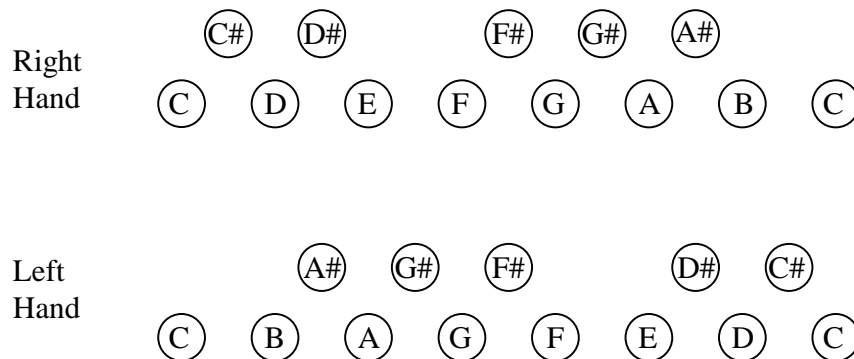Karen Wickert

The Sorcerer

Team Members: Paul Vidich and Jackson Dolan

Electronic Musical Instrument Design: Project 1

For our first project, we decided to create an instrument that involved using handheld devices over platforms. The distance between the handheld device and the platform would be measured and used to change some aspect of the sound in real time. The pitch and roll axes of the handheld devices would be used to alter sonic properties when moved from the neutral position.

The devices were made out of salad bowls and their lids. 13 button holes were punched into each bowl in mirrored configurations with a soldering iron. Their configuration was that of a chromatic root-C keyboard scale:

Right Hand

(C#) (D#)   (F#) (G#) (A#)

(C) (D) (E) (F) (G) (A) (B) (C)

Left Hand

(A#) (G#) (F#)   (D#) (C#)

(C) (B) (A) (G) (F) (E) (D) (C)

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The mirrored configurations allow each hand to play the same notes with the same fingers, since the accessibility of the notes was important. These 26 buttons were screwed into the bowl with washers and nuts during the wiring process.

A thumb switch was added to each bowl, at first at a slight angle and then at a more defined angle since that made it easier to play. The holes for these buttons were also made using a soldering iron. This button controlled octave switching on each hand independently, both up and down several octaves. These buttons were positioned and hot-glued into place.
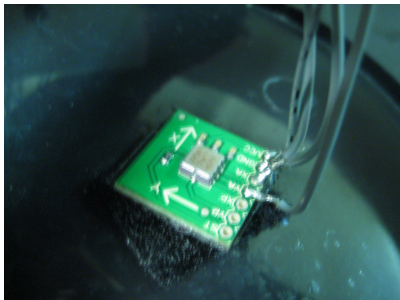

A 2-axis accelerometer was velcroed onto the flat upper portion of each inverted bowl, so that they could be easily repositioned and would not be overwhelmed by an adhesive such as hot glue interfering with the circuit's integrity.

Two wooden platforms were built from split 2 x 4 boards for the legs and plywood for the round, flat tops. Three legs support each top, and a hole in each top holds an IR sensor and its wiring port. The salad bowls rest on these when not in use. The original idea was for the zero point read for the distance between the bowl and the platform to occur when the bowl was resting on the platform, but the IR sensors' ranges actually started about 8-10 cm above the platforms, with the signal increasing again below this range.
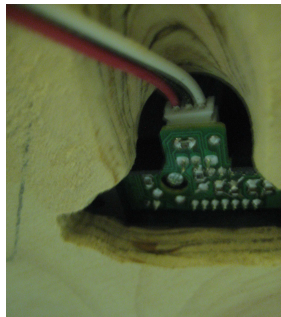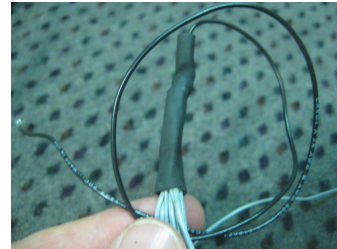

Each bowl was fitted with a strap made from a belt and buckle. However, some problems occurred when the buckles would loosen and the instrument became very difficult to control and play. Therefore, we attached velcro strips to the straps so that they can be adjustable, yet secure. The straps attach to the bowls through two horizontal slits in the each bowl, made with a soldering iron. Our first attempt at placing the strap was too far back to hold the hand to the bowl snugly. The second
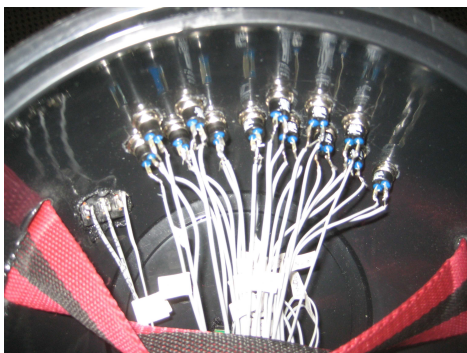
attempt was much closer to the front of the bowls and to the buttons, and worked much better than the original.

The buttons on each bowl were wired with ribbon cable. The buttons were added to the bowl one by one during this process since the terminals were hard to get at when all thirteen buttons were installed. The ground leads of all the buttons were combined and soldered to a single lead with heat shrink protecting the exposed wire from accidentally shorting when inserted into the Doepfer box. The thumb switches were wired with a strip of three wires of ribbon cable. The x-y accelerometers were soldered and then attached to the bowls. The IR sensors used custom multipin connectors with short leads, which then were added to so as to provide enough length to make the instrument playable. All of these wires were threaded through a flat cutout at the back of each bowl. When the lid of the bowl was secured, the wires are moved out of the way of the IR sensors. This also allows for the ability to remove the lids without worrying about tearing out any wires, which might have been a problem if we had threaded the ribbon cables through the lids.

The two IR sensors along with the x and y axes of both accelerometers were wired into the continuous controller section of the Doepfer box. The 26 push-buttons and two thumb-switches were wired into the binary inputs of the Doepfer box. No circuit manipulation was necessary to read the sensory data.

In Max, each button pressed on a hand triggered a Note On of a certain value in the root-C chromatic scale. The octave thumb-switches control each patch's pitch separately. A press to the right will send a signal into Max which then adds 12 to the note value playing for each button on that hand. Pressing the octave switch on a hand to the left subtracts 12 from the note values. These ranges are limited so that they do not go outside of a certain range of pitches. The x and y axes of the accelerometers are separated into four components so that left, right, forward, and back all can be sent out as separate

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MIDI controllers. Each IR sensor reads the distance from the platform to the lid of the bowl, which is passed through Max as a continuous MIDI controller.

Each Note On triggered by the buttons goes into one of two available Subtractor modules in Reason – a bass patch for the left hand and a lead patch for the right hand. The lead patch has its attack controlled by velocity, with mod controlling the phase of the signal by sending out to LFO 1 which modulates the phase via a continuous random waveform. The bass patch mod affects the FM of the signal through the use of a continuously random waveform. Its velocity controls the phase and the attack of the sound. Each axis of each bowl controls one aspect of its respective Subtractor patch. Moving the left hand bowl backward controls pitchbend, moving left controls mod, forward controls filter resonance, and right controls filter frequency of the bass patch. The same controls apply on the right hand to the lead patch. There was also some NN-XT work done that involved triggering discrete samples when the bowls' accelerometers read a higher value than they would through simply tilting the bowl, as well as some reverb added to these modules. However, these were primarily created as a separate Reason rack with samplers instead of synthesizer modules.
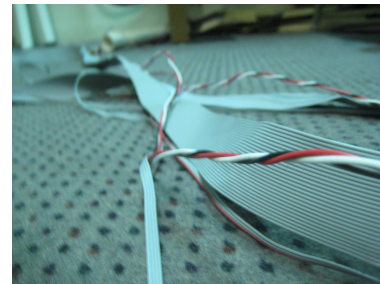

This device is now known as the Sorcerer, since the method of playing evoked memories of Mickey Mouse directing the waves in Fantasia as a sorcerer – dramatic, yet playful, and a little comical at times. There were several design flaws – the strap positioning, the thumb switch positioning – that were improved upon and made more playable, but the overall design was fairly solid. I would have liked to make the pressing of the small round buttons more ergonomic so that playing the instrument at length would be more comfortable. To do this, we would have needed flatter push-buttons so that the hand could rest more on the curvature of the bowl while playing and not get so fatigued. The strapping could also have been a little more
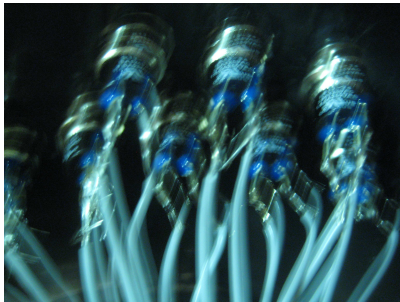
solid, but with the late addition of velcro, they improved in comfort quite a bit. The wiring took some time, and it was a little difficult to figure out how best to order and label the wires without being in constant contact with the Max patch numbering as it was derived, but it was worked out in the end. All in all, I believe this project presents a very expressive instrument that can be played by one person or as a duet, each person with one hand bowl and their other hand over the IR sensor. It is very playable and accessible with a little practice.

I mainly worked on figuring out the wiring, soldering all leads and making sure all of the leads were properly labeled and in place. I tried to make the cable system manageable for the player, but even using ribbon cables it was a little difficult to keep the cables out of the way while playing. The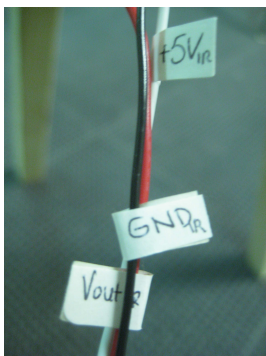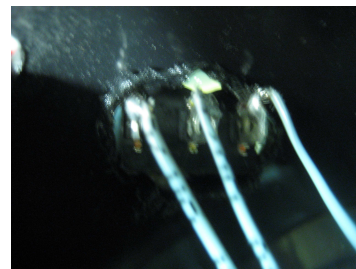 use of velcro cable ties to attach the ribbons to a vest worked, but only if you wore the vest – another solution would have been good to have for any other players. The wiring and soldering of the 26 individual buttons took the longest, as initially the buttons were all screwed in and the leads left very little space to solder. Taking the buttons out and soldering them one by one as they were reattached to the bowl worked well. The soldering of the accelerometers was fairly easy with the helping hands, and the thumb-switches were much easier to access for soldering purposes than the individual buttons. The IR sensors had multipin connectors and so I just needed to solder on some longer lead wires to each of the three wires on the connector. I sealed off the resulting live wire patches with electrical tape. The velcro on the accelerometers was used as a way to reposition them in case the axes weren't perfectly aligned, and it was more gentle on the circuit board than glue or another, more permanent adhesive might have been.

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I also worked on designing a Reason rack with three Subtractor modules – two bass patches to choose from and one lead patch. I changed the functions of the velocity and mod wheel controls, as well as the LFO 1 functions which were controlled by the mod wheel in each case. I wanted to be able to switch patches in real time eventually, perhaps with another switch or a footpedal, but this did not happen in the space of time we were given. I decided to use Subtractor modules instead of NN-19 or NN-XT modules since I wanted to keep the sounds simple enough that manipulations of filter frequency, filter resonance, velocity, volume, mod, and pitchbend would come through more clearly during testing and initial playing. Paul later expanded upon this patch and then made his own patch using two main sampler modules, a reverb on the acoustic bass patch, and a third sampler module for the discrete samples triggered by the high accelerometer readings from the bowls. This was very interesting, and I thought his work on the patch was excellent.

Paul worked on the Max programming, and did a great job. He was often programming his ideas into the patch and would surprise us with his work, especially with the discrete samples – when testing one day, he just started to trigger cymbals and drums! I was really intrigued as to what was happening and was pleased to see that he was so inspired by the project. His working and reworking of the math in the patch was awesome – he brought up great points about a lot of difficulties in implementing features that I had not begun to think about in my envisioning of the project. For example, the switching of Note-On control between the IR sensor and the buttons to evade the problem of the IR sensor causing notes due to its continuous sending out of velocity data greater than zero was very fundamentally important. Also, the switching of accelerometer axes caused problems with stuck values on certain parameters, so Paul made a workaround by reading the sensor data every period of some milliseconds. When the axes were changed quickly, the parameter that was left behind would be reset to the resting value (0 for all parameters but filter frequency, whose default at rest was 127 – otherwise the patches would not play any sound at rest). He definitely worked a lot on smoothing the kinks out of the project and had a lot of fun with it. He also built the two stands since he had access to the SMFA woodshop, which was awesome. They worked really well, and were at a great height. Paul also helped briefly with the soldering, putting all of the ribbon-cable

ground leads from the buttons of one hand in a bunch and soldering them to a single lead to better fit into the Doepfer box terminal.

Jackson took on the making of all sorts of holes and slits in the bowls so that the sensors would fit nicely. He had the great idea of using the soldering iron to melt through the plastic, which was especially nice on a rounded plastic bowl. Otherwise, I would probably have attempted to use a drill which may have ended up in split holes for the buttons. The drill definitely would not have worked for making slits, and we would have had to use the machine shop to mill those parts out. This simple solution saved a bunch of time. He also helped with the soldering of the second bowl's ribbon cable ground leads from the 13 buttons, attaching them to a single lead so that they would fit into the Doepfer box terminal better. He helped to put heat shrink onto the two areas of exposed wire so that they would not accidentally cause a short when the project was wired up.