The XP3™ Clock - Persistence of Vision

Fascinations' new XP3™ Clock uses "Persistence of Vision" technology to create images floating in mid air. We live in a world of both blinking and continuous lights. The phenomenon known as the "persistence of vision" causes many of the flashing lights we see to appear continuous. This phenomenon has been recognized for over 350 years.

Sir Isaac Newton in Book I of his treatise on Optics wrote "When a coal of fire moved nimbly in the circumference of a circle makes the whole circumference appear like a circle of fire, is it not because the motions excited in the bottom of the eye by the rays of light are of a lasting nature, and continue till the coal of fire in going round returns to its former place?"

Today, it is understood that once light has struck the retina, all the detection, processing, and transmission of the neural signal are chemical. The retained image is a result mainly of the time required for the production and decay of the photosensitive retinal molecules.

The continuous flow of retinal information received by our brain is interpreted in discreet packets. This is because some time is required to collect enough data for interpretation. The collection time is referred to as the "integration time". Amazingly, our brain is able to automatically adjust for different light intensities. For in-stance, when less light is available, our brain requires more time to collect sufficient data for interpretation so it automatically selects a longer integration time.

The XP3™ clock offers an excellent demonstration of the "persistence of vision".

The XP3™ clock's wand oscillates back and forth; in a plane that is typically nearly perpendicular to one's line of vision, approximately 16 times per second. Eight LEDs (light emitting diodes) are embedded along a line near the tip of the wand. Because the flashing LEDs remain on for only .185 milliseconds, only one point on the retina is stimulated so our brain interprets the information as a point of light. As the oscillating wand passes across one's field of vision, the eight LEDs are programmed to blink, such that a pattern is produced, which is interpreted by our brain as a character.

Some of the LEDs need to blink more than once in order to produce a character. For instance, the top LED on the wand blinks five times in order to produce the horizontal line of the top portion of the number "3". Since up to 12 characters can be displayed at one time, if the number '3' were repeated 12 times across the display with no spaces between the numbers, the top LED would flash on and off 60 times per sweep of the wand. Amazingly, since the wand makes 16 sweeps per second, the top LED in this example would be required to flash 960 times per second to create the perceived pattern. Due to the 'persistence of vision', the brain does not perceive that the points of light are being repainted 16 times per second.

However, since our eye's integration time is only slightly greater than the wand's sweep time, some flickering is noticeable. One way to reduce the flicker would be to operate the clock in a darker location. This works because our brain, in order to gather enough light information from the retina, automatically shifts to a longer integration time in reduced light. Another way to prevent flicker would be to increase the wand's sweep rate. It is interesting to note that movie film, which runs at only 24 frames per second, would produce some noticeable flicker were it not for the fact that the theater's movie projectors use a triple shutter. By shuttering each frame three times, a flash rate of 72 times per second is achieved. This rate is well above our brain's integration time, thereby eliminating the flicker problem. Computer monitors also avoid this flicker by flashing approximately 75 times per second.

Due to the fact that alternating current is used to power most of the lights around us, you might be surprised to learn how many of these lights, which seem to be continuous, actually blink. In order to discover which lights do blink, try the following experiment: Attach a mirror to a small round stick. Look at the reflection of a point light source while rotating the stick back and forth around its major axis with the palms of your hands. If the light source is continuous, the point of light will become a solid line, but if it is blinking, the light will appear as a dotted line.