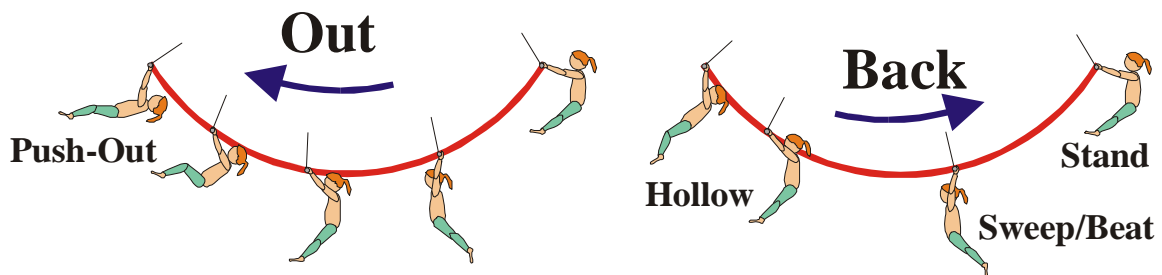


Investigation 6: An advanced swing

Although the trapeze is relatively straightforward for beginners, there are many skills and strategies that are mastered only after continued practice. The advanced swing is one of these skills. It enables a performer to 'work' their swing (i.e. swing higher) during a trick.

The advanced swing is especially useful on tricks where the swing is damped by the movements performed during the trick, but where height is still required. It is also used when the timing of the trick requires the position or somersault to be performed on the second swing. Rather than just hanging motionless on the trapeze, and allowing air resistance to eventually dampen the swing, you work against air resistance, so you maintain your height for the second swing.



In fact, the advanced swing is one of the most difficult tricks to learn, since being able to feel the rhythm is as important as simply knowing what to do. The main problem I found with practicing this swing is that timing is all-important. You may find that one swing seems to go fine, but by kicking slightly too late may throw off the next swing, so that you can't recover without stopping and starting again from the board. It is also all too easy to damp your swing by badly timed kicks, and thus the ability to keep up a consistent rhythm is very important, and it is only after this has been achieved that you find you are swinging higher than when you started.

Energy Considerations

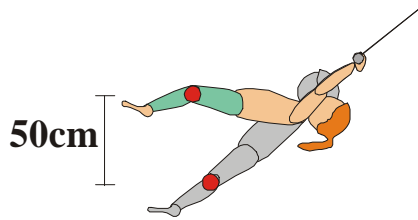
In Investigation 1, it was demonstrated that energy was the crucial quantity that defined the speed and height of the swing, and in Investigation 2, it was shown how, by changing the initial energy (in that case by starting from higher), the height of the swing could be changed.

Whilst swinging, you are constantly 'swapping' your energy between potential and kinetic, but the total amount you have (after leaving the board) is constant. In order to work your swing higher, you need to put energy in. The only available source of energy is your body (in the form of chemical energy). You therefore use your body to add energy into the system, this can either be added as potential energy, or kinetic. In the advanced swing, you add both, in two stages. The other two stages do not involve energy, and will be discussed separately.

Stage One - The 'Force-Out' (adding potential energy)

At the front end of the swing, the flyer uses his stomach muscles (and therefore his chemical energy) to lift his legs up, so he gains potential energy. He then pushes his body into a straight line, thereby bringing his hips up as well, further increasing his potential energy. When he swings back down again, he will have more energy, and will therefore rise higher at the backend of his swing.

We will now estimate the extra energy this contributes to the swing:



We will assume that the flyer lifts his legs by an average of 0.5m on the push-out. His legs are approximately half the mass of his body, which in total weighs 70kg.

$$PE = m \times g \times h$$

$$PE \text{ gained} = 0.5 \times 70 \times 9.8 \times 0.5m = 171.5J$$

When he gets back to the other end, he will have 171.5J extra, how much extra height will he have (excluding extra energy from sweep)?

$$PE = 171.5 = 70 \times 9.8 \times h$$

$$\text{So } h = 0.25m.$$

25cm does not seem like a very substantial figure, but if he can avoid losing more than this energy before the next push-out, he can at least keep his swing at a constant height.

Stage Two - The Hollow

This is one of the more subtle aspects of the swing. What the flyer is effectively doing is lifting his legs slightly, on the way back down after the force-out, before sweeping them back. Otherwise the feet remain behind after the force-out and the flyer cannot then sweep them back in the next step.

Stage Three - The Sweep/Beat

During the back swing, as you come out of the hollow, you add kinetic energy to your swing by sweeping your legs back. The timing of this is such that when your legs have swept back as far as they can go, you have reached the back of the swing, and your torso swings up, so you end up in a standing position. It is very difficult to calculate the speed of the legs, relative to the body, and therefore to calculate the extra energy this contributes. However, it is likely that the sweep contributes at least as much extra energy to the swing than the push out. With air resistance, you are constantly losing swing energy, so you must put at least this amount back into the swing to remain at a constant height (more to gain height).

Stage Four - The Stand

Stands - misses board



No stand:
hits board

Standing at the back of your swing serves a very important purpose. Once you begin to swing higher, there is a risk that you will swing back and hit the board you started from. Apart from hurting, it will jolt your swing, and throw off the rhythm. By standing, you are bringing your legs in, and preventing them from hitting the board (and also making it easier to get back onto the board, should you wish to).