Eleonora Oreggia London, November 2011

IDMT - The Quantum Clock

The idea of this project came about during an IDMT lesson held by Nick Weldin, when, listening to the sound of a servo motor, its musical noise reminded me of a clock... It was October 4th and I thought that, if Arduino can control a motor, maybe it can even control... the hands of a clock?

This idea was discussed at the end of the lesson on October 18th, when Nick asked us for questions. The research had slowly started, and I was collecting data on a wiki page[1].

Nick had a look and confirmed my findings: the project is doable but - common knowledge says - it's probably impossible to get the clock go backward in time, probably for the mechanical nature of the clock's gears...?
Nick encouraged me to reuse the code I had found online and focus on the behaviors that could characterize my project.

To get started, I followed the instructions to hack a quartz clock and I copied the *Clock Tick Demonstration* By Matt Mets[2], completed in 2008. In Arduino the function *millis()* returns the number of milliseconds since the device began running. Millis() currently overflows after approximately 50 days, whereas in 2008, when the Clock Tick demonstration was initially written, it was overflowing after 9 hours and 32 minutes. There are ways to solve the Millis overflow whereas needed. In Arduino all the time based operations use millis(), which is preferred to *delay()* because this function has drawbacks: no reading of sensors or mathematical calculation is possible because the microprocessor is temporarily stopped.

My fascination with clock has ancient roots: I have always been obsessed by clocks and their sound, and it's impossible for me to sleep in a room nearby the ticking of a clock, with the result that I am secretly extracting the battery out off every clock present in any house it happens to me to sleep in, even for short periods or during a night in a hotel. To avoid confrontation, I tend to say - to anyone asking about it - that the clock is defected. A high school friend once told me: "It's impossible that all the clocks around you are broken".

During the elementary school, when I was bored in the class if the teacher wasn't saying much, I would spend long minutes intensely observing my watch: is time really going always at the same speed? Can it be predicted? Can I influence the rhythm of a clock? The magical illusion of infinite superpowers, bliss of the childhood, produced strange experiments, and I found myself trying to morph either the instrument, or time itself, with the power of my

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[1] http://research.theoraclemachine.net/QuantumClock

[2] http://www.cibomahto.com/2008/03/controlling-a-clock-with-an-arduino/
(Link active on October and November 2011)

mind. It must go faster, it will go faster... In the meantime, while the teacher was rarefying the atmosphere of the classroom with yet another slow fragment of an obvious discourse, the big clock on the wall above the blackboard was, along with the Jesus, acting as lightning rod, absorbing the emotions and fears and anguishes of the present spectators.

Unveiling the mechanism of a clock is a very satisfying and delicate hack: the impression that these gears are not made for human hands is pervasive, and rebuilding the mechanism is not just as simple.

Quarz clock are half electronic and half mechanic: whereas in mechanical clocks a spring is wind up manually, Quarz clocks use a battery and a micro chip. To hack it with Arduino, the microchip and all the circuitry is cut out and the board is connected to a coil. Changing from positive to negative the charge running through the two wires that reach the coil creates an electromagnetic field which moves a magnet. The rhythmic movement of the magnet moves the first gear which triggers all the mechanism. Against every expectations, my clocks (the tester and the main piece) where both, initially, running only backwards. To invert the direction of the hands, I changed the duration of the delay between the inversion from positive to negative charge.

The Quantum Clock is inspired by Quantum Mechanics and, specifically, by Werner Heisenberg's book *Physics and Philosophy*, dated 1958.
In this book Heisenberg, comparing the findings of quantum physics with the history of philosophy, questions the ontological status of reality itself: there is no science, and no matter, and no space and no time, whereas there is no observation. The Copenhagen interpretation of quantum theory pushed the revolution of relativity one step forward, one step to which Einstein severely objected. Quantum theory, in fact, surpassing both physical and dogmatic realism, hazarded that science does not concern what is true or what exists, because reality is potential. It is the presence of the spectator - be that a human presence or a man-made measuring instrument - that allows this potentiality to become datum.

To introduce the spectator and the environment in the measuring instrument The Quantum Clock uses a light sensor and two long range infrared proximity sensors[3]. Two OpAmps[4] are amplifying the sound of the clock to a PA and to an external speaker. The clock at this stage can change speed according to light, changes direction according to proximity, can scratch and in certain conditions it goes completely crazy. Further development will implement an ultrasonic range finder, a temperature sensor and a humidity sensor to create different rhythms generated by the spectators interaction. The Quantum Clock becomes, this way, a musical instrument.

Project website: http://xname.cc/quantumclock Related project: http://noise.hotglue.me
Media and Arts Technology. Queen Mary University of London

[3] Sharp GP2Y0A02YK0F.

[4] LM 386. Voltage gain: 200.