"Everyone who understands the subject will agree that even the basis on which the scientific explanation of nature rests, is intelligible only to those who have learned at least the elements of the differential and integral calculus, as well as of analytical geometry."

F. Klein

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- Theory Behind the Program
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Introduction

- Initial Problem
  - Motors: mathematical control
- Objectives
  - Test Vex microprocessor
  - Use abstract mathematical concepts to understand Vex processor

Different Solutions

- Choose from a variety of techniques:
  - Encoders
  - Potentiometers
  - Time

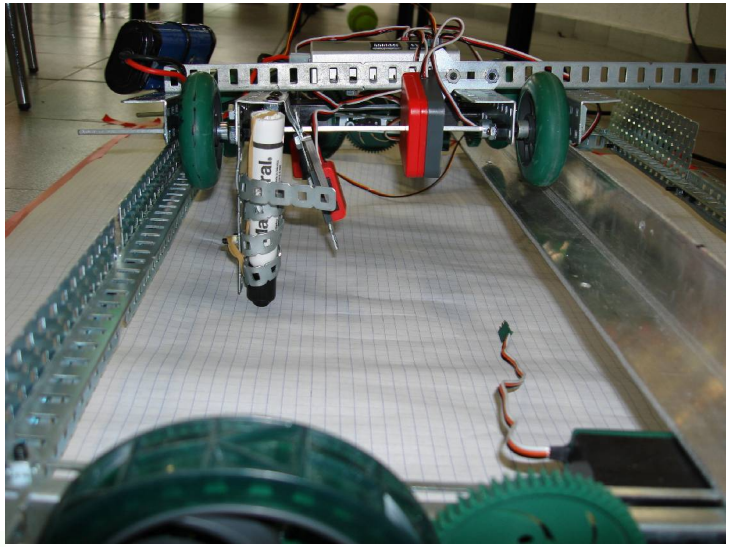
- Distance as a function of time implies velocity (voltage) as a function of time which is really what we can control with programming

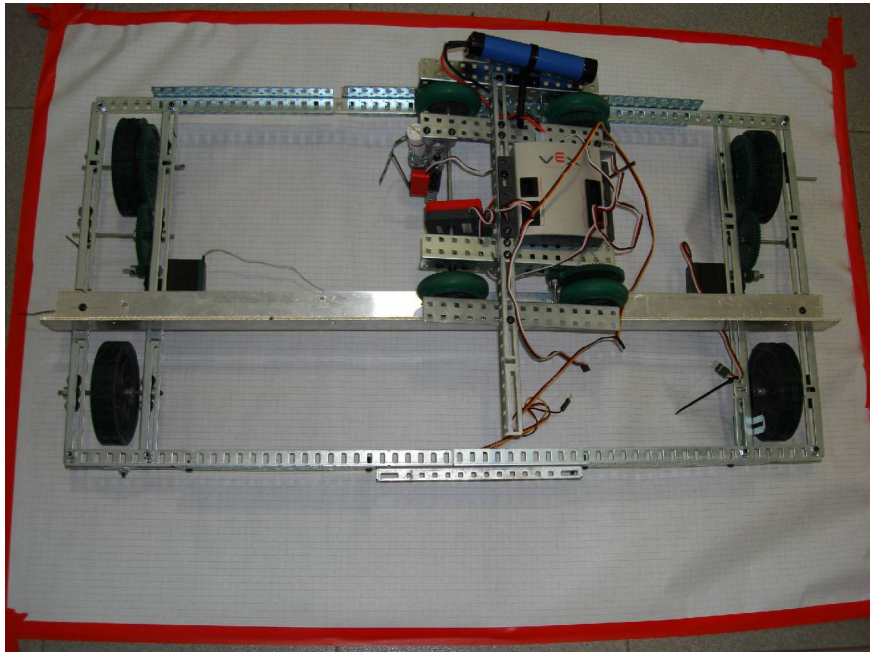
"God does not care about our mathematical difficulties, he integrates empirically"

Einstein

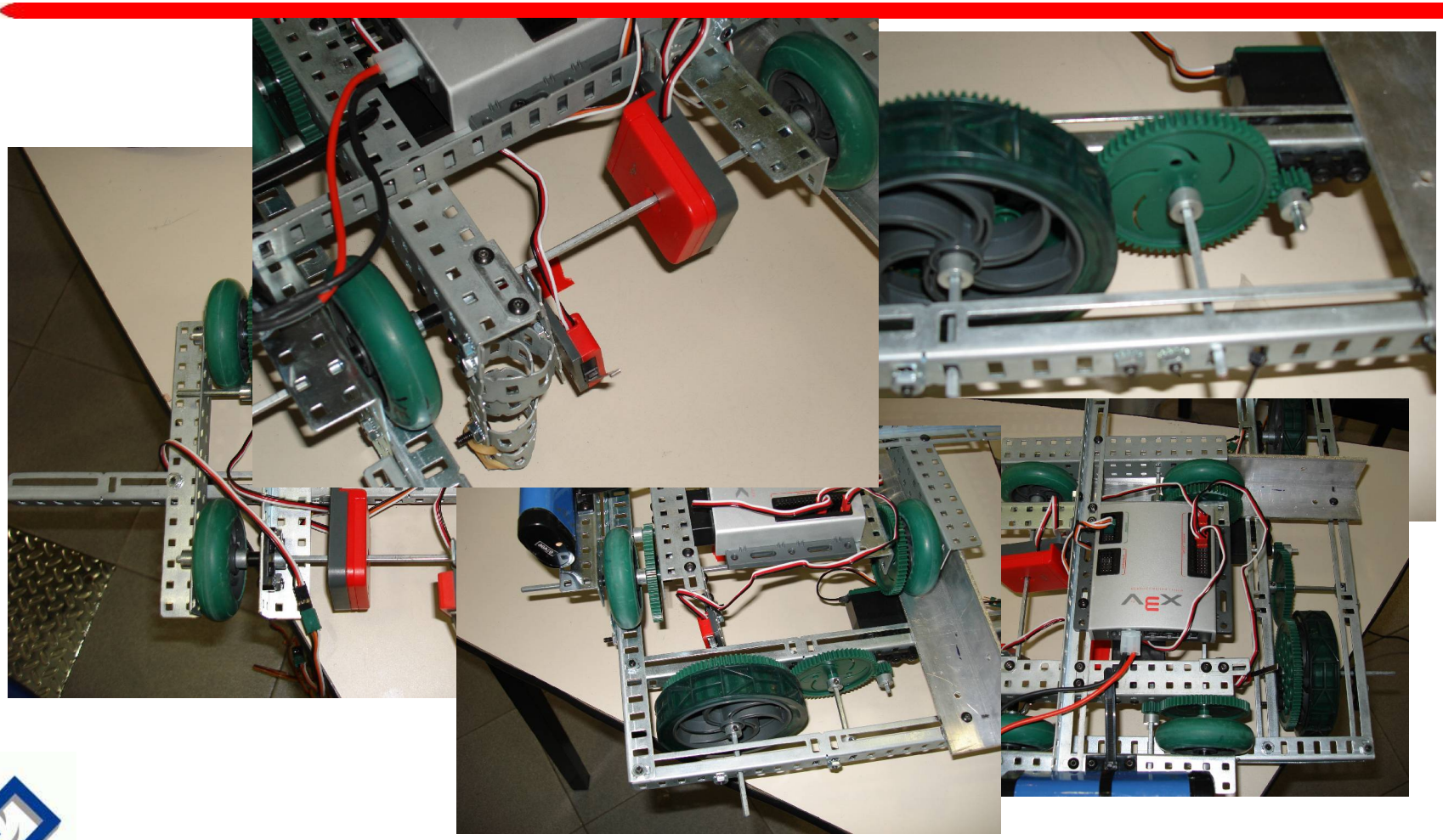
Mechanical Function

- Initial models
- Robots evolution to its actual state
- Benefits and disadvantages of our model





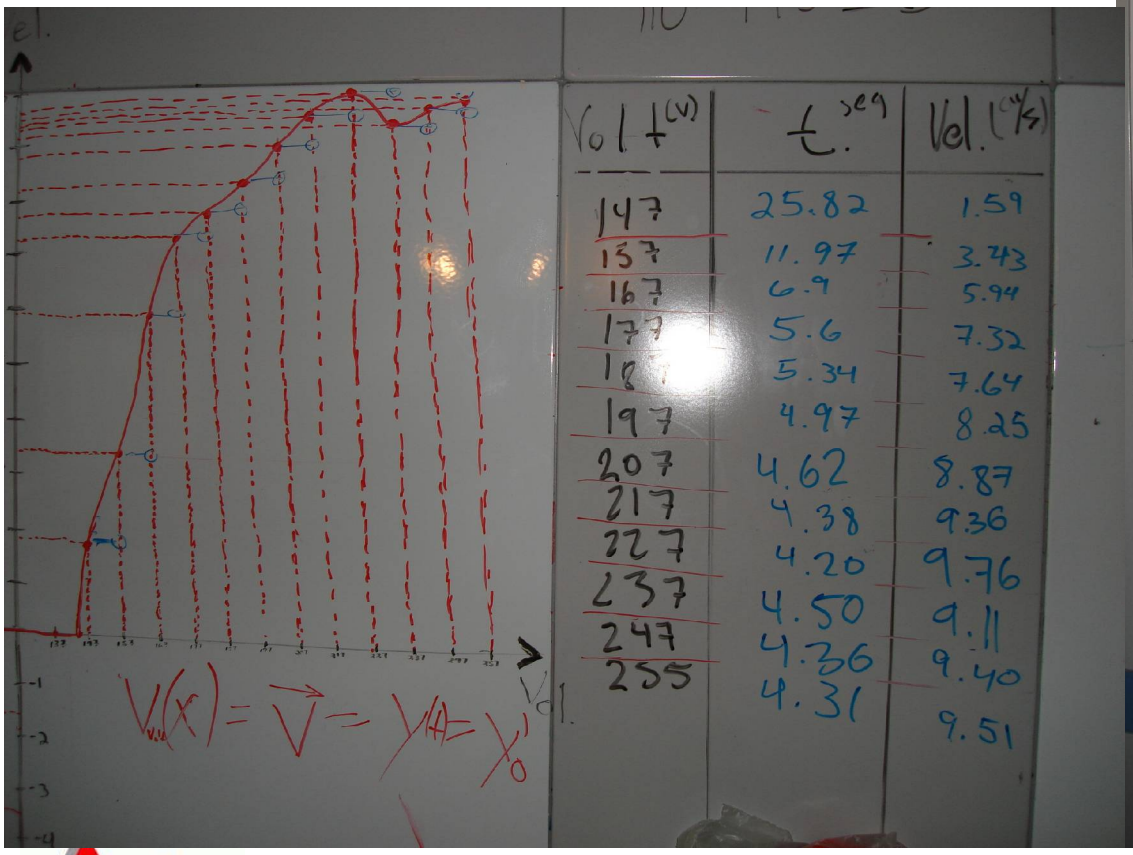
Mechanical Function

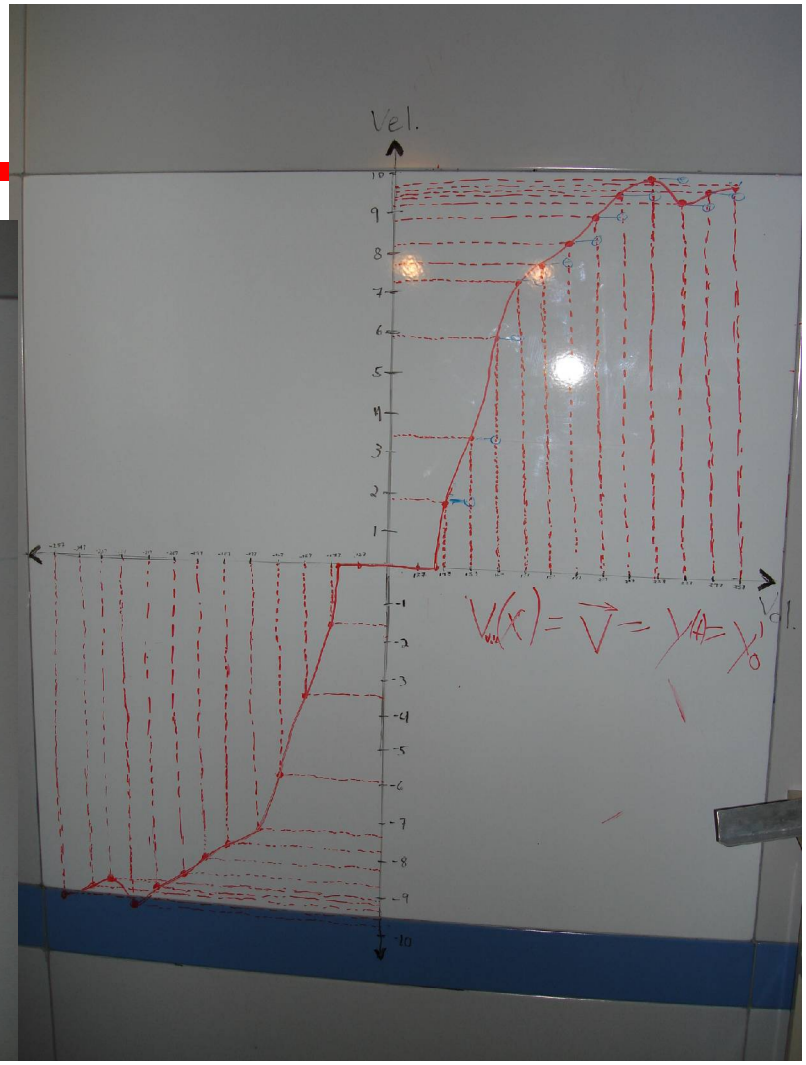


voltage ≠ velocity

- Since the voltage isn't a linear function of the speed we needed a more complex and accurate equation to describe the motors response.
- After a more complete evaluation of our system we managed, through testing, to graph the voltage vs. speed function

Mechanical Function





Theory Behind the Program

- Calculus as a problem solving tool
- Research of the function velocity = f(voltage)

Calculus as a problem solving tool

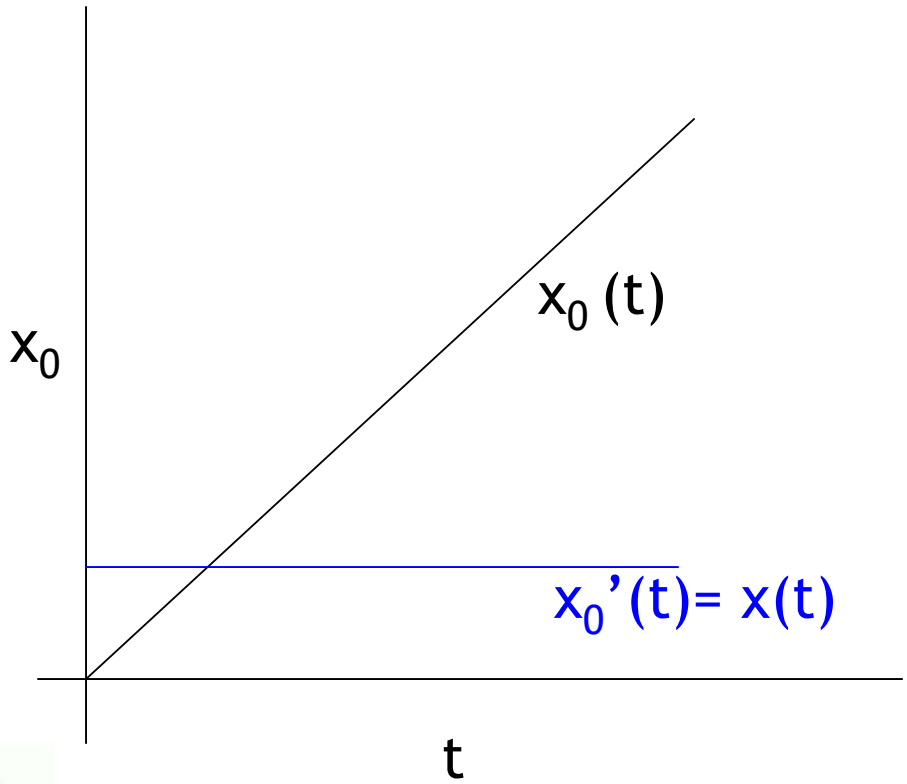
- Let's define x_0 as the displacement in the x axis and y_0 as the displacement in the y axis. x="velocity of the car in the x axis"

  y="velocity of the car in the y axis"

- Also we define x =(velocity in the x axis) a constant (a middle voltage (about 160 in the scale of the program)). So that leaves $x_0 = \alpha t$, with α =constant.

- y="velocity in the y axis" is a function of time.

X axis velocity and displacement



- x_0 is a linear function of time,

  so that x is constant

Functions and variables

$$\frac{dx_0}{dt} = x$$

$$e.g. \rightarrow \; y_0 = x_0^2$$

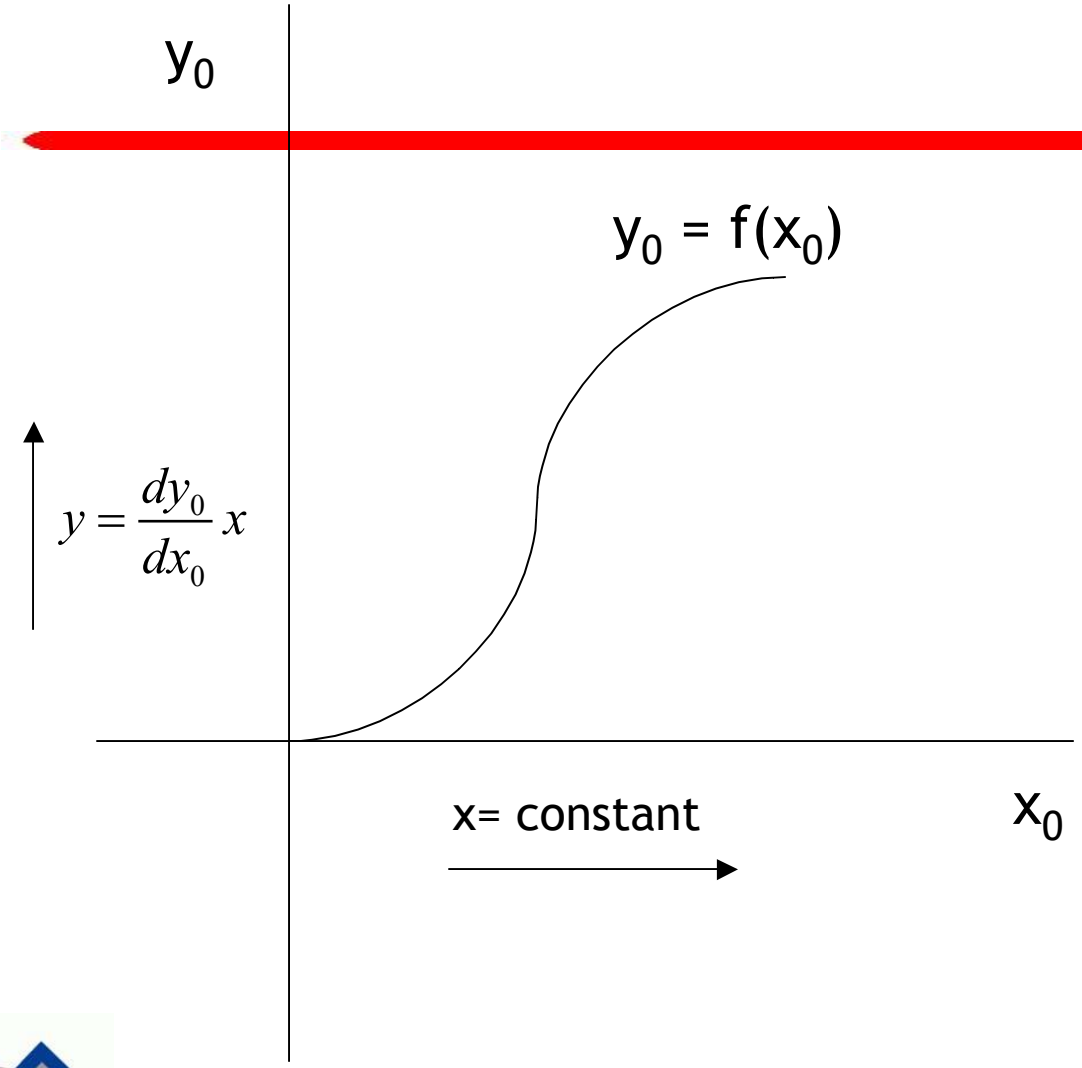
$$y = \frac{dy_0}{dt} = \frac{2x_0 dx_0}{dt} = 2x_0 x$$

$$generally$$

$$y = \frac{dy_0}{dx_0} x$$

$$y = \frac{dy_0}{dx_0} x$$

- What this really means is that to graph $y_0 = f(x_0)$ you only need to find the derivative of the function and multiply it for the velocity of the x axis and that will give you the y axis vel.



$$y_0 = f(x_0)$$

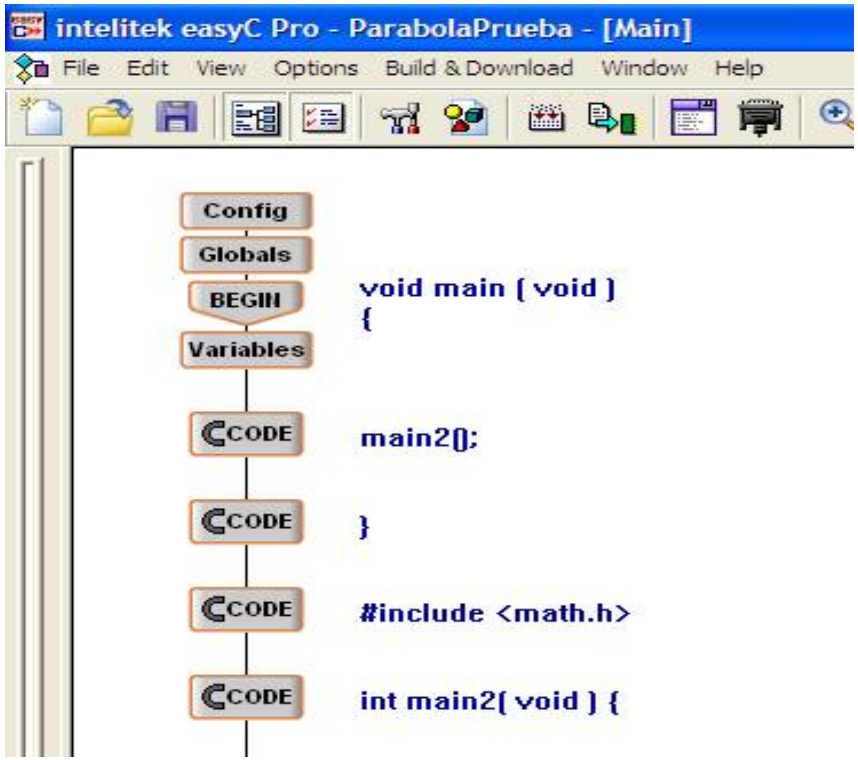
$$y = y_0'$$

$$x = x_0'$$

“ We live in a complicated world, where nothing is as simple as it once was, nothing is as simple as it seems to be. Mathematics knits that world together. Don’t you forget it”

Ian Steward

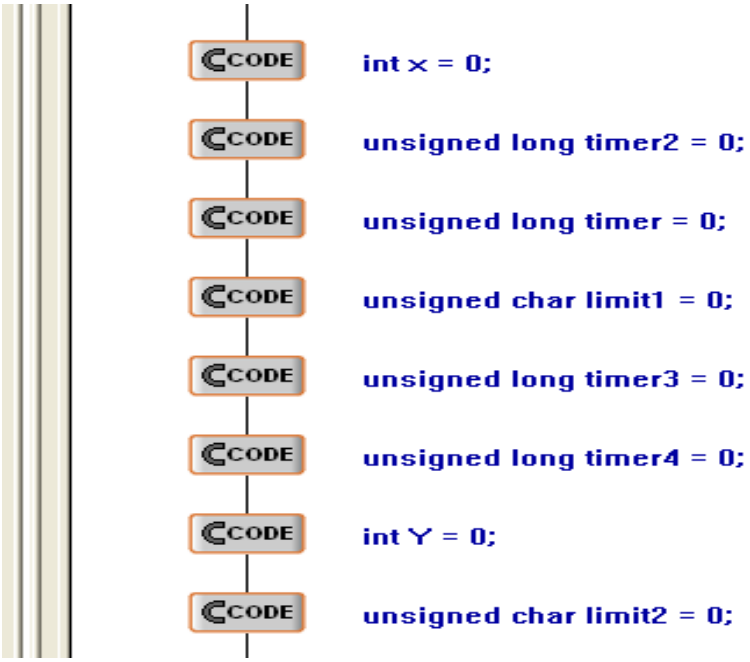
Structure of the Program



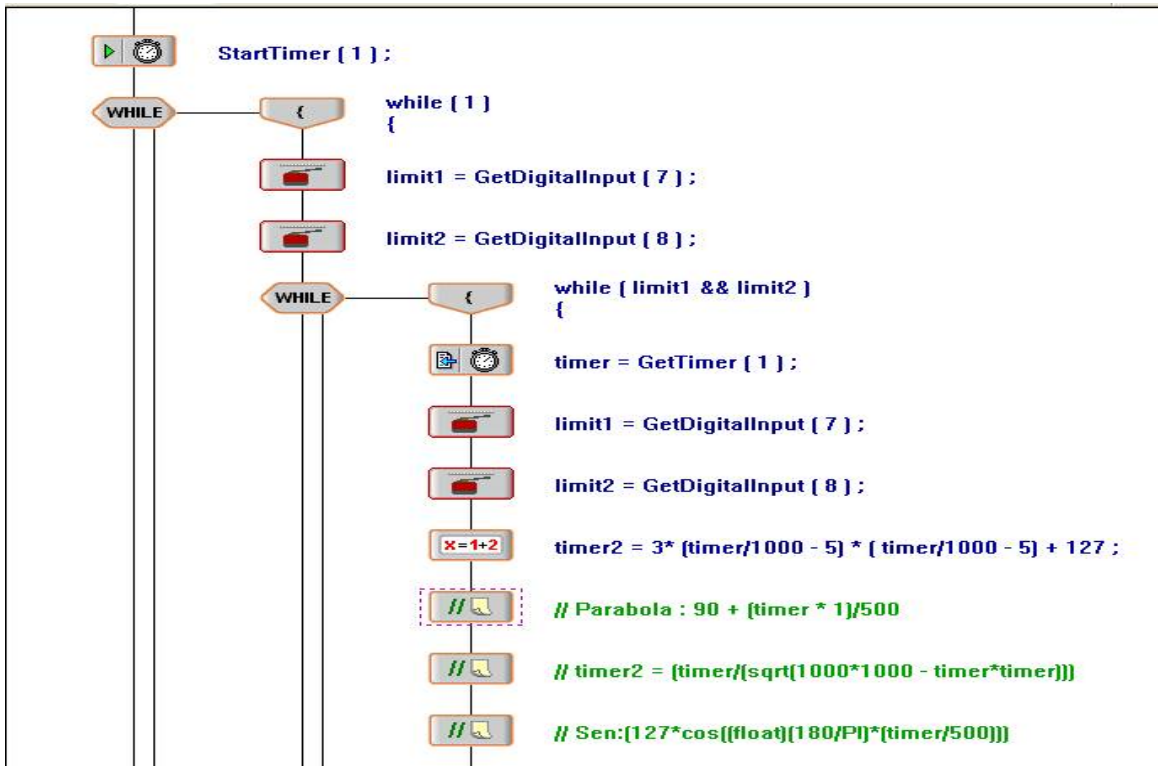
- Closing the Main()
- Importing the Math.h Header File
- Calling a Second Main Function().

Structure of the Program

- Defining the variables for later use.

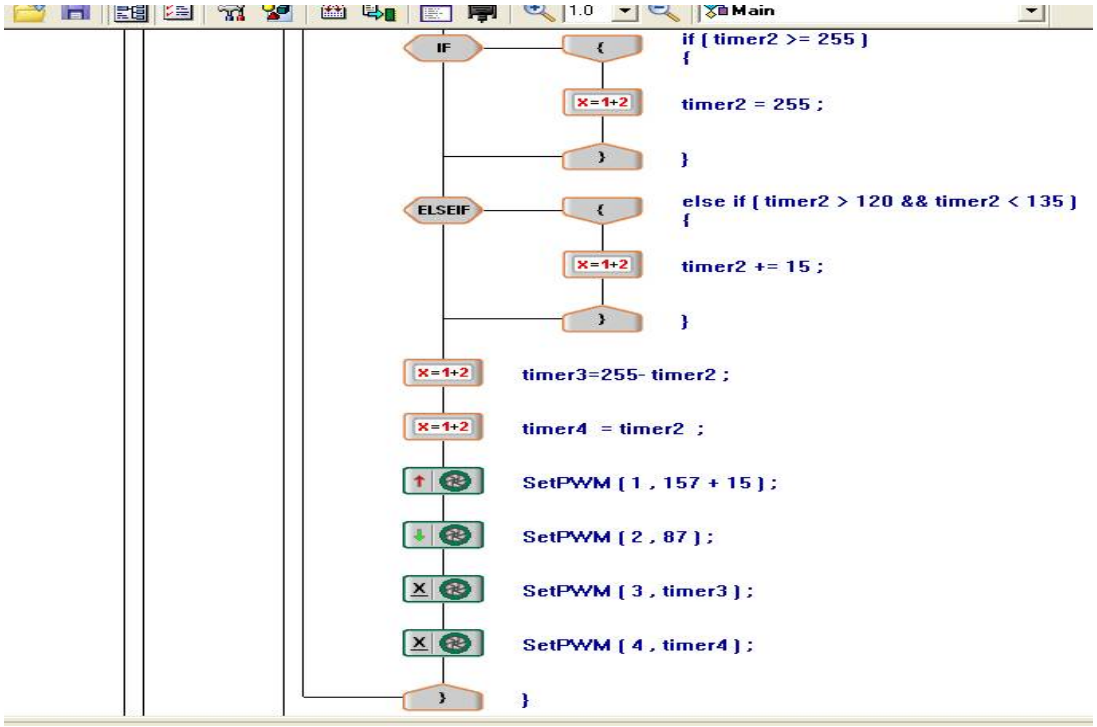


Structure of the Program



- Start the Timer
- Define Function of time ($f(t)$). Replace when needed.

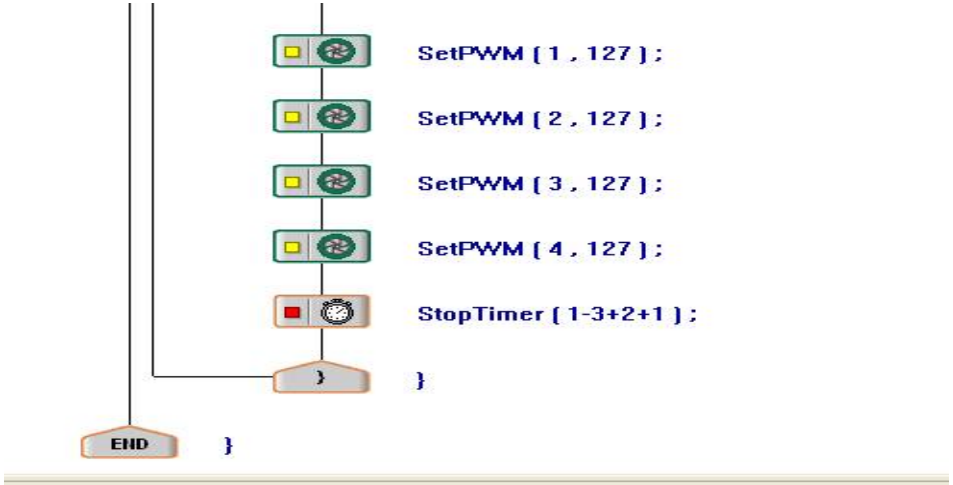
Structure of the Program



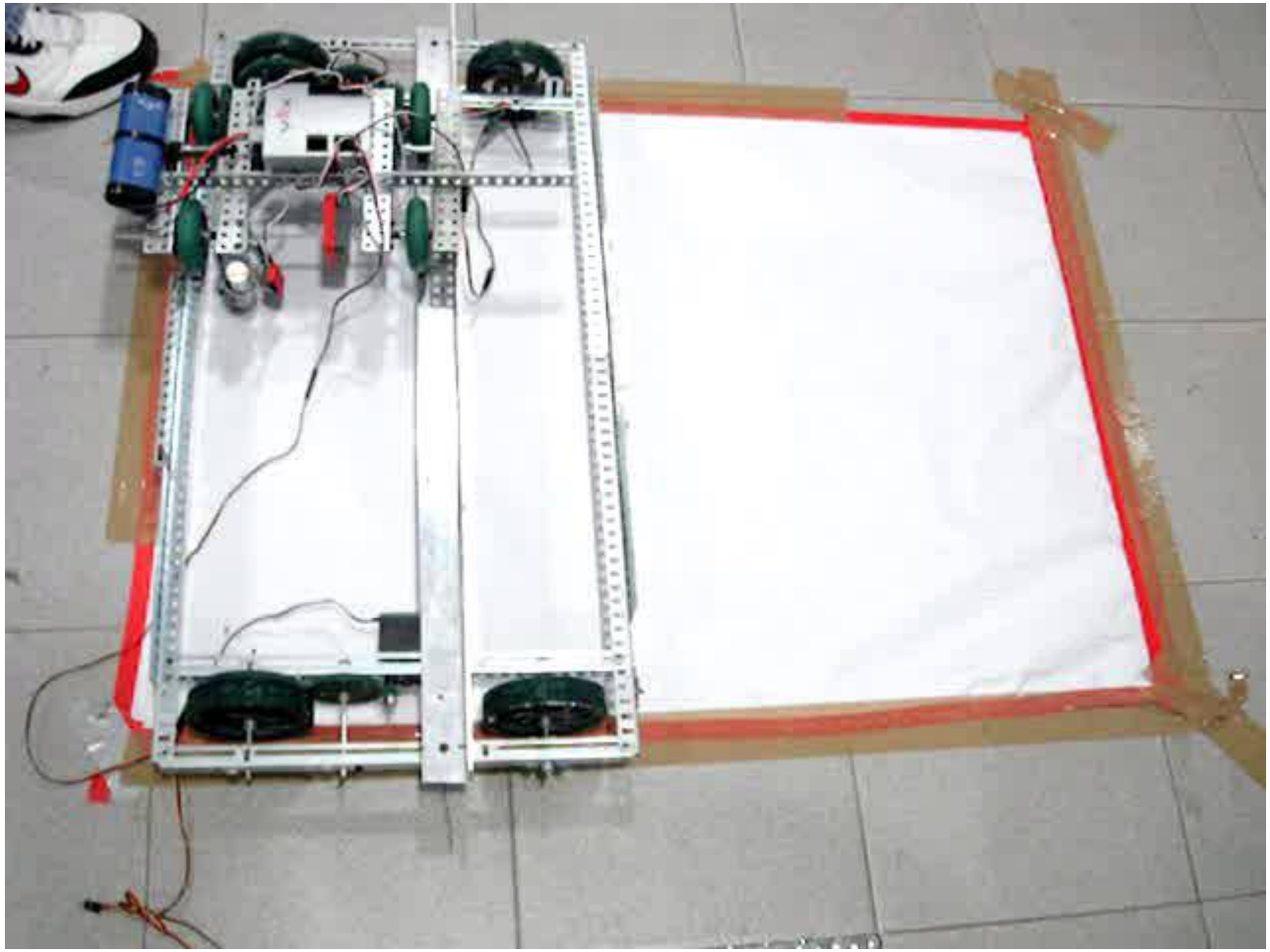
- Voltage within limits =255.
- Range : 110 ~ 145 [V]
- Inverse Motor
- Set Motor Movement
  1. X axis with Constant Movement
  2. Y axis with *f(t)* Movement.

Structure of the Program

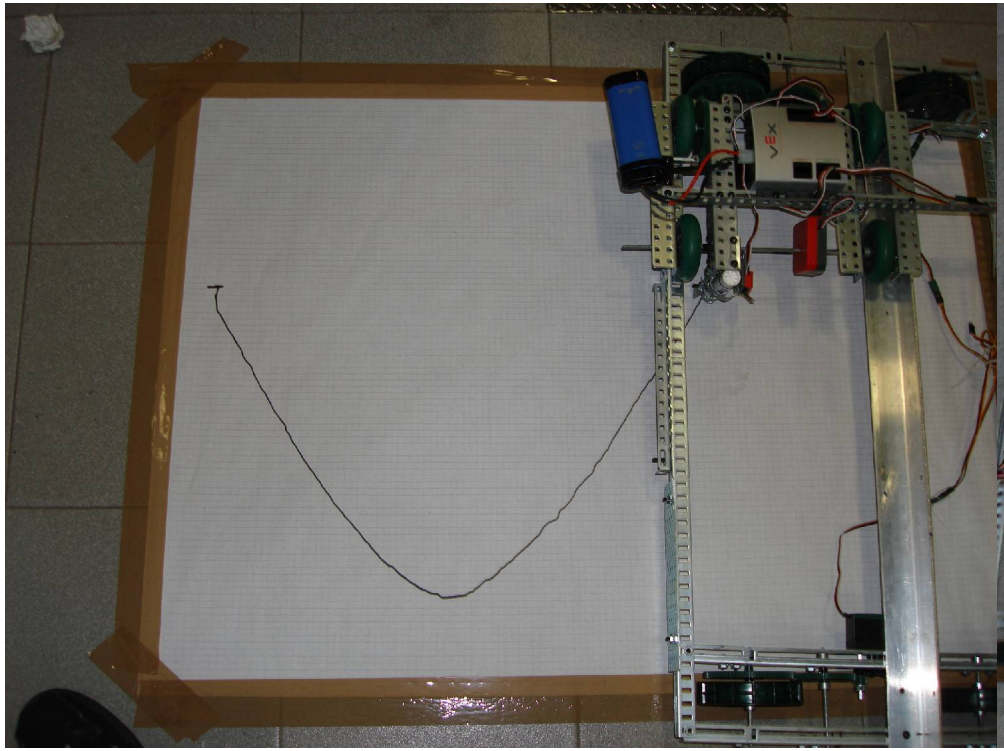
- Limit Pressed
- Stop Movement
- Stop Timer

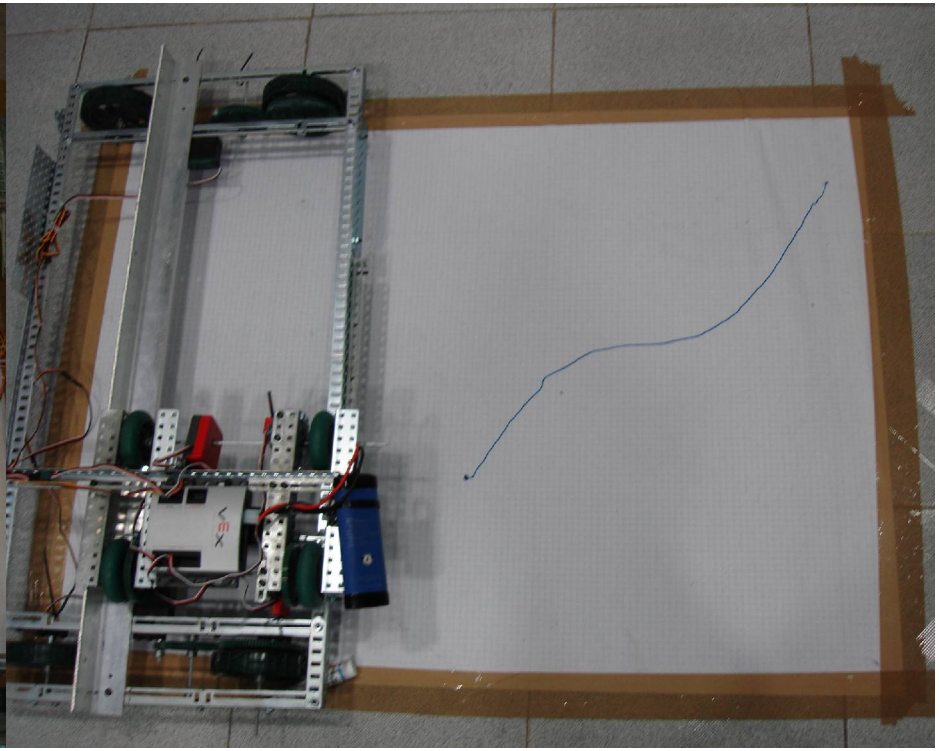


Results



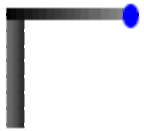
Results





What's Next?

- Non cartesian robot
  - Diminishes mechanical issues
  - Gives more weight to the programming
  - Need to develop formulas for an inverse dynamics
  - Needs greater processing capacity



//Thank you for your time