Illogical: What Else Would You Call It?

by Dr. Clayton Boyer (CA)

Author's Note: The beautiful mechanisms shown in this article were all imaginatively crafted through the artistry of Forrest Burnett. The author and Burnett have teamed up to create even more unique and wonderful wooden-geared mechanisms that can be seen at www.lisaboyer.com.

It is obviously illogical. What else would you call a clock that doesn't follow convention? A wooden-geared electric clock with contra-rotating dials and planetary gears must be considered somewhat illogical.

Having created more than 50 unique and interesting wooden-geared clocks and kinetic sculptures, I have, up until now, avoided designing clocks with motors and have crafted my wooden-geared mechanisms using gravity and rocks or the occasional spring to power them. Until the Illogical I had generally felt that using a motor was somewhat like cheating; however, sometimes a design is unique enough that it justifies using an electric motor to drive it.

With its combination of wooden planetary gear movements and contra-rotating systems, the Illogical seemed to qualify as just such a unique mechanism. The Illogical has all wooden-geared clockworks driven by a one-revolution-per-minute synchronous motor located below its base (Figure 1–3).

Although illogical in design and deviating from convention, the Illogical is actually quite a simple and accurate mechanism from which to read the time. Figure 4 shows the Illogical's various parts.

Figure 1. The Illogical from the front.

Figure 2. The Illogical from the side

Figure 3. The Illogical from the back.

How It Works

The numbers for telling the hours and minutes are engraved into separate disks that are attached together to create a multilevel dial that rotates one complete revolution in a clockwise direction every 12 hours. A stationary pointer attached to the base curves up to indicate the passing hours. But what about the minutes?

The minutes are shown on the upper level of the multilevel dial that is traveling in a clockwise direction. A pointer attached to the large outer planetary ring, which is itself traveling in a counterclockwise direction, indicates the correct minute on that clockwise traveling dial.

This outer planetary ring with the minute pointer makes one counterclockwise rotation every 65.4545 minutes. This lag of more than five minutes exists because the planetary minute pointer ring and the numbers dial are traveling in opposite directions. With normal gearing, the opposing motion of the numbers dial and indicator planetary ring would cause the pointer and numbers dial to meet before 60 minutes has elapsed. To correct for this contra-rotationary timing, the planetary ring must move even more slowly than the 65 minutes one might expect. For example, part of this effect is similar to the daisy shown on the motion train of my Radiance one-wheel clock (*NAWCC Bulletin*, No. 378 [February 2009]:17–19). Twelve hours are shown by each rotation of a normal hour hand, but the daisy has only 11 lobes instead of 12 because the rotation of the hour hand around the daisy counts as one (11 lobes + I rotation = the 12 hours we require). This is also similar to why it appears to take us 365.25 days to go around the sun each year, while the stars appear to take 366.25 days. However you will note that neither of these examples has countra-rotationary effects that need to be taken into consideration.

In addition to showing the minutes and hours, the Illogical also has an additional set of planetary gears and a planetary seconds ring. A stationary pointer indicates the seconds that are shown constantly moving in the background. This slightly smaller seconds planetary ring rotates clockwise once every four minutes. The seconds planetary ring has 240 drilled holes with every fifth hole being offset, and every 60th hole enlarged and offset so it is a simple matter of noting the ever-passing seconds.

However, even with such an odd and illogical arrangement, the Illogical is an amazingly easy clock from which to read the time. All one needs to do is look at the numbers that the pointers are indicating.

A mechanism with lots of visible gears is always attractive, and internally toothed planetary gears make it even more seductive. However, when the gears *also* have the function of keeping time, that makes for an incredibly unique machine.

Only after building the Illogical was I delighted to discover that because the outer planetary minutes ring is so large and moving in a direction opposite the movement of the numbers dial, the viewer (if he or she is watching closely) can easily see that the ring is actually slowly rotating—something that is difficult to see on a clock with normal hands.

Zaturn

Taking the Illogical design even further, we created the Zaturn by substituting a large rotating copper hemisphere complete with hour and minute numbers drilled into it. The Zaturn is fitted with internal LEDs that at night spray their light in delightful patterns out through the drilled holes and onto the surrounding walls. This spectacularly lit LED design not only puts on a beautiful light show but the internal lighting makes it both a stunning night-light and a clock that is easy to read at night. There are additional ultraviolet LEDs that are directed outwardly to light up the acrylic "Rings of Zaturn," giving the sculpture a brilliant luminescence (Figures 5–7).

Figure 8 shows a Third Generation variation on the Illogical concept. This beautifully unique and unusual clock has the vertical orientation of the original Illogical design, but the internally toothed planetary gear, which is so prominent in the Illogical and Zaturn, is

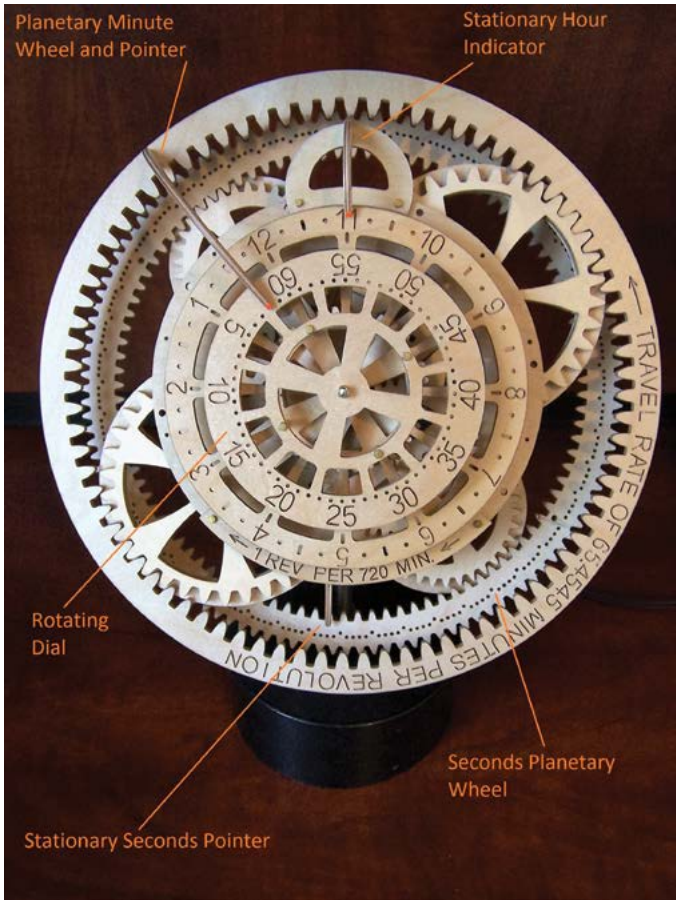

Figure 4, left. The Illogical's various parts. It is simple to glance at the pointers to see that the time is 11:02.

Figure 5, below. Top view of the Zaturn II.

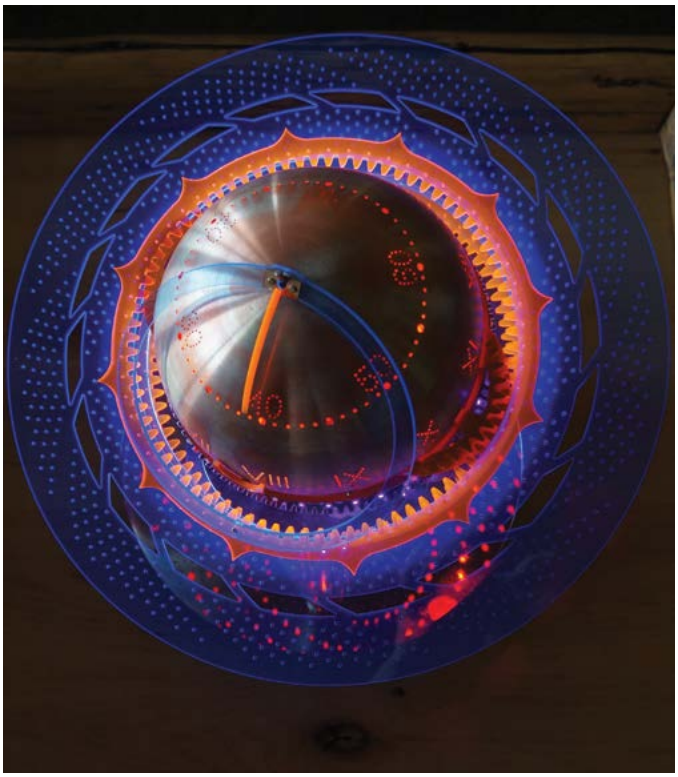

Figure 6. Below the Zaturn II emanates light in every direction.

Figure 7. Internal lighting and reflections of Zaturn II.

now hidden behind the dial, giving this clock a more conventional appearance.

The Illogical, the Zaturn, and the Third Generation use the same internal wooden clockwork gearing and synchronous one-revolution-per-minute motor. Figures 9–14 show a successive building up of the various layers inside the Illogical as the wooden gears are progressively added to complete the mechanism.

Figure 9 shows the lowest frame, which is the motor base. The central arbor and drive pinion are seen here. The outer pinions will eventually drive the seconds planetary ring. Note the seconds pointer is attached to this base level. To the right, in the background, you can see the numbers dial that carries the hour and minute numbers in a clockwise direction.

In Figure 10 we added another frame layer, and this pinion will eventually be the driver of the minutes planetary ring and pointer in a counterclockwise direction. The central four-trundle pinion will drive the numbers dial rings through another intermediate set of wooden gears.

Figure 11 is another stationary frame that holds the hour indicator, which is shown here not yet completely attached. In the background you can see various dials to be added, and to the right is a partial view of the acrylic Ring of Zaturn. Both of these exceptional clocks sit on my desk at my right elbow.

Figure 12 shows the planetary seconds ring and its idler gears have been slipped into place. In Figure 13 the minutes idler gears

have been inserted as well as the intermediate dial gearing. In Figure 14 we slide on the numbers dial ring and attach the hour indicator. All that is left is to add the planetary minutes wheel. In Figure 15 the planetary minutes wheel has been added and the Illogical is complete. This picture shows the Illogical indicating that it is 1:21.

With its synchronous electric motor, the Illogical has been keeping perfect time for over a year. However, if the power should go off and the clock should ever need resetting, with the slip clutch designed into the multilevel numbers dial ring and the easy adjustability of the minutes planetary ring, the Illogical is a simple clockworks to reset.

Figure 8. Wood, acrylic, and LEDs come together to make the Third Generation.

Figure 9. The bottom layer is mainly responsible for the gears that will show the seconds. The 25-toothed gear on the left will be driving the large internally toothed planetary seconds ring through two sets of idler gears. The 24-toothed gear on the right will eventually pass the power through to drive the various minutes wheels.

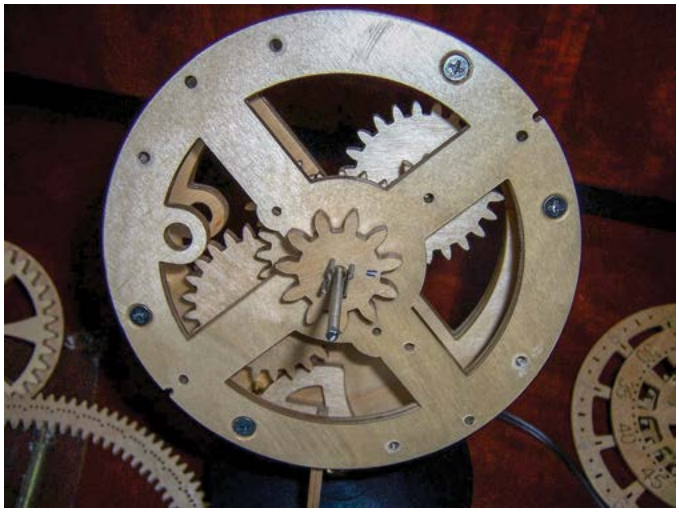

Figure 10. The middle layer is primarily responsible for moving the large internally toothed planetary minute wheel on this level through a set of idlers. The 11 pinion drives the idlers, and the four-trundle pinion in the center will pass through to the top layer to drive the layered numbers dial.

Figure 11. The base of the top layer has now been put into place, and the four-trundle pinion for driving the multilevel numbers dial is showing through the center.

About the Author

Dr. Clayton Boyer is a designer of kinetic sculptures and wooden clockworks. He has designed and built more than 50 of these remarkably unique mechanisms and loves to share with other woodworkers the joy of making wood move. You can see more of Clayton's designs and access building tips, tricks, and great information at www.lisaboyer.com.

Figure 12. Two of the seconds idler gears have been pinned into place and the planetary seconds ring set into the idler gears.

Figure 13. The intermediate wheel is set into place and the two minute idlers pinned to accept the large internally toothed, contra-rotating planetary minute wheel.

Figure 14. The multilevel dial and hour pointer are installed. The multilevel dial with the hour and minute numbers is tight to the center arbor but is adjustable with a slip clutch so that it can easily be adjusted to show the correct time.

Figure 15. The final step is setting the large contra-rotating planetary minute wheel on the idlers to indicate the correct minutes on the layered dial. In this picture you can see the three pointers: the hour pointer at the top, the minute pointer to the left, and the seconds pointer at the bottom, deep inside the mechanism.