

## A Brief History of Time

*Excerpts from Infinity in Your Pocket*

by Mike Flynn

Self-awareness is what distinguishes us from the rest of the animal kingdom. We are aware that we have been born, can expect to live for a while, and will eventually die. We are able to surmise this because we are aware of the passage of time. Time has a profound effect on our lives and so it was inevitable that we would attempt to find ways of measuring it, if only to discover how much longer we have left.

Even in ancient times, few people could have failed to notice the rhythmic passage of the season, the phases of the Moon and journey across the sky of the wandering stars. Some of the earlier timepieces relied on the apparent movement of the celestial bodies such as the Sun in order to mark the passage of time.



Passing an alternating current through a piece of quartz crystal causes it to vibrate millions of times every second. This vibration is consistent and can be used as a base against which to measure the passage of time. Quartz technology developed in the 1930s and 40s, improved timekeeping performance far beyond the pendulum.

### Atomic Clocks

Atomic clocks rely on the resonant frequency of certain atoms to help in the measurement of the passage of time with extreme accuracy. The energy change of an atom produces a regular pulse, which can be measured, quantified and counted.

The current SI standard for the passage of one second is the time taken for a cesium-133 atom to cycle through 9,192,631,770 of these energy changes.

### Sundials

The earliest form of the sundial date from 3500 B.C. They used a stick called a **gnomon**, to cast a shadow across a dial which had been calibrated to tie in with the movements of the Sun. Useful on sunny days only, the sundial proved to be little more than an interesting ornament when the Sun didn't shine or night-time fell.

### Candles

Candles that were known to burn at a steady rate were adapted to display the passage of time. Bands were marked down the side of the candles at roughly one-hour intervals.

### Pendulum Clocks

The pendulum marks the point at which measurements of the passage of time began to become a little more accurate. A pendulum always takes the same amount of time to complete a cycle, almost regardless of the speed or duration of the swing. As the pendulum slows so the lengths of the swing shortens, which compensates for the drop in speed. This means that a release mechanism tied to the swing of the pendulum will operate .... Well, like clockwork.

### Quartz Digital Clocks

### Greenwich Mean Time and Universal Time

Greenwich Mean Time (GMT) was calculated from 0° degree longitude at the Royal Observatory at Greenwich in England. The plan was to avoid confusion over variations in local time by calculating it from this one spot. Originally, 00.00 GMT was at noon, but this was changed in 1925 so that the day began at midnight. Unfortunately, not everyone kept up and confusion reigned once again. In 1928 the International Astronomical Union decided to replace Greenwich Mean Time with Universal Time, which for practical purposes differs from GMT in name only. The term GMT is still used by English speaking navigators.

### Astronomical Measurements

The universe is incomprehensibly vast, a fact that was not truly appreciated until relatively recently. In order to interpret the vastness of space mathematically, it became necessary to figure out new ways of measuring it. Because we have a good idea of the speed of light in a vacuum, it seemed that the distance traveled by light during a set period of time might be a useful way of measuring distances in space.