

## RoboRiddler: A Small-Scale Automated Riddling Machine

The production of sparkling wine, using the traditional in-bottle fermentation method, requires a lengthy and labor-intensive process known as “riddling”. This process is needed to shake-down the yeast sediment into the neck of the bottle where it can subsequently be frozen and eliminated through the art of disgorging the ice plug. Done properly, the wine remaining in the bottle is both clear and sparkling. At this point, the bottle is topped-up and fitted with an oversized cork which is wired in place in order to withstand the pressure produced by the carbon-dioxide gas trapped inside [See [Mazza video](#) for an elegant description of the traditional method of sparkling wine production].

### Design Modules

The RoboRiddler consists of six major design modules: (1) a 40 x 18-inch wooden platform mounted on an axle to allow partial rotation along its longitudinal (tilt) axis, (2) a linear actuator used to modulate the level of tilt of the riddling platform, (3) a small motor designed to vibrate the riddling table on demand, (4) a Windows-based computer with a parallel printer port used to control the timing and operational states of the vibrating motor and linear actuator, (5) an interface circuit linking the digital outputs of the computer to relays controlling the vibrator and actuator, and (6) Visual Basic 6 software allowing manual and automated control of the RoboRiddler apparatus.



Figure 1.

The RoboRiddler Platform with Control Computer Console

## Riddling Platform, Linear Actuator and Vibrator

The riddling platform is large enough to accommodate 3 cases of sparkling wine bottles. This platform is mounted on a surrounding support structure via a 4-foot long axle (3/4-inch diameter) and two pairs of pillow-block ball bearings (see Figure 2). This arrangement allows the platform to freely rotate around its longitudinal axis and provides the basis for achieving the  $\pm 20$ -degree tilt in the orientation of the table top holding the wine bottles. This free rotating riddling platform is held in place by a *Duff-Norton Model SK-6905-100* AC-powered linear actuator. The linear actuator is affixed to the underside of the “forward” edge of the riddling table and anchored to a support beam integrated into the design of the surrounding support structure. When the linear actuator is fully retracted, the riddling table is tilted 20-degrees toward the front of the apparatus. Upon fully extending the linear actuator (6-inches), the riddling table is tilted 20-degrees toward the back of the apparatus (i.e.,  $\pm 20$ -degree tilt = 40-deg total). This actuator is rated with a lifting/pulling/holding force in excess of 500 lbs. – plenty strong enough for this application (In fact, it probably is too strong as noted in the commentary below). Periodic changes in the tilt angle prevent excessive build-up of yeast sediment on one-side of the bottle during the extended riddling process.

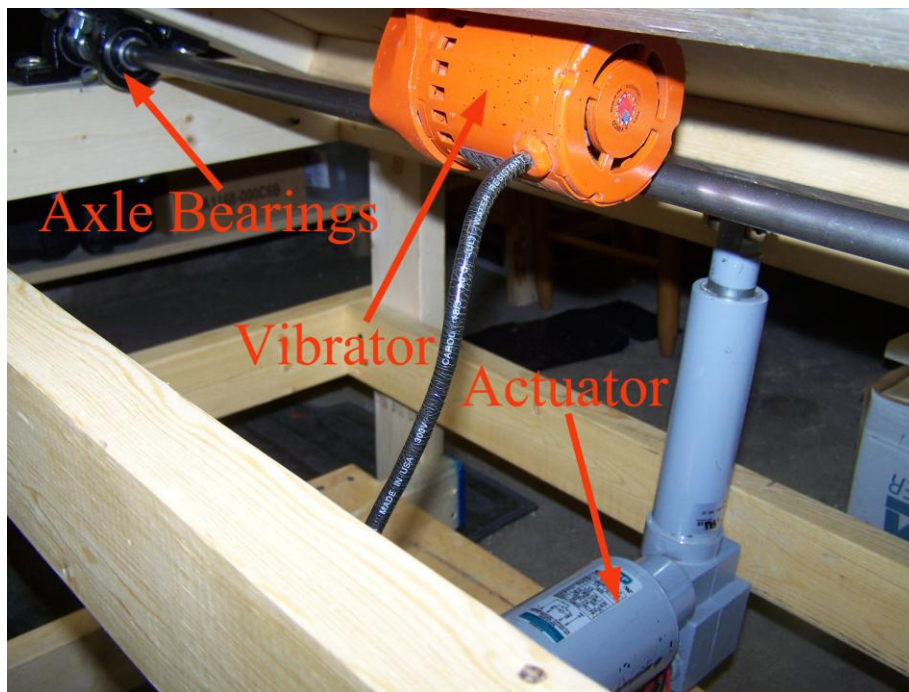


Figure 2.

View of RoboRiddler undercarriage showing vibrator and linear actuator.

The ability to tilt the bottles back-and-forth under manual or computer control of an electronic relay is convenient. However, the major force driving the sediment (in the inverted bottles of sparkling wine) toward the neck and into the cap is provided by the gentle, high-speed mechanical vibration introduced by a *Vibco Model SPR-20* electric vibrator motor mounted on the underside of the riddling table (see Figure 2). The motor is mounted via two bolts that pass through rigid steel mounting plates on both the top and bottom sides of the riddling platform. The top plate is extended across the entire width and most of the length of the platform in order to provide a rigid surface capable of transmitting the mechanical vibrations across the entire surface area of the riddling platform. The Vibco SPR-20 generates a vibratory force of 67 Newtons (approximately 15 pounds) at a frequency of 1600 oscillations per minute. It operates via 115 volt household AC current (at 0.5 amps) which the RoboRiddler controls via a DC-powered solid-state relay. *Use of vibration to riddle the sparkling wine is facilitated by adding a bentonite-alginate riddling aid to the cuvée.*

### **Windows-based Control Computer**

The relays which regulate the state of the linear actuator and vibrating motor are controlled via a Windows-based computer running a legacy version of the operating system (in this case Windows NT4). The computer achieves this control via a built-in parallel port interface (DB-25-pin connector). Three digital output lines are used to (1) energize the linear actuator, (2) program the linear actuator's direction of travel (i.e., retract or extend) and (3) energize the vibrating motor. The legacy CyberResearch computer used in the RoboRiddler prototype, described here, has a touch-sensitive screen so that the device can be operated without the need of a mouse or keyboard (which is very convenient in the confines of most wine cellars).



Figure 3.  
RoboRiddler control computer with touch-screen interface.

## Electrical Interface Circuits

A single housing (about the size of a cigar box) holds the AC electrical circuits that drive the vibrating motor and the linear actuator as well as the digital interfaces that allow the computer's printer port output lines to control the behavior of these circuits (See the small gray box sitting on the floor beneath the RoboRiddler's main platform in Figure 1). First the AC wiring connecting the relays to the linear actuator and vibrating motor will be described.

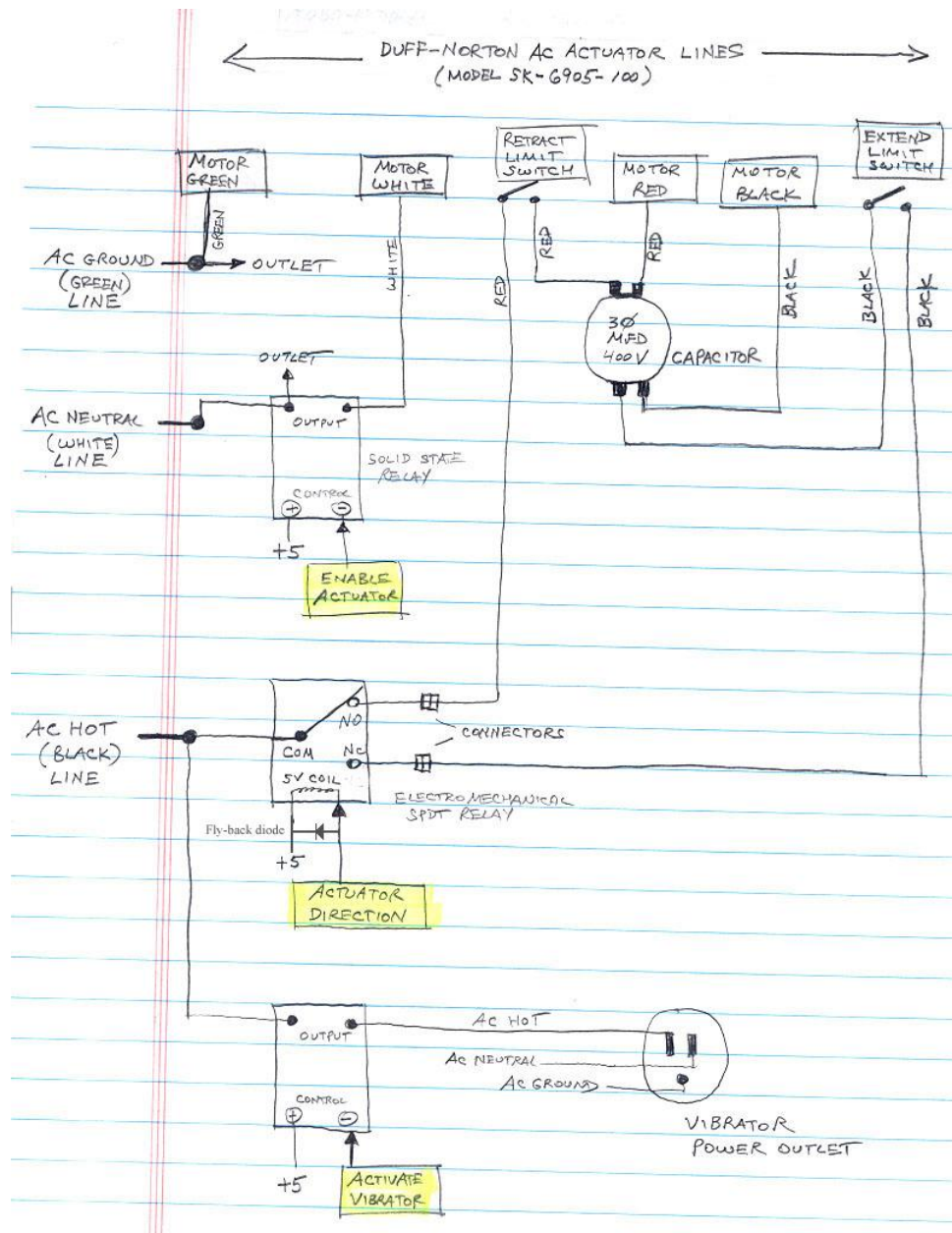


Figure 4.

AC driver circuits controlling the linear actuator and vibrating motor.



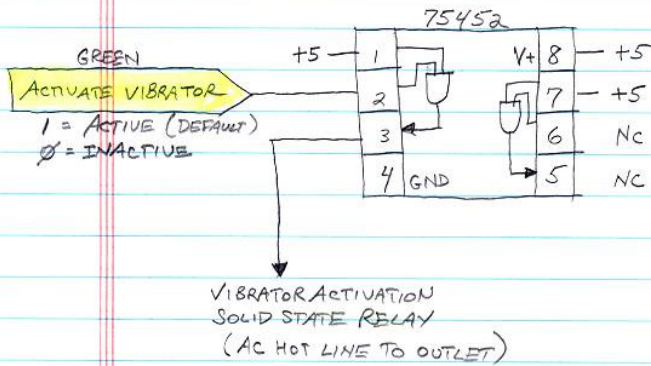
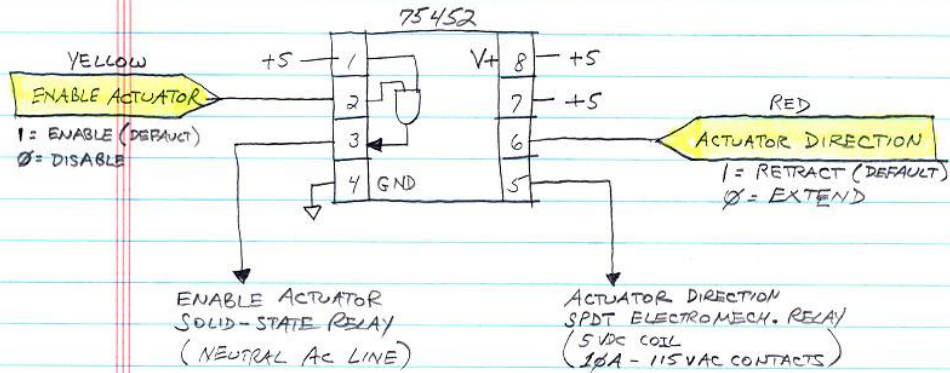
The upper part of Figure 4 depicts the wiring of the circuits controlling the linear actuator. The AC neutral line is routed to the linear actuator via a WHITE wire that runs through a solid state relay. This relay opens or closes depending on the state of the ENABLE ACTUATOR input (colored yellow) programmed by the control computer. The linear actuator cannot operate unless this relay is activated.

The direction of the linear actuator's travel depends upon the state of a SPDT electromechanical relay that routes the AC "hot" line to either the clockwise (CW) coil of the actuator's drive motor (causing it to retract) or through the counter-clockwise (CCW) coil (causing the linear actuator to extend). The state of this SPDT relay is controlled by the ACTUATOR DIRECTION input (colored yellow in Figure 4). Both the CW and CCW circuits are also routed through limit switches built-in to the linear actuator's main housing. When the actuator reaches the fully retracted state the CW limit switch opens and the CW motor coil is automatically disconnected and the linear actuator stops. Similarly, when the actuator reaches the fully extended position the CCW limit switch opens (automatically stopping the actuator at its preprogrammed maximum point of extension).

Energizing the vibrating motor is achieved via another solid-state relay that modulates the motor's AC "hot" line connection. This relay can be opened or closed depending upon the state of its ACTIVATE VIBRATOR control input (colored yellow in Figure 4).

The **digital interface circuits** connecting the digital outputs of the control computer to the relays operating the vibrator and linear actuator are depicted in Figure 5 below. These digital interfaces are designed using two 75452 dual peripheral driver packages capable of sinking 500 mA of current (more than sufficient to drive any of the control relays described above). The peripheral driver circuit that activates the relay that energized the linear actuator is driven by pin-2 of the computer's printer port (i.e., DATA-0 output line). When the computer sets this line to the logic-high state (5 volts) the peripheral driver becomes activated and closes the ENABLE ACTUATOR relay by completing its connection to ground. Similarly, another peripheral driver circuit is connected to the coil of the SPDT electromechanical relay that controls the direction of the linear actuator. This peripheral driver is controlled by pin-3 of the computer's printer port (DATA-1 output). When the computer sets this line to logic-high the SPDT relay is set to the RETRACT state. Otherwise, the relay assumes the EXTEND state. Finally, a third peripheral driver circuit links pin-4 of the computer's printer port (DATA-2 output) to the relay controlling the AC vibrator motor. When pin-4 is set to logic-high the control relay is activated and the vibrating motor operates. Otherwise, the vibrating motor is disconnected from its AC power source.

DIGITAL INTERFACE CIRCUITS [ 3 LINES + GROUND ]



LPT INTERFACE LINES : BLACK (25) GROUND  
YELLOW (2) D0  
RED (3) D1  
GREEN (4) D2

Figure 5.  
Computer digital interface circuits.

## Visual Basic Software – RoboRiddler.exe

Microsoft Visual Basic 6 together with a freeware I/O port module (WinIO.dll) were used to implement software allowing flexible manual and automated control and timing of the RoboRiddler's main functions. The user interface (depicted in Figure 6) is intuitive and can be operated easily with the standard mouse/keyboard console. As mentioned above, the current prototype uses a touch-screen interface to control and automate the riddling process. RoboRiddler.exe divides the riddling process into four successive states or processes. The first state (**Pre-Tilt Vibration**) turns on the vibrating motor and then waits for a programmatically defined time period (specified in seconds). Next, the program enters the **Tilt Toggle** phase where the state of the actuator motor is changed and the riddling table's orientation is moved from 20-degrees forward to 20-degrees backward tilt (or vice versa). Once the actuator has been given sufficient time to complete its state transition, the program enters the **Vibration** phase. In this phase the vibrating motor runs for a specified time interval. Upon completion of the Vibration phase the program transitions to the **Inter-Riddle Interval** phase during which time neither the actuator nor the vibrating motor are active – thus, completing one full 4-phase riddling cycle.

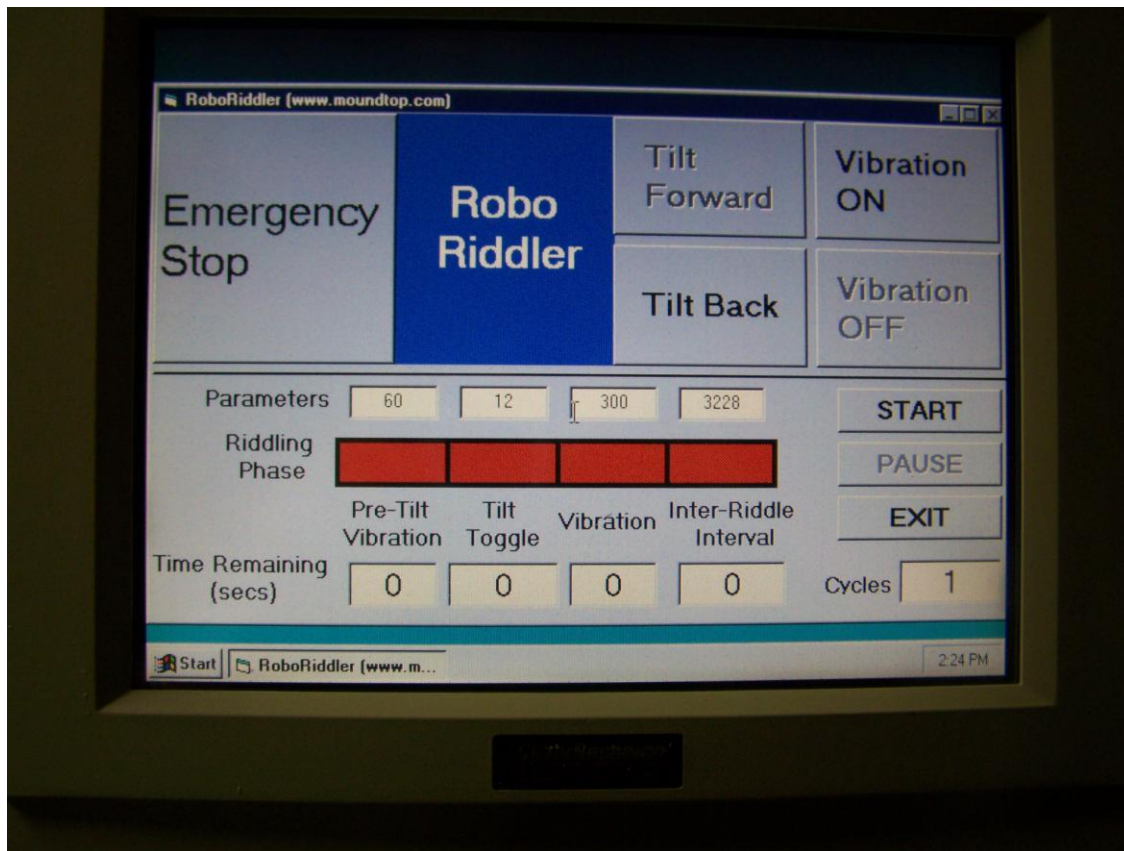


Figure 6.  
RoboRiddler.exe's touch-screen user interface.

The default time settings (specified in seconds) are depicted in Figure 6. By attaching a keyboard to the Windows-based control computer, any combination of time parameters can be programmed by the user. Any of the four phases of the riddling process can be skipped by setting its time parameter to zero.

### **Critical Mechanical & Electronics Parts – Source/Cost**

Duff-Norton SK-6905-100 linear actuator Purchased on eBay; used, like-new condition (\$560 if purchased new)	\$81
Vibco SPR-20 vibrating motor Purchased on eBay; used, like-new condition (\$235 if purchased new)	\$100
(2) Solid-state AC relays 25 amp AC load; 3-24 VDC control inputs eBay China-based vendor	\$10
SPDT Electromechanical Relay (Potter & Brumfield T9AS5D22-5) 120 VAC @ 20A contacts; 5-volt coil (220 mA)	\$4
(4) NorTrac Pillow Block ¾-inch Bearings; 2-bolt mount purchased new from Northern Tool's eBay store	\$40
¾-in O.D. Solid Steel Steering Wheel Shaft – 4ft long purchased new from Speedway Motors eBay store	\$34
CyberResearch Industrial Control Computer with Touch-Screen Interface purchased on eBay many years ago (used; good condition) pre-loaded with Windows NT (supported by VisualBasic6 free runtime)	\$100

### **Video Demonstrations of the RoboRiddler in Action:**

{more refined video coming to YouTube soon}

Manual operation of tilt table

<http://www.moundtop.com/RoboRiddler/actuation.wmv>

Effects of vibration on a cup of water (proxy for wine in bottles)

<http://www.moundtop.com/RoboRiddler/vibration.wmv>