# Using the Enhanced Rotary Table for Time Lapse

**Caution:** The rotary table is made from common steel. It is not plated or anodized to protect it from corrosion. It will tarnish over time and can rust if left in wet conditions. If you want to keep it shiny, you will have to keep it oiled or protected in some way. But it will not be harmed by tarnish.

The Enhanced Rotary Table can be used to rotate a camera between each exposure of a time lapse sequence to produce a time lapse movie that pans across a scene. The system can be programmed to shoot a simple, constant speed pan, or a “ramped” speed pan which can be programmed to gradually increase to a constant speed then gradually decrease to a full stop. The ramped pan is comprised of five sections, all of which can be adjusted to achieve the exact shot you have in mind.

Section 1, the Lead-In, does not move the rotary table, and allows you to have a number of static frames at the start of the shot. Section 2, the Ramp-Up, begins to move the table, taking it incrementally from zero to full speed for a given timing you set. Section 3 is the constant speed portion of the pan. Section 4, the Ramp-Down, does the reverse of Section 2, gradually slowing the table from full speed to a complete stop. Section 5, the Lead-Out, like Section 1, does not move the table, and allows you to have a number of static frames at the end of the shot.

Each program is stored in the Time Machine. You can store 40 programs, and for more complex shots, you can link one program to another so a second programmed pan begins as soon as the first one ends.

The rotary table can also be used to provide linear motion by using it to roll up a cable that pulls a camera on a track.

There are several components to the system. The Time Machine sends motion commands to a Motion Controller box. The Motion Controller drives the rotary table. An AC adaptor is provided for the Motion Controller if you have access to the 110 volt American power grid. If you are in Europe or the wilderness, you can run both the Time Machine and the Motion Controller on a 12 volt battery.

The power plug in the Motion Controller is a 2.5 mm coaxial barrel plug with center positive polarity. The Time Machine uses a 2.1 mm plug. The Motion Controller draws an average of about 150 mA when running, but may draw two or three times that amount at the instant of moving. If you use eight alkaline “C” cells in series, you can expect to run the rotary table for about 20 hours. Eight alkaline “AA” batteries might last for about 8 hours. You could also use the battery in a car or a 12 volt rechargeable gel cell.

If you use the same 12 volt battery to power both the Time Machine and rotary table, be careful. The metal flash jack on the Time Machine is grounded. If you accidentally let the postive terminal of the battery touch the flash jack, you’ll burn up the flash circuit. We can repair this, but it will take a few days.

**Be sure the Motion Controller is turned off any time you plug or unplug the motor. Otherwise, you may damage the electronics.**

Mount the rotary table to a sturdy photographic tripod. An easy way to do this is by utilizing a metal mounting plate available from Mumford Micro Systems that bolts to the bottom of the table and has a 1/4-20 or 3/8-16 threaded hole in the center.

Mount the camera to the top of the rotary table. An easy way to do this is by utilizing a camera mount available from Mumford Micro Systems that bolts to a hole in the center of the rotary table. Such a mount allows you to tilt the camera up or down, or side to side, while keeping the rotary table level.

Plug the motor of the rotary table into the Motion Controller using the provided extension cable.

Plug the interface cable into the Motion Controller and into the Flash jack of the Time Machine.

Plug the camera’s shutter cable into the Shutter jack of the Time Machine.

Plug the Motion Controller into your power source.

**Programming the rotary table**
There are two ways to use the Motion Controller. One way is for measured, relatively coarse motions. The other way is for fine scale ramped panning. You will choose the Motion Controller mode by pressing the MODE key on the Motion Controller. There are several different modes, but only two of them are probably of interest to you: Degrees Mode and Time Lapse Mode. The other modes are for the machine work the rotary table was originally designed for. (We have customized the rotary table for photographic use.)

**Direction of rotation**
Use the Settings Mode of the Motion Controller to change the direction of rotation of the rotary table.

**Degrees Mode**
This is the mode you will use for coarse, non-ramped movements. You can enter a number of degrees, and every time the Time Machine triggers the table, it will move that far. You can also move the table forward that far by pressing the NXT key. If you press the PRV key, the table will rotate backwards by the amount specified. Forward usually means clockwise, but this can be changed with the Motion Controller's Setup Mode.

Note: you can also move the table manually with the Jog Mode. Press the Stop/ Jog key, and then use "1" of "3" to rotate the table. "7" and "8" will move the table by smaller amounts.

To configure the Degrees Mode, press the MODE button until the LCD screen says "Degrees Mode". Then press Enter. The cursor will blink in the degrees value, which starts at "000.000". Press NXT to advance the cursor, and PRV to move the cursor left. Press a number to enter that value at that location. For now, enter "005.000" degrees and then press ENTER.

The Motion Controller is now ready. Each time you press the NXT key the rotary table should advance 5.0 degrees. Press PRV to back up five degrees. You can use the Motion Controller in this way, without the Time Machine, to plan a rotary pan. You can use the Motion Controller to move the camera through various degrees of travel to see exactly how many degrees you need for a shot. But you can also use the Time Machine to drive the rotary table in this mode for non-ramped pans. The following section describes this usage.

**Programming the Time Machine**
The Motion Controller interface cable should be plugged into the flash jack of the Time Machine. To get the rotary table to move in advance of each exposure, we configure the Time Machine to "fire the flash" before it trips the shutter. This is done with the Configuration Mode. You can enter the Configuration Mode of the Time Machine by holding down "BEGIN/options" as you turn it on. Set the primary "Output" to "Shutter". Then press BEGIN three more times to get to the "Pre-Flash" setting. Set this to one second (1.0). With this configuration, the Time Machine will trigger the flash jack (which makes the rotary table advance), wait one second (to let any vibration settle), and then trip the camera shutter.

Exit the Configuration Mode by pressing BEGIN until the LCD screen says "The Time Machine". Press the MODE key until the LCD screen says "Time Lapse". You can now program the Time Lapse Mode with whatever settings and interval is needed. Be sure to use the setting "Day and night" unless you know what this means and have a specific reason to use a restricted setting.

**When you enter the time lapse interval, keep in mind that one second will be added for the "pre-flash" operation. Also, the shutter duration specified in the Configuration Mode is added to the sequence time.**

You can determine how wide the pan will be when you enter a value for the "Exposure Limit" in the Time Lapse Mode. This is based on the amount of motion programmed in the Motion Controller. If you used 0.100 degrees, the camera

will rotate 10 degrees for every 100 exposures. For other settings, refer to the following table to see how many degrees the camera will rotate for every 100 exposures.

| Degrees | Number of exposures | | | | | | |
|---|---|---|---|---|---|---|---|
| per step | 100 | 200 | 300 | 400 | 500 | 600 | 700 |
| **0.025** | 2.5 | 5.0 | 7.5 | 10.0 | 12.5 | 15.0 | 17.5 |
| **0.050** | 5.0 | 10.0 | 15.0 | 20.0 | 25.0 | 30.0 | 35.0 |
| **0.075** | 7.5 | 15.0 | 22.5 | 30.0 | 37.5 | 45.0 | 52.5 |
| **0.100** | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 | 60.0 | 70.0 |
| **0.125** | 12.5 | 25.0 | 37.5 | 50.0 | 62.5 | 75.0 | 87.5 |
| **0.150** | 15.0 | 30.0 | 45.0 | 60.0 | 75.0 | 90.0 | 105.0 |
| **0.175** | 17.5 | 35.0 | 52.5 | 70.0 | 87.5 | 105.0 | 122.5 |
| **0.200** | 20.0 | 40.0 | 60.0 | 80.0 | 100.0 | 120.0 | 140.0 |
| **0.225** | 22.5 | 45.0 | 67.5 | 90.0 | 112.5 | 135.0 | 157.5 |
| **0.250** | 25.0 | 50.0 | 75.0 | 100.0 | 125.0 | 150.0 | 175.0 |

**Width of panned field for different settings**

How long does it take to shoot a time lapse sequence? Refer to the table below. The left column is the interval between exposures (in seconds). The top row shows the number of exposures taken. The time to shoot the sequence is shown in the table. When the duration exceeds sixty seconds, it is shown in minutes. For example, it takes 1.3 hours to take 800 exposures at a 6 second interval. Don't forget that the shutter duration programmed in the Configuration Mode is added to the interval specified in the Time Lapse Mode.

| | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 | 17 |
| **2** | 3 | 7 | 10 | 13 | 17 | 20 | 23 | 27 | 30 | 33 |
| **3** | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| **4** | 7 | 13 | 20 | 27 | 33 | 40 | 47 | 53 | 60 | 1.1 |
| **5** | 8 | 17 | 25 | 33 | 42 | 50 | 58 | 1.1 | 1.3 | 1.4 |
| **6** | 10 | 20 | 30 | 40 | 50 | 60 | 1.2 | 1.3 | 1.5 | 1.7 |
| **7** | 12 | 23 | 35 | 47 | 58 | 1.2 | 1.4 | 1.6 | 1.8 | 1.9 |
| **8** | 13 | 27 | 40 | 53 | 1.1 | 1.3 | 1.6 | 1.8 | 2.0 | 2.2 |
| **9** | 15 | 30 | 45 | 60 | 1.3 | 1.5 | 1.8 | 2.0 | 2.3 | 2.5 |
| **10** | 17 | 33 | 50 | 1.1 | 1.4 | 1.7 | 1.9 | 2.2 | 2.5 | 2.8 |
| **11** | 18 | 37 | 55 | 1.2 | 1.5 | 1.8 | 2.1 | 2.4 | 2.8 | 3.1 |
| **12** | 20 | 40 | 60 | 1.3 | 1.7 | 2.0 | 2.3 | 2.7 | 3.0 | 3.3 |
| **13** | 22 | 43 | 1.1 | 1.4 | 1.8 | 2.2 | 2.5 | 2.9 | 3.3 | 3.6 |
| **14** | 23 | 47 | 1.2 | 1.6 | 1.9 | 2.3 | 2.7 | 3.1 | 3.5 | 3.9 |
| **15** | 25 | 50 | 1.3 | 1.7 | 2.1 | 2.5 | 2.9 | 3.3 | 3.8 | 4.2 |
| **16** | 27 | 53 | 1.3 | 1.8 | 2.2 | 2.7 | 3.1 | 3.6 | 4.0 | 4.4 |
| **17** | 28 | 57 | 1.4 | 1.9 | 2.4 | 2.8 | 3.3 | 3.8 | 4.3 | 4.7 |
| **18** | 30 | 60 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
| **19** | 32 | 63 | 1.6 | 2.1 | 2.6 | 3.2 | 3.7 | 4.2 | 4.8 | 5.3 |
| **20** | 33 | 67 | 1.7 | 2.2 | 2.8 | 3.3 | 3.9 | 4.4 | 5.0 | 5.6 |

**Ramped Pans**
There is a different procedure for more sophisticated ramped pans. These require more planning, and finer control over the rotary table to move in very small increments.

**Programming the Rotary Table**
This is easy for ramped pans. The Time Machine controls almost all parameters. So just go to the Time Lapse Mode on the rotary table Motion Controller and press ENTER.

When a ramped pan has completed, you can press the PRV key on the Motion Controller and the rotary table will return to the same position it was in when you first entered the Time Lapse Mode.

**Programming the Time Machine**
Ramped pans are programmed with the Rotary Table Mode of the Time Machine. Here you will enter a set of parameters for one ramp "program". The ramp program will then be executed by the Time Lapse Mode. You can enter 40 different ramped pan programs.

**Note: If you enabled "Pre-Flash" in the Time Machine for non-ramped panning, you should set it back to zero for ramped panning.**

There are several parameters of a pan program. These are:
- Lead-in: the time before motion begins.
- Ramp up: the period over which the motion ramps up to full speed.
- Pan speed: how much motion there is between each exposure in the main pan.
- Pan length: the duration of the main pan.
- Ramp down: the period over which the motion ramps down to no motion.
- Lead-out: the time after motion has stopped.
- Program link: the program number of another pan program to execute after this one has finished, if any.

To plan a pan program, you will need to come up with the parameters needed by the Time Machine, based on the amount of motion you require. We have prepared an Excel spreadsheet to help with this, and it can be downloaded from this web site:

http://www.bmumford.com/photo/rotary/PanPlanning001.xls

This spreadsheet incorporates some of the complications of timing for ramped pans. Remember that the time lapse interval includes the interval you set in the Time Lapse Mode, the duration of the shutter contact set in the Configuration Mode of the Time Machine, and the time it takes the rotary table to complete it's motion.

The Time Machine trips the shutter of the camera for the duration you set in the Configuration Mode, then it moves the rotary table. You want to make sure

that the table does not move before the shutter closes. Be sure that the shutter contact time is a little longer than the maximum exposure time your camera will use. This may take more care with long nighttime shots.

In general, you need to tell the Time Machine how many exposures to take in each step of the pan program, and how far to move between each exposure.

The number of exposures you take determines how long the time lapse movie will last. At 30 frames per second, you need 30 exposures for each second of time lapse movie.

The amount of motion between each exposure may be more difficult to come up with because it depends entirely on how wide the field of view of the camera lens is. One rule of thumb is that a pan should move at a rate of seven seconds per field of view.

The increment of motion in the ramped pan rotary table is .001 degrees per step. This will be barely noticeable. The more “steps” you take between exposures, the faster the pan will be. If you move too slowly, the time lapse will be tedious. If you move to quickly, the time lapse will be jerky. You probably need to do some trial and error with your equipment to find what settings work in your situations.

The following table helps you plan what value to use for “Pan speed” in a program. For example, if you wanted to pan 30 degrees and you wanted to shoot 300 exposures, you would use “100” for Pan speed. This is 100 increments of .001 degrees between each exposure. Note that this does not include additional rotation that’s part of the ramp up or ramp down. Also, you can’t enter a value larger than 255 for Pan speed.

| | Degrees of travel | | | | | |
|---|---|---|---|---|---|---|
| **Exposures** | **10** | **20** | **30** | **40** | **50** | **60** |
| **50** | **200** | | | | | |
| **100** | **100** | **200** | | | | |
| **200** | **50** | **100** | **150** | **200** | **250** | |
| **300** | **33** | **67** | **100** | **133** | **167** | **200** |
| **400** | **25** | **50** | **75** | **100** | **125** | **150** |
| **500** | **20** | **40** | **60** | **80** | **100** | **120** |
| **600** | **17** | **33** | **50** | **67** | **83** | **100** |
| **700** | **14** | **29** | **43** | **57** | **71** | **86** |
| **800** | **13** | **25** | **38** | **50** | **63** | **75** |
| **900** | **11** | **22** | **33** | **44** | **56** | **67** |

**Choosing a Pan Speed for an amount of rotation**

Let's take a look at a sample program. I will enter the following parameters into the PanPlanning spreadsheet:

Frame rate: 30
Total pan angle: 20 degrees
Lead-in: 1 second
Ramp up: 1 second
Duration of main pan: 5 seconds
Ramp down: 1 second
Lead-out: 1 second
Time lapse interval: 5 seconds
Shutter contact time (in Time Machine): 0.2 seconds

This produces the following values to enter into the Rotary Table program of the Time Machine:

Lead-in: 30 (exposures of 30 fps for one second)
Ramp len: 30 (exposures of 30 fps for one second)
Pan speed: 111 (this many increments of travel between each exposure.
Each increment of travel is .001 degrees)
Exposures: 150 (exposures of 30 fps for 5 seconds)
Ramp len: 30 (exposures of 30 fps for one second)
Lead-out: 30 (exposures of 30 fps for one second)

The spreadsheet also tells us it will take about 24 minutes to shoot this sequence (the time is approximate).

To enter these values in the Time Machine, go to the Rotary Table Mode and select which program number you will use. Then enter each of the values shown above. After the "lead-out" you will be asked for a "Link to" number. For a simple pan, set this to zero. If you want one pan to jump to another one after it has finished, you can enter the program number of the next pan sequence here.

Hit BEGIN to enter the "Link to" value, and the Time Machine will go back to the beginning of the Rotary Program Mode so you can check your settings if you want to. If you are finished with the setup, hit the MODE key. This will take you to the Time Lapse Mode because, to execute the pan program, you use the Time Lapse Mode. Here you will specify the Time Lapse interval and the rotary pan program number to use. The pan sequence will begin as soon as you hit BEGIN after setting the rotary program number.

**Using the rotary table to pan video cameras**
You can also use the rotary table to pan a video camera. This would usually be done with the Degrees Mode of the Motion Controller and need not involve the Time Machine at all.

Using the Degrees Mode, you can specify how many degrees to rotate. You can also tell the Motion Controller to move continuously without limit by entering "000.00" for the degrees of motion. It will run until you stop it with the JOG/

STOP key.

The speed of travel is set with the Settings Mode of the Motion Controller. There are two parameters: “Slow” and “Fast”. When the rotary table starts moving, it travels at the rate set by the “Slow” parameter and ramps up until it reaches a speed set by the “Fast” parameter. The stepper motor can’t start moving at high speeds, so you can’t enter a number larger than “20” for “Slow”. You have no control over how long it takes to go from the Slow speed to the Fast speed. It also ramps down from “Fast” to “Slow” before it stops. If you enter the same value for “Slow” and “Fast” there is no ramping and the speed is constant.

The following table shows the time it takes the table to rotate 360 degrees for various settings of “Slow” and “Fast”.

| **Speed Setting** | **Minutes to rotate 360°** |
|---|---|
| 5 | 12 |
| 10 | 6 |
| 15 | 4 |
| 20 | 3 |
| 30 | 2 |
| 40 | 1.5 |

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