VRIJE ASO.SCHOOL

Let's go for a ride! The physics of roller-coasters

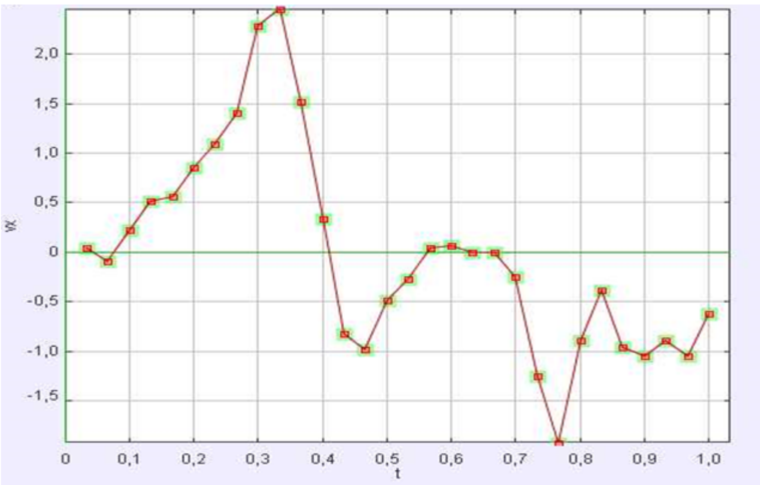
Creating a scale model and performing measurements on the model

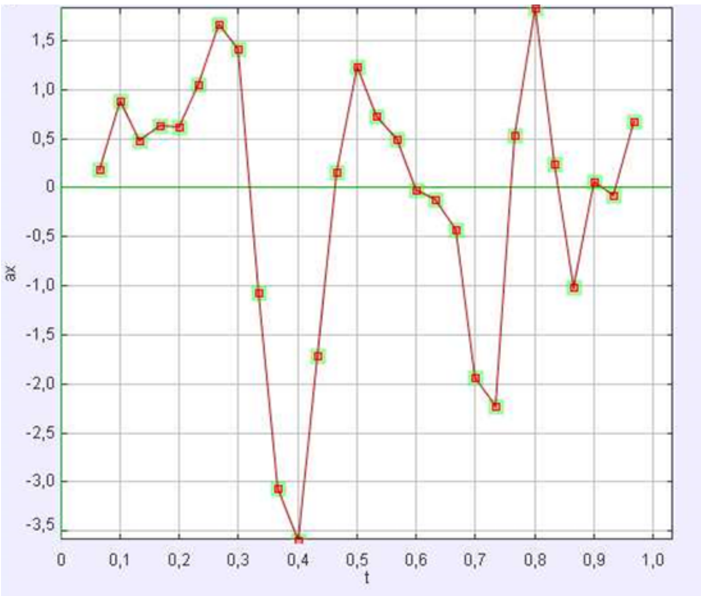
THE ROX-FLYER – Candice Gruyaert & Michiel Warnez

AQUILA TONANTE – Montanari Federica, Donati Gianmarco, Santi Margherita, Coletta Vittorio & Pirazzini Giada

The Rox-Flyer is an attraction that goes up and down while rotating in the air around its own axis. Because of this, we don't have a potential energy to calculate like with a roller-coaster for example, but we can however calculate the angular velocity and a centripetal force per kg.

Our graphs

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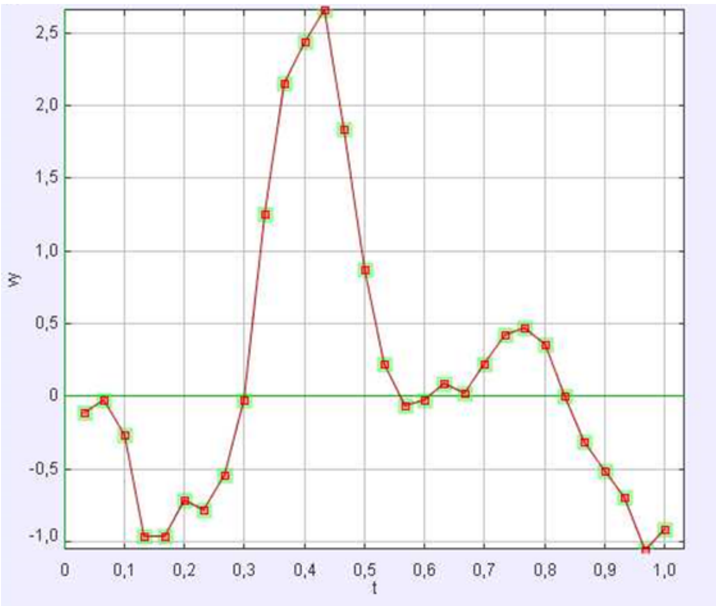
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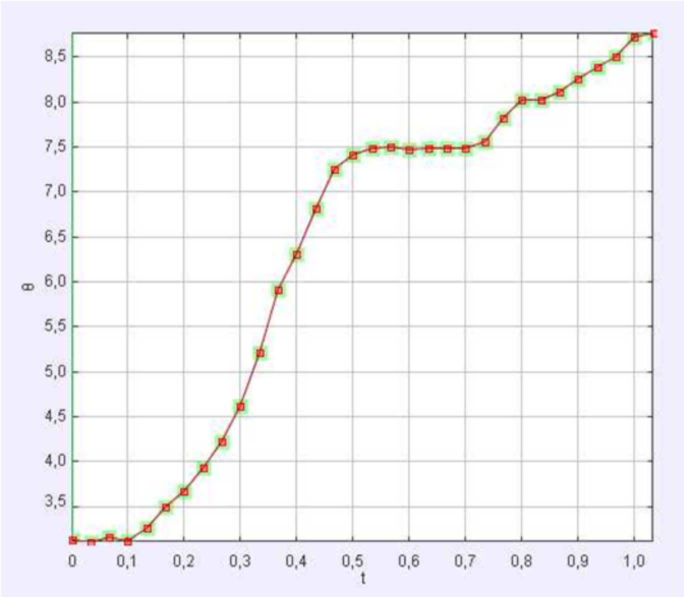
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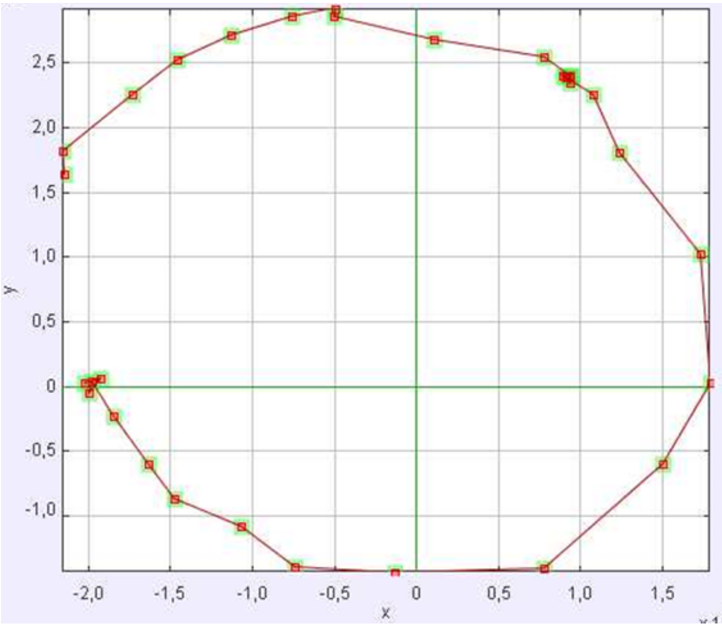
t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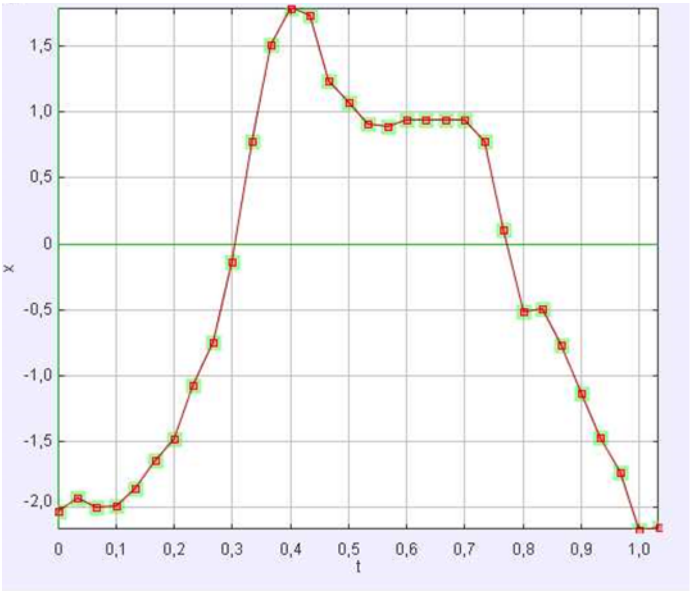
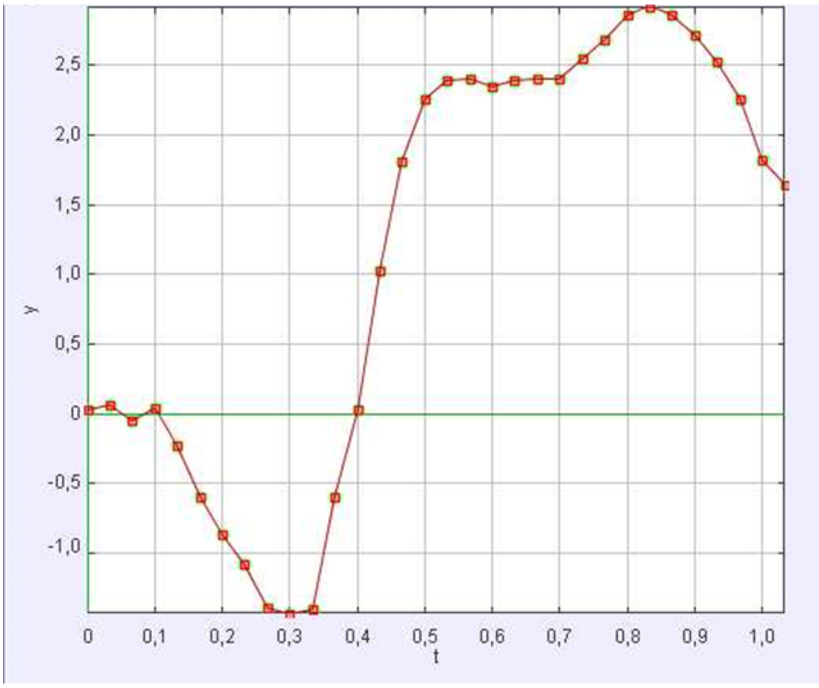
x





1. Speed (average)

The speed on different points : $V = \Delta x/\Delta t$

$V = (2.4 – (-1.9)) / (1.00 – 0.04)$
$V = 4.3 / 0.96$
$V = 4.5$ m/s

On our video, you can clearly see that our homemade scalemodel sometimes stops turning. Our graph also shows this. The speed increases enormously in the beginning and then dives under the t-axle. After that, the graph moves up and down a little bit, but never that much above the t-axle

2. **Acceleration (average)**

Acceleration (a) = Change in speed (Δv) / Time interval (Δt)

$a = (v_2 - v_1) / (t_1 - t_2)$
$a = (2.5 – (- 0.02)) / (1.0 – 0.04)$
$a = 2.52 / 0.96$
$a = 2.6$ m/s²

3. **Kinetic energy** per kg : $Ek = ½m·v2$

$Ek = ½ * (4.5)^2$
$Ek = ½ * 20.25$
$Ek = 10$ J per kg

4. **Centripetal force** per kg

$F_{\text{mpz}} = \frac{mv^2}{r}$ (d = 4.3 cm - r = 2.15 cm = 0.0215 m)

$F = (4.5)^2 / 0.0215$
$F = 20.25 / 0.0215$
$F = 942$ N per kg

5. **Angular velocity** (time used: 0,4 seconds)

$$\omega = \frac{\Delta\theta}{t}$$

$\omega = 6{,}4 / 0{,}4$

$\omega = 16$ rad/s

6. Mechanical energy

It is not possible to calculate the mechanical energy (Em) , because we only have the kinetic energy (Ek), but not the potential energy (Ep).

→ Em = Ep + Ek

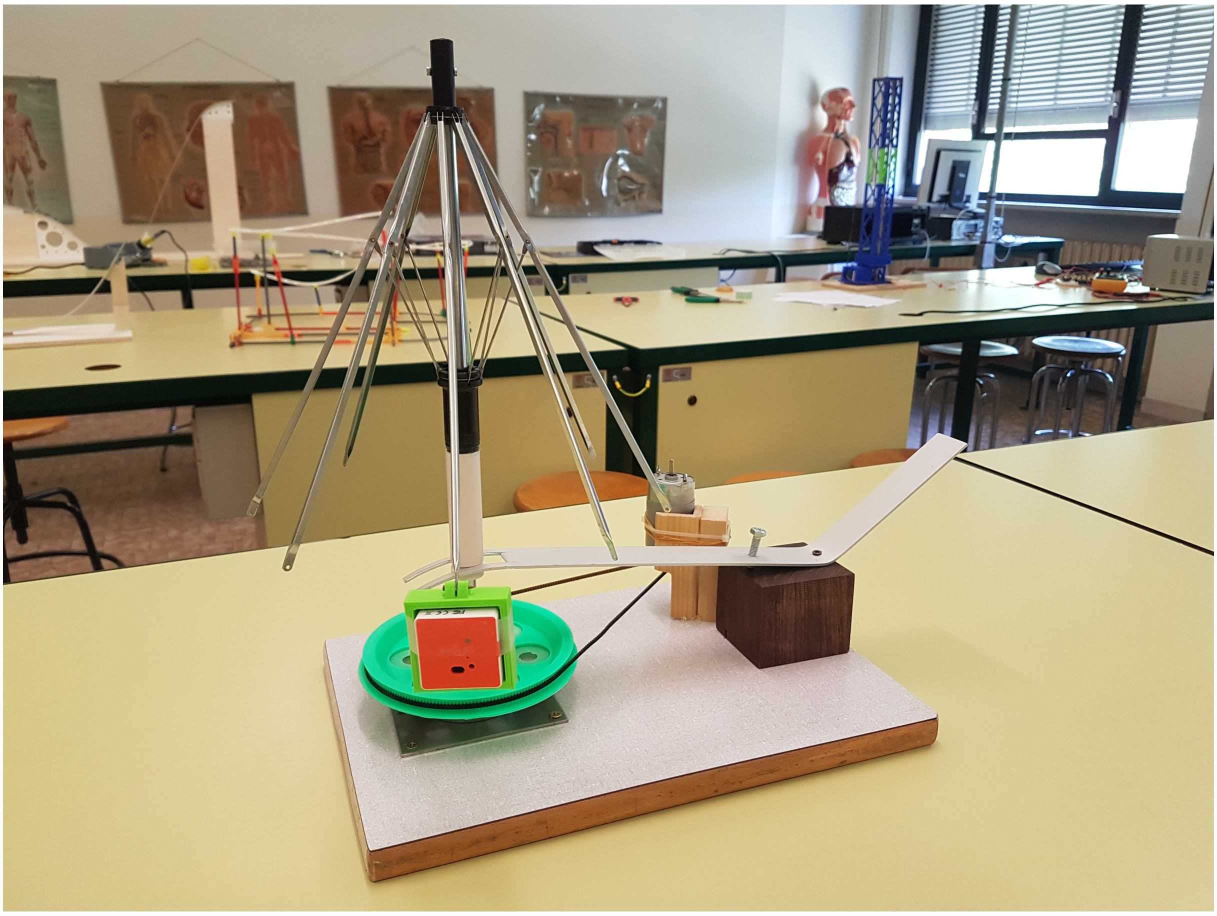
Aquila Tonante is an attraction that makes a circulary motion around a central pivot, where in a half part of the circumference Aquila Tonante has a minimal high of approximately 1,50 metres, while in the opposite part there is a maximum high of about 3 metres.

The implementation of our model have been very complicated.

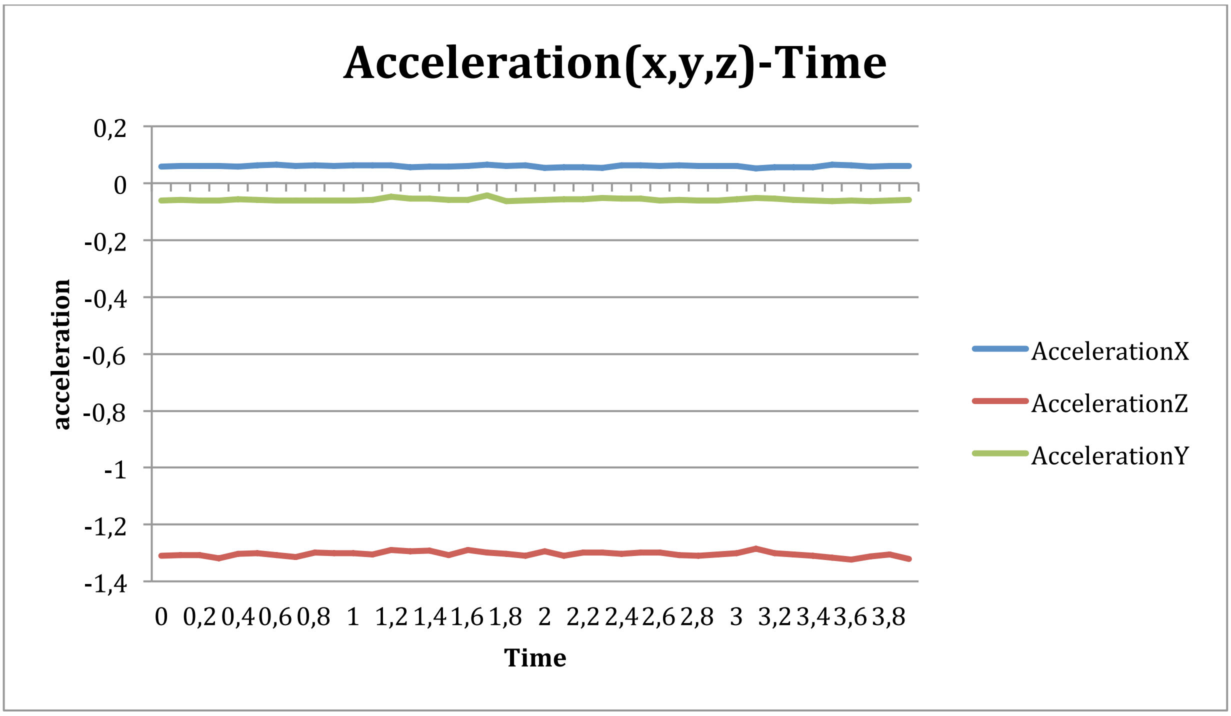
For our attraction we thought how an umbrella model. For building it we used the top of an umbrella without the cover and we fixed a support in the end of one splint in which we put an acceleration sensor.

The base for the umbrella is composed with a plate of iron fixed to a block of wood with four nail on the corners. On the are of the block of wood we stuck a cube that served us to set an object that we used as knob for change the radius of the circumference, this knob is also set to the central pivot so we can raise and lower the splints of the umbrella. We used an engine to move a toothy disc positioned over the iron plate.

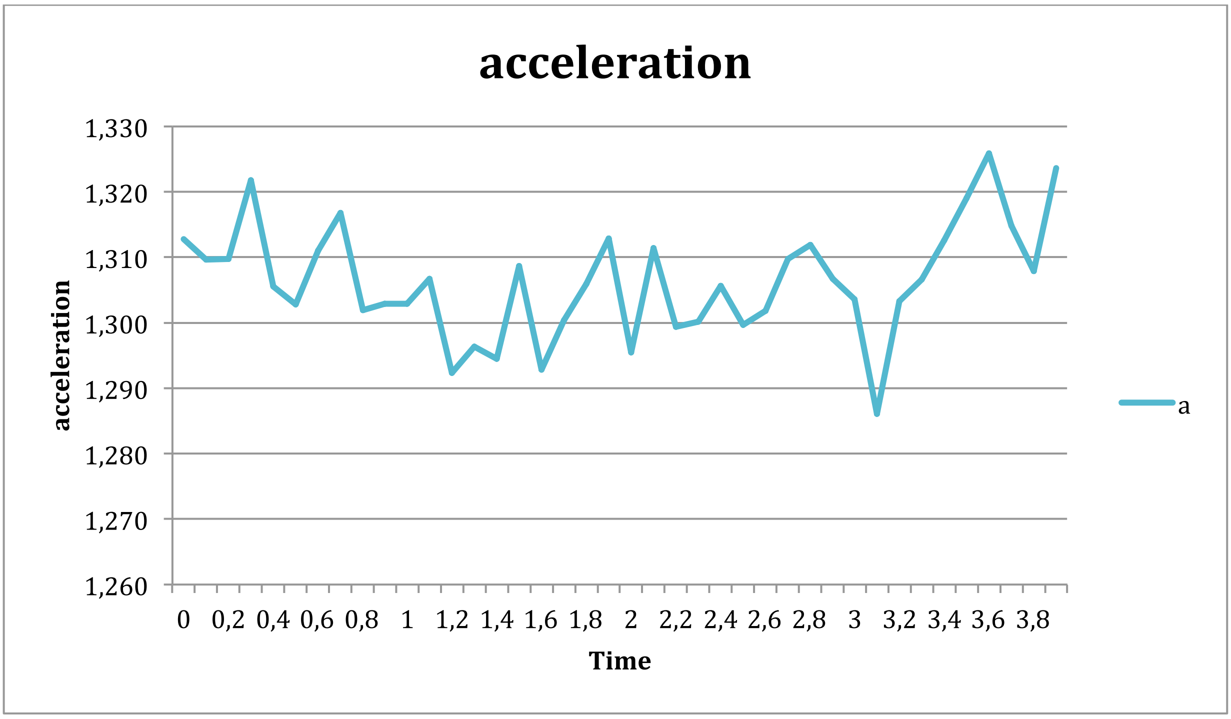
We realized the toothy disc and the support for the sensor with a 3D program, call Rhinoceros, and then we printed them with the school's 3D printer.



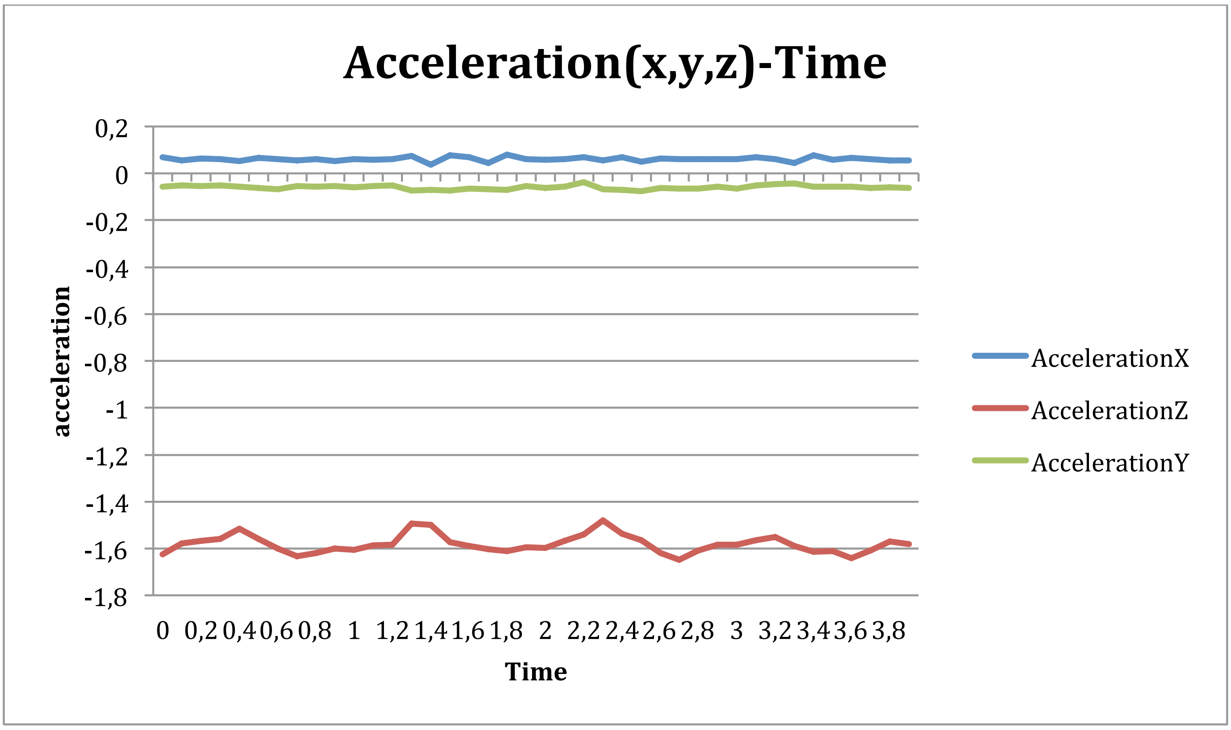
Our graphs



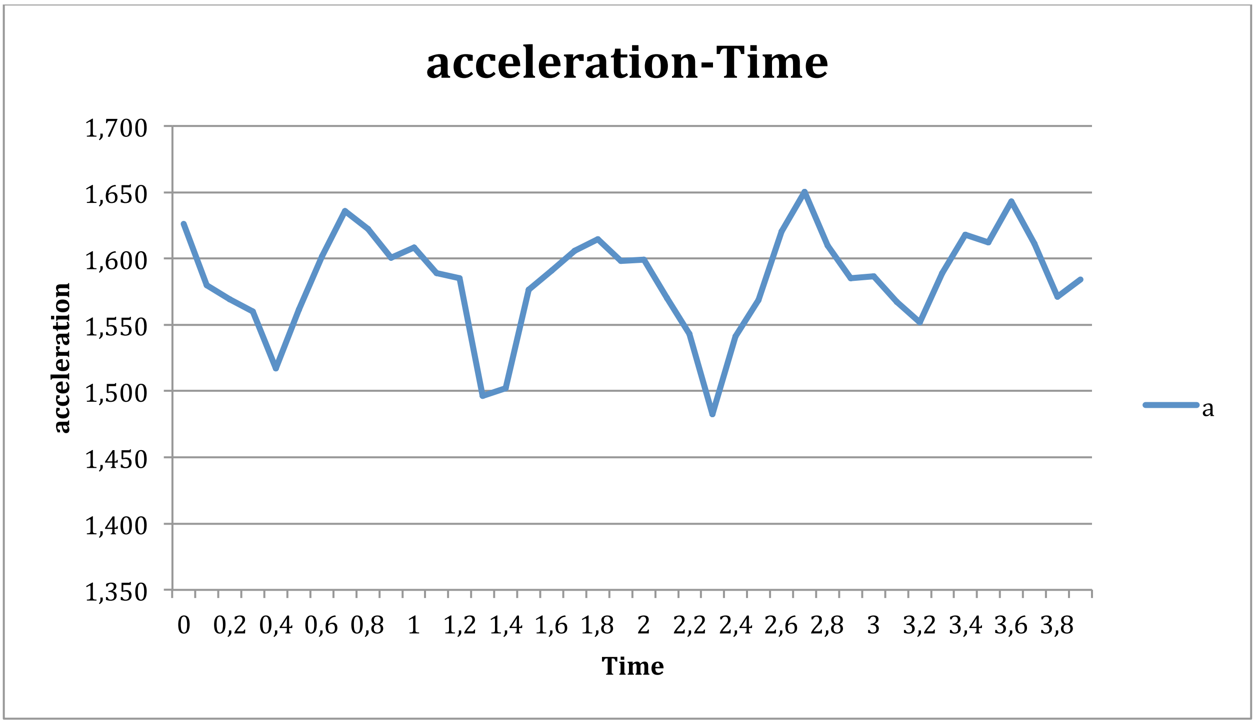
This graphs represents the acceleration in three direction x, y, z in a low point of the model.



This graphs represents total acceleration in a low point of the model.



This graphs represents the acceleration in three direction x, y, z in a high point of the model.



This graphs represents total acceleration in a high point of the model.