

# Climber Extraordinaire

## Abstract

The climber extraordinaire is an automaton that combines elements of classic automatons and the technology of crickets. The inspiration for the climber came from our common interest in rock climbing. With this automaton we bring the thrill of rock climbing safely to your living room. The idea is that the climber starts climbing from the bottom of a wall and climbs to the top while a belayer system insures its safety. When the climber reaches the top it detaches and the belayer lowers it to the ground. The climber's upward movement is controlled by a crank while the belayer system is an electrical motor controlled with a touch sensor via the cricket. The cricket is also responsible for reversing the direction of the belayer motor when it detects that the climber has reached the top.

## Design

### *1. Mechanisms*

The climber automaton consists of four mechanisms: the climbing mechanism, the belayer mechanism, the detachment mechanism and the detection mechanism.

Computation is involved in the belayer and detection mechanisms.

## **1.1 Climbing Mechanism**

The climbing mechanism consists of an elastic belt with magnets glued to it. The magnetic pull of the belt-magnets keeps the climber's magnetic hands in contact with the wall and pulls the climber to the top. The belt is driven by a shaft and crank; in order to avoid belt slippage the bottom axle of the belt mechanism rotates on a dowel covered with sand paper. Furthermore, to keep the belt aligned and on the dowel, two circular discs with diameters larger than the dowel were glued on both sides of the dowel. The same design was used for the top axle with the exception that the dowel is not glued to the top shaft and that the dowel is not covered with sand paper.

The previous successfully powers the belt and magnets. The wall between the belt and the climber is made of cardboard, the wall is thin enough so that the magnetic pull between the magnets is strong enough to keep the climber attached to the wall and thick enough so that the pull does not pinch the wall and increase friction.

## **1.2 Belayer Mechanism**

The belayer mechanism consists essentially of Lego parts. The main component is a Lego motor that powers a winch. The winch winds the "rope" as the climber makes its way to the top and unwinds it when the climber detaches from the wall. The motor is connected to the cricket's motor port and is controlled by a touch sensor connected to one of the cricket's sensor ports. Pushing the touch sensor turns on the motor. The direction of the motor is reversed by the detection mechanism, a second touch sensor connected to the cricket (discussed in more detail below).

The “rope” is anchored at the top of the wall by another Lego construction essentially composed of a Lego wheel, which was stripped of its tire. The groove in which the tire normally fits holds the “rope” aligned and keeps it from becoming tangled.

### **1.3 Detachment Mechanism**

The detachment mechanism is very simple. The climber detaches from the wall when the belt-magnets move around the top dowel and therefore move away from the wall. The climber cannot follow the movement of the belt magnets as they move away from the wall and therefore detaches.

### **1.4 Detection Mechanism**

The detection mechanism is composed of two elements acting together. The first is a touch sensor connected to the cricket, the second is a wooden block glued onto the belt. Simultaneously with the belt-magnets moving away from the wall, the wooden block goes around the bottom dowel and pushes on the touch sensor that is placed directly below the dowel. The signal sent to the cricket causes the change of direction in the motor of the belayer mechanism described above. The wooden block has the same thickness as the magnets: when the magnets, in turn, go around the bottom dowel they too push the touch sensor and therefore resets the direction of the motor. Whenever the touch sensor is pushed the cricket plays a melody, this indicates the detachment of the climber in one case and the resetting in the other.

## ***2. Materials***

Various materials were tried, rejected and accepted in the building of this automaton. The materials used can be divided into their functions:

- Structural materials: the final material used for the overall structure is bass wood. It gave the structure the sturdiness it needed and it was easy to use.
- The wall: the final material used for the wall is a smooth cardboard that has the required thickness and smoothness.
- The belt: there is no shame in admitting that the belt is in fact the waist band from one of Fabien's old but clean boxer shorts.
- The belayer system: this was made of Lego parts. The use of Lego parts came from the fact that the motor is a Lego motor and that it was easier to combine it with other Lego parts rather than making our own.

## ***3. Design Process***

The first idea for the automaton included two characters the belayer and the climber moving autonomously. This was the first element of the design that was changed, after watching some of the videos we felt that our automaton would benefit from having an interaction with the user rather than being an object to look at once and move on. Furthermore, we felt that this could easily be done with the crickets.

The first and main challenge was finding a way for the climber to reach the top of the wall. The original idea called for two belts acting asynchronously in order to simulate the natural motion of a climber. This remained our goal until the difficulties of getting a

single belt to function properly changed our perspectives and forced us to resort to using a single belt for the climbing mechanism. At this point we had achieved in obtaining a working belt. The next challenge was to find the correct material for the wall. Our first impression was that the magnets were not going to be strong enough to hold the climber to the wall we therefore chose to use a thin plastic sheet. This was quickly ruled out, as the magnets were in fact too strong; they were pinching the sheet and producing friction. The material that turned out to work best was a medium-thickness cardboard.

We now had a working climbing mechanism but the magnets were still producing too much friction for a small motor to power our climber up the wall. After much struggling with motors, we decided to remove the motor from our original design and replace it with a crank. The rest of the original design was reasonably respected. Our original design was definitely too ambitious, this is due to our lack of experience in building “things”. The design process was therefore more of a “learn from your mistakes”- process.

#### ***4. Influences***

The automatons that made the biggest impact on us were the ones seen on the Arthur Ganson video; fortunately we were lucid enough to realize that we lacked both the creativity and the genius to make objects that induce such awe. We thus decided that it was probably best to “keep it simple”.

We did however recognize that some of the automata only kept the observer’s attention for very short times. Automata such as the “doctor” and the “podiatrist” that interacted with the users/observers kept their attention much longer. This is why we

decided to involve the users by assigning the role of belayer to them. We hope the user will feel compelled to ensure the climber's safety.

## **Evaluation/Education**

Our Climber Extraordinaire is mainly an automaton you interact with; there is more a playful intent than an educational one. However, our automaton accurately describes the mechanics of the climber/belayer interaction on a rock climb; this makes it a good tool in teaching the dynamics of belaying to an inexperienced climber (like Fabien).

Another educational aspect is that our automaton can be easily examined (by taking off the black front wall) in all its parts. We believe that it would be not too difficult for someone to pick up our automaton and, by playing and examining it, figure out how it works. All the mechanisms are realized in a simple and straightforward way and all are visible in our automaton. The cricket code is the only invisible part of the automaton but it is easy to understand from the standpoint of its functionality, and not very difficult for a programmer to imagine.

Climbing has a very strong affective value for Simone, and Fabien is taking his first steps in this wonderful sport, therefore our automaton has a deep meaning for both of us.

Moreover, all the climbers we showed the automaton to were very amused and wanted to play with it, they often wanted the belayer to perform all the wrong actions, like pulling the rope up to tightly or leaving the rope really loose to see what happened to the climber when put in a really uncomfortable situation. It seemed to us that this was a way for

climbers to act out the fears and problem that every climber can or is scared to encounter with his/her belayer and we can, as climbers, easily relate to that.

We also felt that all the climbers had an affective interaction or identification with the little climber, thus making us think of our automaton as a success on the emotional level.

Non climbers have, however, much less emotional responses and are slightly less interested in playing with it and in figuring out how it works.

In conclusion, we are very satisfied with our Climber Extraordinaire, and with the building process that was very interesting and that threw at us a lot of unexpected difficulties very different in nature from the ones that Computer Science majors usually encounter in their school curriculums. All of the above made the realization of our automaton an “extraordinaire” experience.

## Appendix 1 (Code)

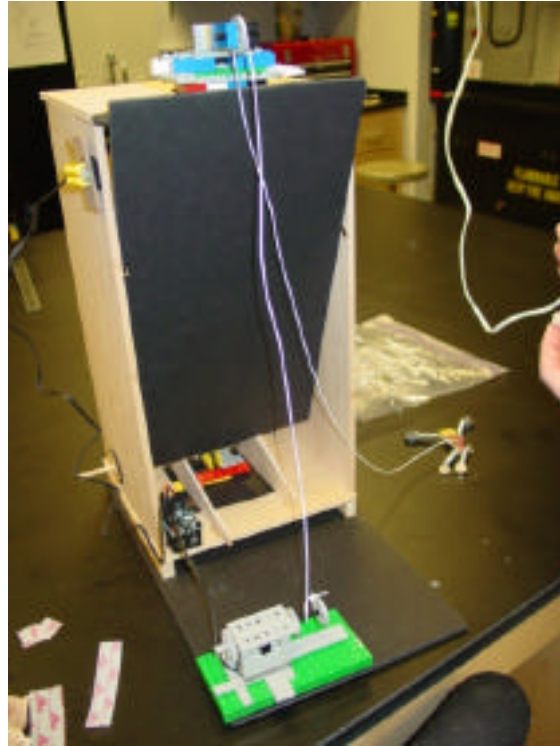
The code of our cricket is straightforward; it is a loop that has inside of it two if statements to detect the pressing of the two touch sensors (switcha and switchb).

If the first touch sensor is pressed (switcha) then the motor connected to the motor port A of the cricket is turned on for 1 second (a, onfor1), and then there is a wait of one second (wait 1) to make the motor action more similar to a real belayer.

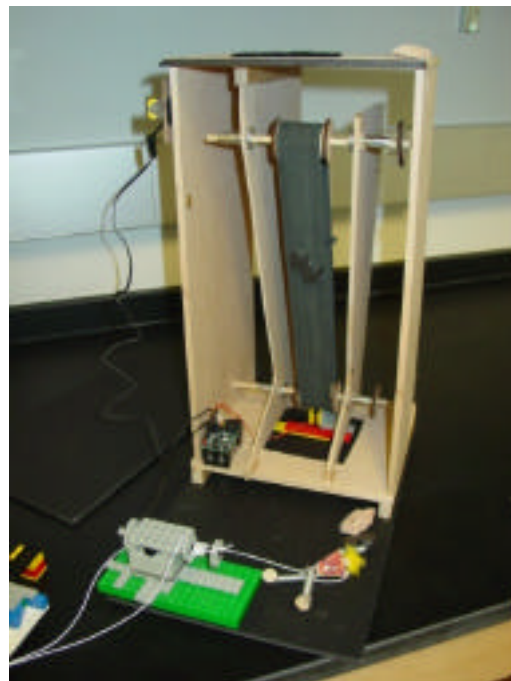
If the second touch sensor is pressed (switchb) the motor is turned off (a, off) and then reversed (a, rd) so that the next time it is activated by pressing the first touch sensor, it will run in the opposite direction to lower the climber. Moreover, a simple melody is played to celebrate the climber successful attempt to the top.

```
to program1 //name of the program

loop //main loop
[
  setpower 3
  if switcha //if the first touch sensor is pressed
  [
    a, onfor 1 //turn motor a on for 1 sec
    wait 1 //wait for 1 sec
  ]
  if switchb //if the second touch sensor is pressed
  [
    a, off //turn motor a off
    a, rd //reverse motor a
    note c3 //play a tune
    note d3
    note e3
    note f3
    note g3
    note a3
    note b3
  ]
]
end
```



The working automaton (not decorated)



The automaton's insides.