

Wine Glass Orchestra

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Things That Think

Abstract

My wine glass orchestra project consists of three mechanical wine glass instruments coordinated with Crickets. The first automaton, Hum, produces a hum as a motor propels a wet cork around the rim of a partially filled wine glass. In the second automaton, Fork, a motor causes a fork to tap against the side of a wine glass. In the third, Toast, two wine glasses slowly come together in a toast. A Cricket is mounted to each automaton. The Toast Cricket sends an infrared signal to the Hum and Fork Crickets just as the Toast wine glasses are about to come together. The Crickets for Hum and Fork then operate switches that turn off the Hum and Fork motors just before the toast.

Automata

This section provides a detailed description of each automaton. A discussion of the design and construction process follows in the next two sections.

The first automaton, Hum, uses a motor to push a cork around the rim of a glass. The motor is mounted directly above the glass, and a dowel connects the motor to the middle of a disc. Another dowel connects the disc to a cork. The cork moves in a circle, pushing lightly against the outer rim of the glass, producing a hum. Figure 1 shows a photograph of Hum.



Figure 1. Hum.

In Fork, a motor propels a crank that is attached to two linkages. The linkages cause a fork to move back and forth, tapping against the side of a glass. Figure 2 shows a photograph of Fork.



Figure 2. Fork.

Crickets are used to control the switches that turn the Hum and Fork motors on and off. For both Hum and Fork, a Cricket controls a small Lego motor that has a gear mounted to it. This gear turns another gear that is mounted to a dimmer switch. The dimmer switch controls a motor. A photograph of this mechanism is shown in Figure 3.



Figure 3. Cricket controlled dimmer switch.

A photograph of Toast is shown in Figure 4. In this automaton, a motor is connected to a worm gear. This worm gear propels a wheel gear on a shaft that is attached to another wheel gear. The second gear is mounted between two large wheel gears and causes them to turn. These large gears rotate on shafts that have wine glasses attached to them. The glasses turn with the large gears and are aligned so that at one point in the large gears' rotation, they meet in a toast.



Figure 4. Toast

Though it is hidden in the photograph, one of the large gears in Toast has a trigger coming off of its shaft. This trigger bumps against a Cricket's touch sensor just before the wine glasses toast. The triggering of the touch sensor causes the Toast Cricket to send out an infrared signal. This signal is received by the Hum and Fork Crickets and causes their Cricket motors to turn on. These motors move the Hum and Fork dimmer switches to their off positions. This behavior is achieved with very simple coding. Appendix A provides a full listing of the code that was used for each Cricket.

The motors that operate the automata came from electrical can-openers I found at thrift stores. They are all 120 Volt, 60 Hz, AC motors and are very similar. In addition to the motors, each can-opener had internal gearing that I made use of. A photograph of the inside of one of the can-openers I used is shown in Figure 5. Each can-opener motor propels a worm gear that turns a series of two wheel gears. In all cases, my automata are connected to the motor via the larger wheel gear.

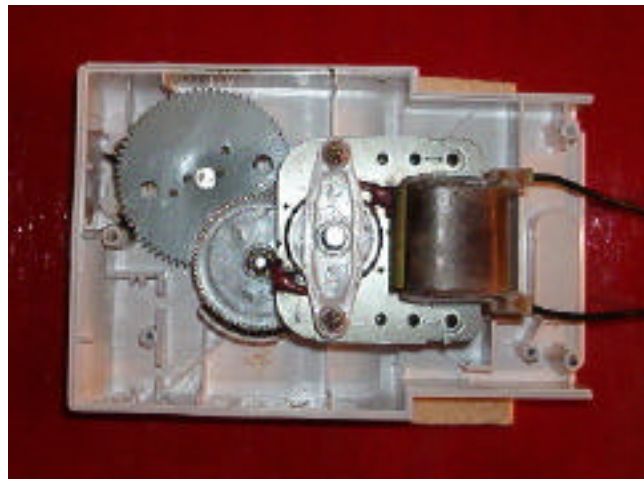


Figure 5. Can-opener motor and gearing.

Design

My primary motivation in designing this mechanism was to create something beautiful. I was interested in approaching this assignment as an art assignment as much as an engineering assignment. I was strongly influenced by the Arthur Ganson video we watched in class. I was also influenced by an Alexander Calder video I watched around the same time. He built a number of motorized sculptures and mechanical wire figures early in his career. Finally, I was motivated by a great installation I saw a few years ago at the P.S.1 Art Museum in Queens, New York. In this installation, a room was strung with musical wire attached to amplifiers and was filled with 50 or so small birds. The exits and entrances to the room were carefully controlled, but once a person entered the room, she could walk around freely. As birds landed on different wires, different notes and chords were produced. It was beautiful!

In the first stages of design, before I had come up with a definite plan, I knew I wanted to incorporate another element in addition to wooden or plastic mechanical parts in my automaton. I tried to come up with feasible ideas for incorporating water or wind into a design, but when my boyfriend suggested building a machine that would make a wine glass hum, I liked the idea of incorporating sound immediately. I also liked the fact that wine glasses are traditionally used to produce noise in a few other ways, and I decided to try to build three automata. Figure 6 shows the original design drawings.

Right away, I found I had to modify my design for Hum. I quickly discovered that it would be impractical to use a crank slider mechanism to move the cork. When the crank is a circle, the shape traced out by the end of the slider is an ellipse. So, I decided on a simpler design where the motor is mounted directly above the glass, as can be seen in the finished automaton.

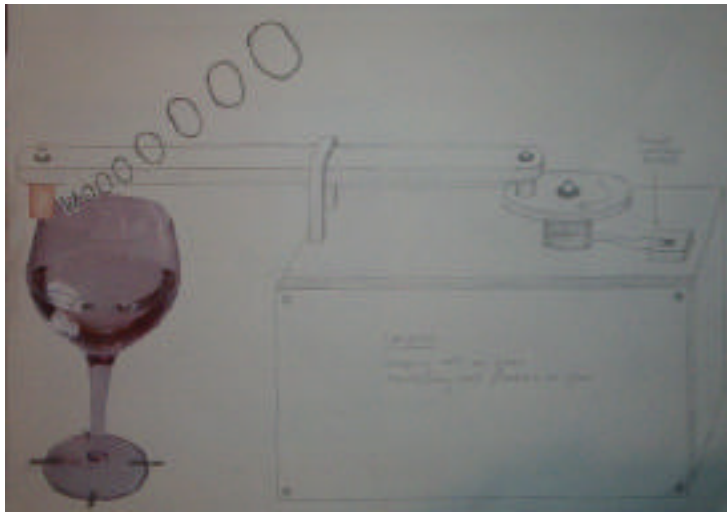


Figure 6. Original designs for Hum, Fork and Toast.

Construction

The first step I took in building my automata was to build prototypes of Hum and Fork. Pictures of these prototypes are shown in Figure 7. Building these mock-ups helped me get used to the materials I was working with and helped me figure out what the dimensions of the final versions of these automata should be. Though I built prototypes of some parts of Toast, I never built a prototype of the entire automaton because most of the parts were very time consuming to make and it seemed like it would be difficult to meaningfully test Toast's function without building all of the parts.



Figure 7. Prototypes of Hum and Fork.

The automata are built primarily out of plywood, dowels, 1x3" pine boards, sheet metal and balsa wood. The frames are screwed together and mechanical parts are glued together where it's

necessary with wood glue or epoxy. I used the laser cutter to cut balsa wood washers and linkages and other basic tools to prepare the rest of the pieces and assemble the automata.

I encountered a number of problems during the construction process. Right away, I encountered the fact that the Crickets were only able to power very weak motors. Because of this, I decided to use motors with external power sources, but I was disappointed to find that it was difficult to gracefully control the external motors with the Crickets. I had hoped I could use the Crickets as programmable switches. I found this was partially possible through the use of motors, but I wish I had been able to easily create a Cricket controlled switch without a mechanical interface.

Once I found the motors I wanted to use, I faced a number of problems when I attempted to integrate them into constructions. To begin with, they were extremely sensitive. Turning a motor upside down or slightly scratching the shaft a gear rotated on could drastically affect the motor's performance or noise output. I burned out two motors throughout the course of the building process. It was also difficult to design ways to connect the motors to the automata and often the designs I produced failed. Since each motor and can-opener housing was slightly different, I did not find a general solution to this problem. When I was finally able to successfully connect a dowel or other piece to a motor, I faced a host of alignment problems. For example, if a dowel attached to a gear slightly off center, it would wobble as the gear rotated, causing problems for the entire automaton.

Alignment of other parts of the automata was also tricky. In particular, setting the cork to rub the glass in the right way in Hum and adjusting the gears in Toast was difficult. If the cork pressure was too hard or too light in any spot in the rotation, in Hum, the glass would not make a sound. Also, if the mechanism connecting the cork to the motor was had no play in it, the vibration of the motor seemed to interfere with the sound made by the glass. Aligning the gears in Toast was also time consuming. Initially, the gears I built were not perfectly spherical, or were not perfectly centered on their shafts. When anything was off center, the gears would grind to a stop in one spot in the rotation or would cease to contact each other in another.

Another problem I had was that I often felt I was working inefficiently. A number of times I found myself unsure whether I should glue a part down and risk ruining my current construction or continue struggling with an unstable taped version. I usually opted for the taped version, but in most cases this slowed or stalled my progress. I think these problems were mostly a result of my unfamiliarity with the type of project I was embarking on and if I continued to work on similar things, I would be quicker and more confident.

Evaluation

In many ways, I am pleased with the outcome of my project. I was able to build the automata with only a few small changes as I had designed them and everything works basically as I intended.

However, for a few reasons, I don't feel that the project works well as a sculpture yet. First of all, I am disappointed in how loud the motors are. It is difficult to distinguish some of the wine glass sounds from the roar of the motors, and even when the wine glass sound is easily heard, as in Hum, the noise produced by the motor detracts from it. I also wish I had used the Crickets in a more interesting way. I would like to experiment with programming the motors for Hum and Fork to turn on and off or change speeds in some pattern. Finally, I feel that this project would be much more interesting if I had been able to build more than one copy of the Fork and Hum automata. Using Crickets to play a number of humming automata, each sounding a different note, could very interesting I think.

While these automata were not designed with education in mind, I think a student could learn a lot about the mechanisms I employed by watching the project in motion since all of the mechanisms are visible. In particular, I think the gearing in Toast and the linkage mechanism in Fork are neat to watch in action. This project could also serve as the basis for a discussion of electrical motors, switches, infrared communication or programming.

As a personal educational experience, this project was great. I feel like I learned a lot about a wide range of topics and I thoroughly enjoyed myself.

Appendix A

Code for the Hum, Fork and Toast Crickets:

```
to hum
  waituntil [newir?]
  wait 20
  a, on wait 5 brake
end
```

```
to fork
  waituntil [newir?]
  a, on wait 5 brake
end
```

```
to toast
  waituntil [switchb]
  send 1
end.
```