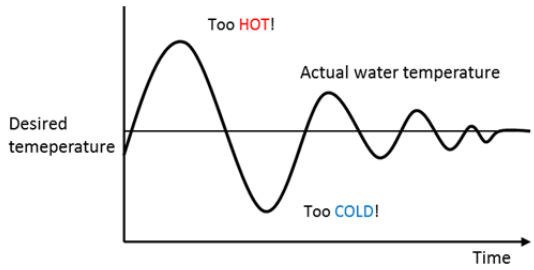
Delays and oscillations

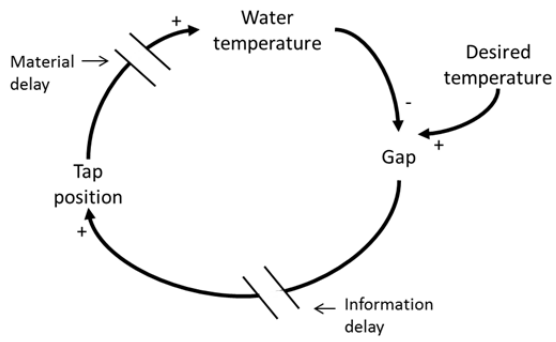
Cause and effect is not always instantaneous. There are often delays in relationships between variables. In fact, delays are everywhere in social and economic systems. When a customer places an order online there is a delay before he or she receives their package. When pollutants are spilled into a river there is a delay before they dissipate. When prices rise there is a delay before people adjust their behavior and buy from a competitor.

Delays can result from the time taken to process physical materials or from the time involved in perceiving and acting upon information. These two types of delays are called **material delays** and **information delays**.

A classic example is the early morning shower problem. You wake up, walk into the bathroom and get ready to take a shower. You turn on the water and wait. The water stays cold. The water heater takes a while to send you the hot water you need so you turn up the hot water a little more to speed things up. As soon as the water becomes warm, you step in. What happens next? That's right, the shower keeps getting hotter. Why? Because you turned on too much hot water to begin with. To avoid getting burnt you quickly turn down the hot water or turn up the cold. That's better. The temperature drops to a more bearable level. But it keeps dropping and the shower is now too cold! Sound familiar?



The temperature fluctuates or oscillates from hot to cold until it eventually reaches the right level. The delays and your overreactions make the temperature **oscillate** around a desired level.



There are **two delays** present in this system. Your reaction time is one delay. It's the time it takes you to collect and process **information** about the water temperature, compare it your desired temperature and then change the tap position. The other major delay is the time it takes the shower to actually change temperature once you have acted upon it. This is a physical or **material** delay that depends on the performance of your plumbing and water heater.

An oscillating variable is one of the six behavior patterns we spoke about in chapter 1. Oscillations in systems are generally due to undetected delays. In the case of the shower problem, the water temperature oscillates because **our reactions are inappropriate** given the time it physically takes the water heater to change the temperature of the water. We must learn to recognize delays and adjust our actions accordingly.

Delays are inevitable. It takes us a while to collect, process and react to information. In some cases delays may even be deliberate. Rather than reacting to every signal we receive, we often average, or smooth out information so that we only react to significant changes. This is called "information averaging" or "smoothing". For example, after a week of bad sales a business owner may wait until the end of the month to see if the week's trend is confirmed with more data. At that point, he or she may then decide on some corrective action.