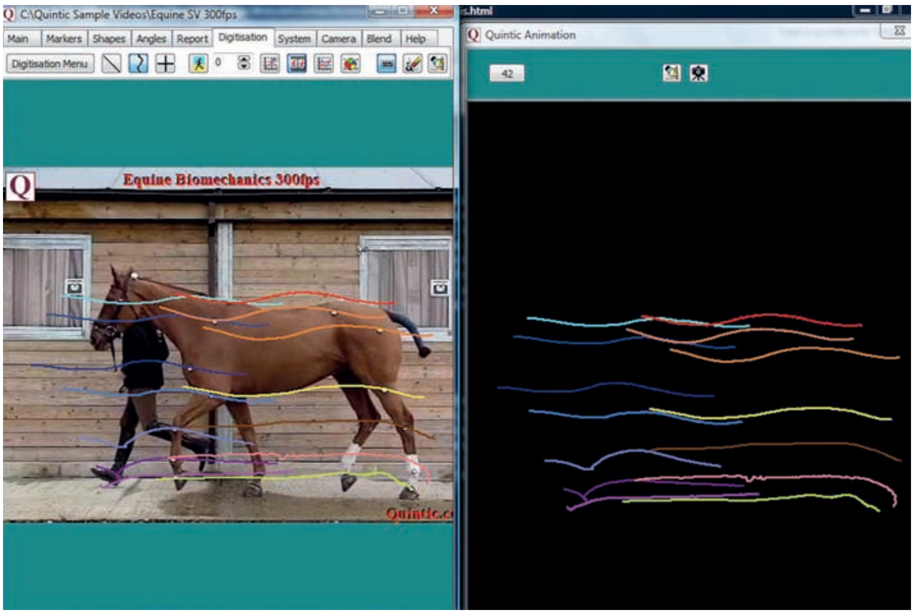

Figure 7.5 Screenshot of marker tracking throughout one stride.