

SAT: Quick start guide

SimFonIA

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CONTENTS

- Introduction 3
- 1 SketchUp..... 3
 - 1.1 First model..... 3
 - 1.1.1 2D Drawing 3
 - 1.1.2 3D Drawing 4
 - 1.2 Groups management 5
- 2 Geometric transformations..... 6
 - 2.1 The processor of transformations 6
 - 2.2 Translation..... 7
 - 2.3 Rotation 9
- 3 Weathervane example.....12
 - 3.1 Simple rotation.....12
 - 3.2 Simple rotation : object coordinate system.....14
 - 3.3 Compound motion14
- 4 Complementaty documentation 16

Introduction

The goal of this document is to give a quick introduction to the animation plugin SAT.

Prerequisites:

- Download and install SketchUp
- Download and install the free trial version of SAT

For installation details, see our [dedicated document](#)

1 SketchUp

Some users of SAT do not have experience with the software SketchUp. This section aims to give them the basic elements and thus accelerate their progress.

1.1 First model

1.1.1 2D Drawing

The first step consists in drawing 2D geometric shapes (circle, rectangle, straight line ...) which will subsequently be extruded.

Note 1: To specify a dimension, one can enter a numeric value (with its unit) while drawing a 2D shape and then press enter. For example, type "1.0m" + enter while drawing a circle to set its radius to 1 meter. The symbol "m" stands for meters. If no unit is specified, SketchUp will use the default unit. For a rectangle with 2 dimensions, one can type "1.0m, 2.0m" for instance.

Example: Draw a rectangle with dimensions (1m, 2m) with one of its vertices on the main axis origin.

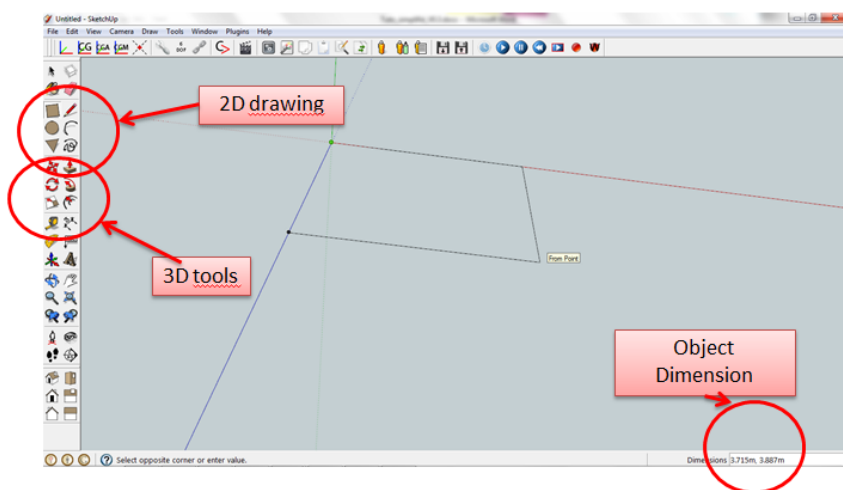


Figure 1 : Drawing interface

1.1.2 3D Drawing

The transition from 2D to 3D will be done in most cases by extrusion.

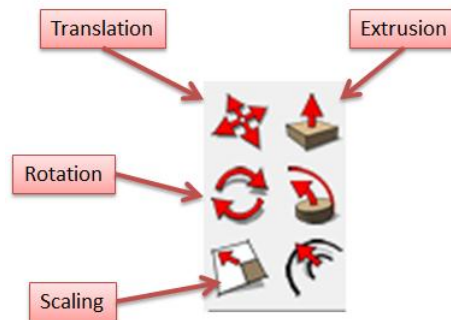


Figure 2 : 3D tools

Example: Extrude the rectangle of the previous example. Then do a triple click to select the entire object (it turns blue). Then "right click" → "make a group."

The 3D object can now be moved with conventional tools as translation and rotation. The latter is done in several steps:

- Select the group
- Click on the icon rotation
- Click on a point that will be the center of rotation and keep the mouse button pressed
- Specify the axis of the rotation and release the mouse button.
- The two following clicks can now set the angle of rotation

Note 2: When making a translation, if you press one of the arrow keys (\leftarrow \uparrow \rightarrow \downarrow) the component is constrained to move along one of the main axes of the coordinate system : X (red axis), Y (green-axis) or Z (blue-axis).

Note 3: One can set the distance of a translation or the angle of a rotation by entering a numerical value on the keyboard when defining the transformation.

Note 4: If the ctrl key is pressed during a translation (respectively a rotation) then this is a copy of the component that is created by translation (respectively rotation) of the original.

Example: Translate the previous groupe by 2 meters along one of the main axes (by using the tips given in Notes 2 and 3). Then create a copy of the group by performing a rotation of 90° around the vertical axis (use note 4). The end result is suggested in the following figure.

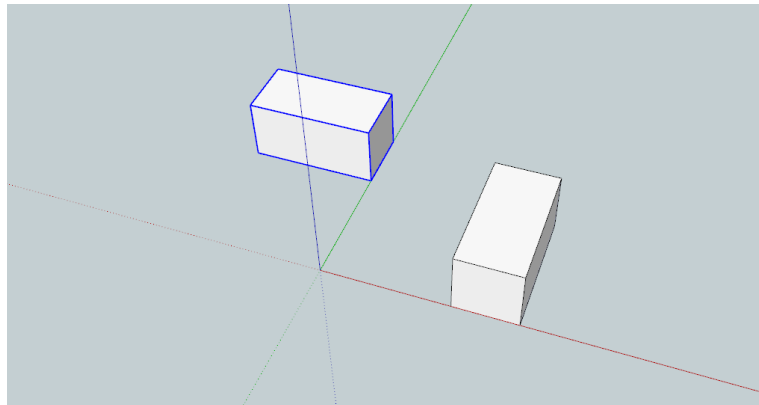


Figure 3: Example result

3D Warehouse

A library of components, "3D warehouse" is available on the web. It allows to avoid the drawings in the most of the cases.

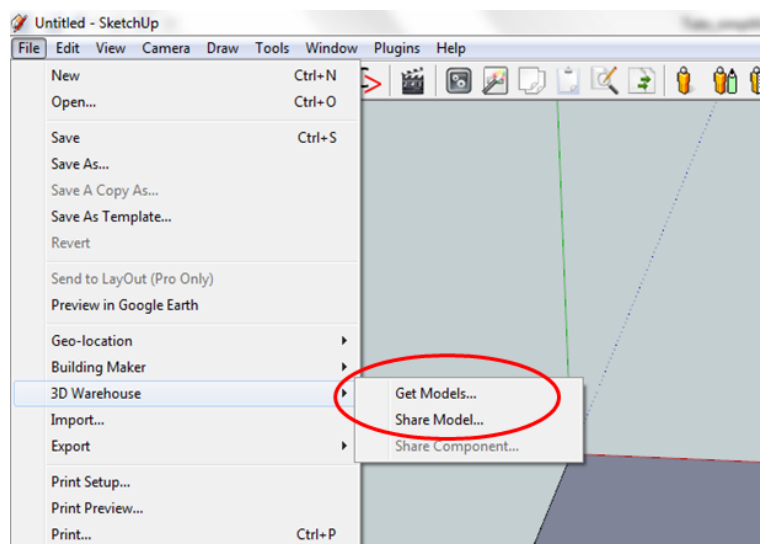


Figure 4 : Access to 3D Warehouse

1.2 Groups management

SAT animations are based on the notion of group. To create a group, one must triple-click on an object (edges and faces turn blue) then right click → "create a group".

To create a hierarchy, simply create a group inside another group.

Example: Select two groups previously drawn then create a group. The "outliner" window (Main Menu → Window → Outliner) allows you to view the created hierarchy.

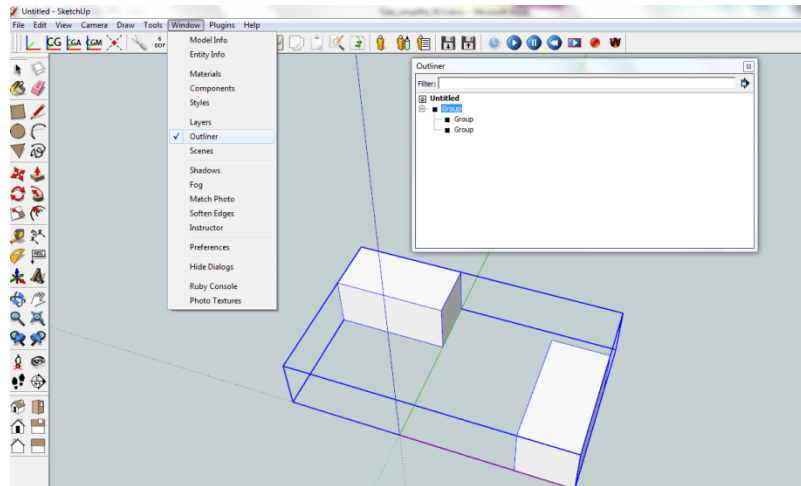


Figure 5 : Hierarchy of groups and Outliner window

2 Geometric transformations

The objective of this section is to present the philosophy of the transformation processor through the most frequently used functions: rotation and translation.

2.1 The processor of transformations

One can access the transformation processor by selecting a group and clicking on the gray icon (see figure below).

Example: Draw a cylinder and create a group. Select the group and click on the transformation processor icon.

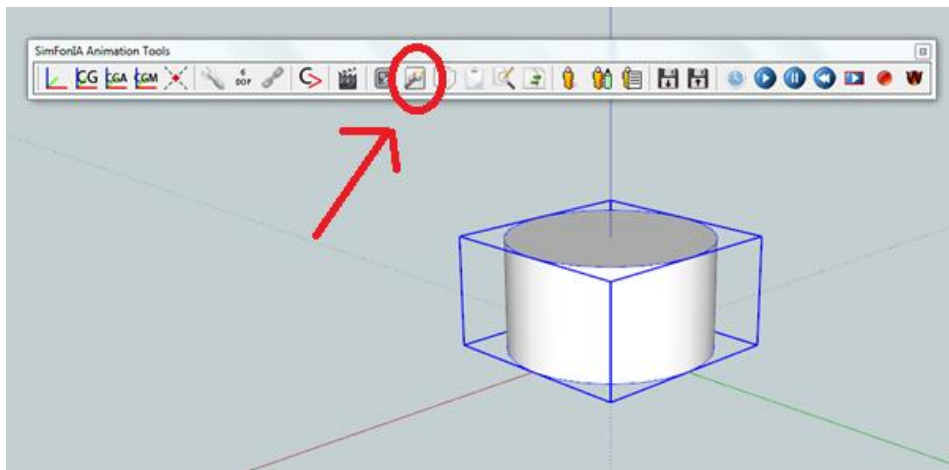


Figure 6 : Transformation processor icon

All the available transformations for the selected object are displayed (see figure below). We note that in addition to the "rotation" and "translation", there are many other transformations as

"visibility" (show or hide an object), "color" or "positioning" (placing an object in a specific position).

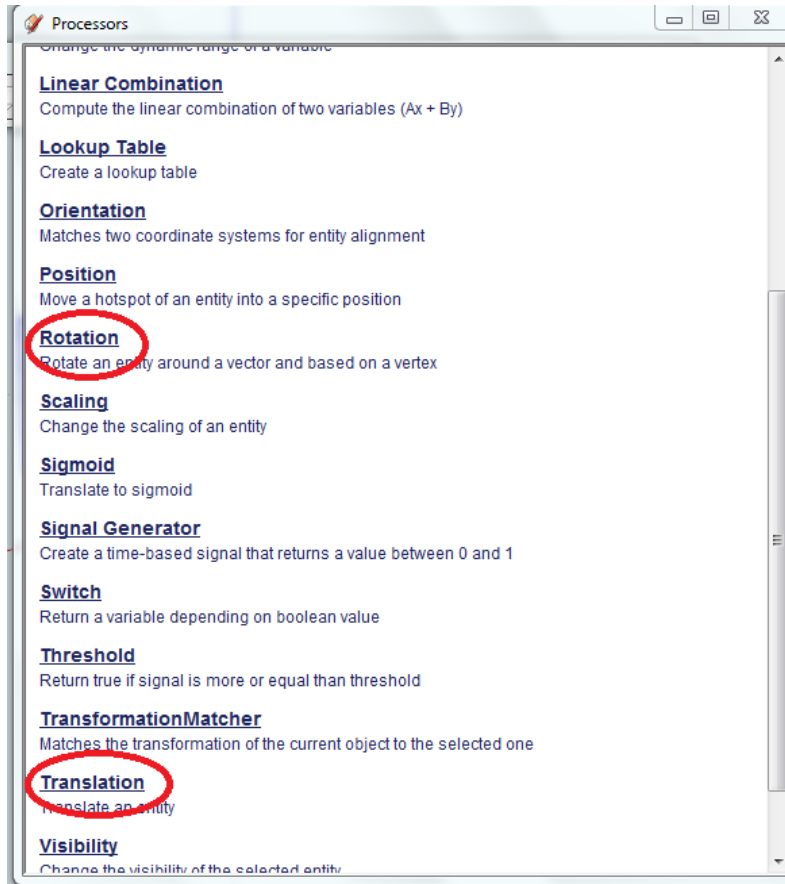


Figure 7 : Transformation Processor

2.2 Translation

According to Wikipedia, a translation is defined as following:

*[...] a **translation** is a function that moves every point at constant distance in a specified direction*

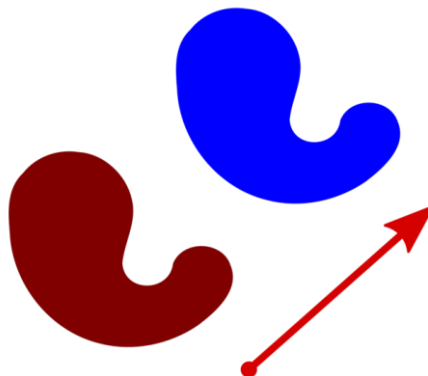


Figure 8 : Wikipedia definition of a translation

To define a translation of an object, one must define a vector which describes the direction of the translation. This is what proposes the interface “translation” of the transformation processor (see following figure):

- Transformation name: name of the transformation
- Parent / object coordinate system: Vector coordinates are associated to a coordinate system which is defined by the red-green-blue axes. The reason of the choice between parent and object coordinate system is that the coordinate system of an object can be different from the coordinate system of its parents (the group which contain the object or the “world” which contains every groups). More details will be given in the rest of the document
- X/Y/Z: a vector is defined by three space coordinates. There are three methods to define them :
 - one can manually enter the coordinates in the text fields
 - one can import the coordinates from a data file (gray icon at the right of the text fields)
 - one can directly trace the vector into SketchUp by clicking on the button “select translation on model”.

In this simple tutorial we will use the third method which is the easiest. If you make the manipulation, you will notice that vectors coordinates are automatically inserted into the text fields.

- Type of translation: This option allows distinguishing absolute transformation (the object is moved just once) and a relative transformation (the object is translated continuously).

Example

1) Define a relative translation along the X-axis of the object coordinate system ($X = 1.0.m$; $Y = 0.0$; $Z = 0.0$). Click on save then on the “play” button of the SAT toolbar ; the animation starts. You will see that the group moves at one meter per second along the x-axis.

Note : It is mandatory to add the suffix “. m” if we want SketchUp to use meters. If you forget this suffix, SketchUp will use its default units that are inches.

2) Modify the options for observing the difference of behaviors between an absolute or a relative translation and between the object and the parent coordinate systems.

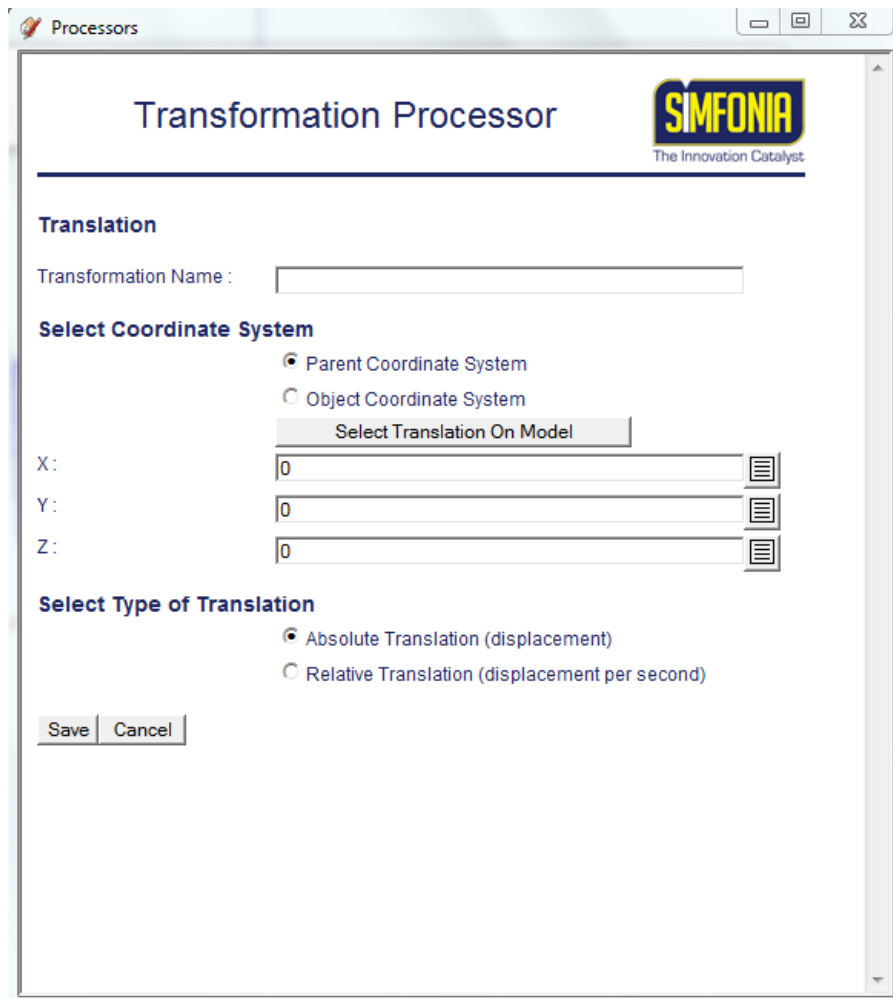


Figure 9 : Translation processor

2.3 Rotation

According Wikipedia:

[...]a rotation is a transformation in a plane or in space that describes the motion of a rigid body around a fixed point

The vector gives the direction of the axis of rotation and the point indicates the location of the center of rotation. The following figure shows two axes whose vectors are identical but whose origins are different.

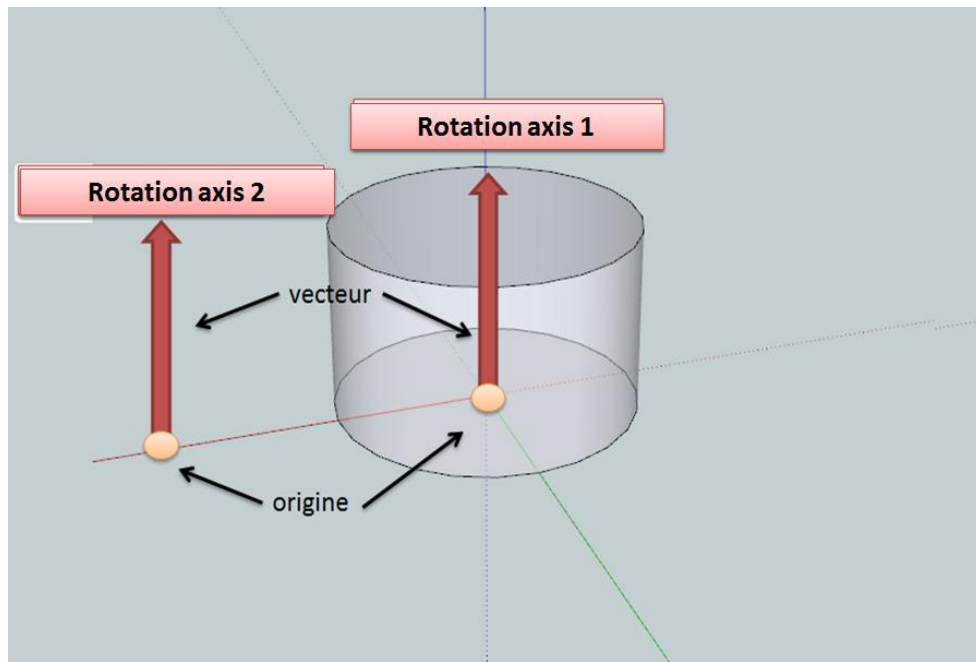


Figure 10 : Definition of a rotation

The philosophy of the interface "rotation" (see figure below) is identical to that of the translation:

- Origin of rotation X/Y/Z : as in the case of the translation, one can define the origin by three ways (manually, directly in SU or with a CSV file).
- Vector of rotation X/Y/Z : identical to the case of the translation
- Type of rotation:
 - If the rotation is absolute, the object is moved just once. The value in the text field is used to specify the rotation angle (in radians, one turn is equals $2 \cdot \pi$ radians).
 - If the rotation is relative, the object is moved continuously. The value in the text field then specifies a rotation speed (in radians per second).

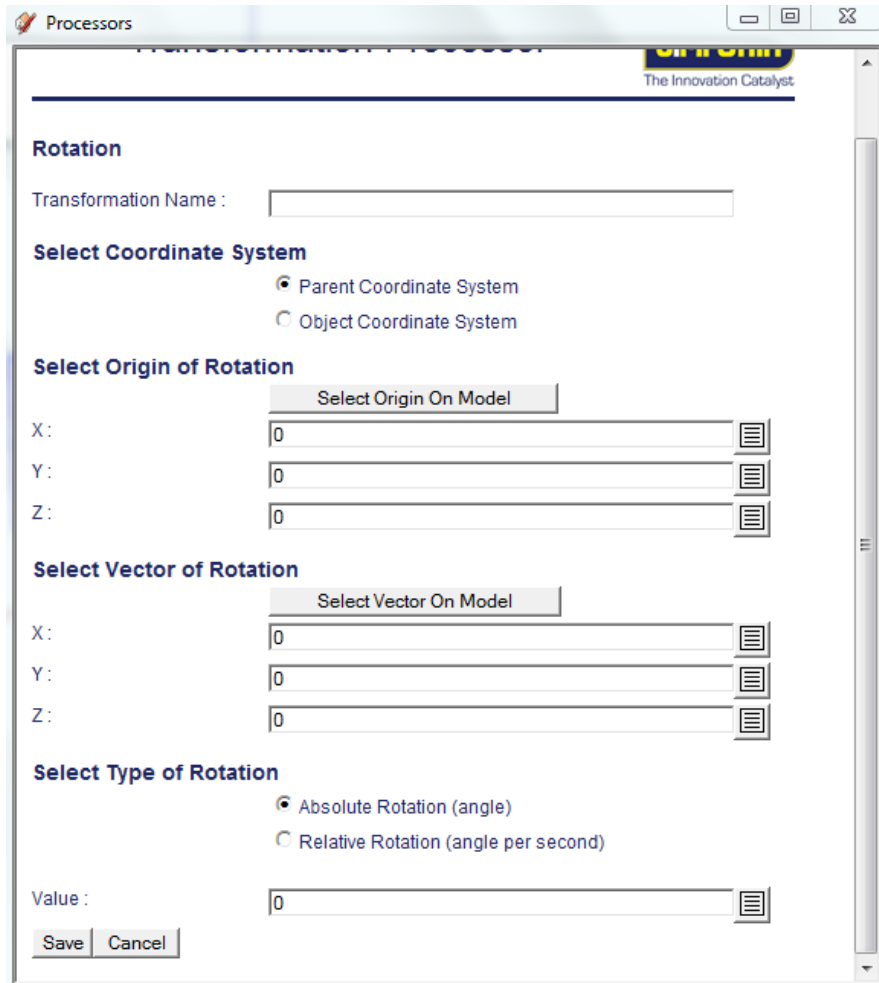


Figure 11 : Rotation processor

Example

1) Draw a cylinder and define a rotation along the vertical axis of the object as suggested in the Figure 10 (Axis of rotation example 1). Click on save and then on the "play" button (blue button) of the SAT toolbar; the animation starts.

2) Repeat the operation after having changed the origin of the axis of rotation (axis of rotation example 2). Observe the difference with the first case.

3 Weathervane example

This example will help to illustrate the functions of SAT and to give some practical tips. The goal is simple: to turn a weathervane about its axis of rotation.

3.1 Simple rotation

The weathervane model is available in the folder that accompanies this document: "girouette.skp"

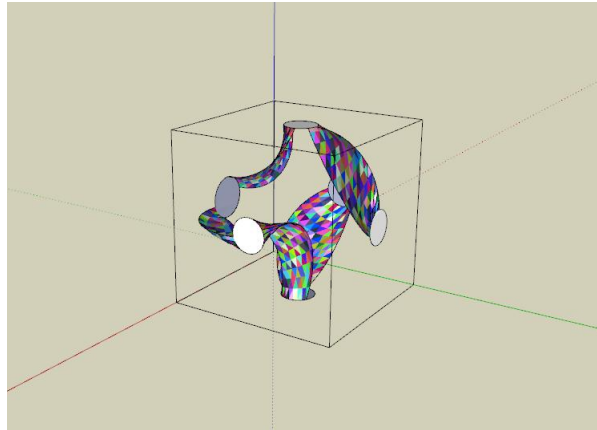


Figure 12 : Weathervane example

The first step is to create a group. Then, to make the work easier, we plot the axis of rotation (Figure 13). For this we create two axes to locate the center and then draw a vertical line. Note that this step is not necessary; it is presented here to simplify the definition of the rotation vector drawing in SU.

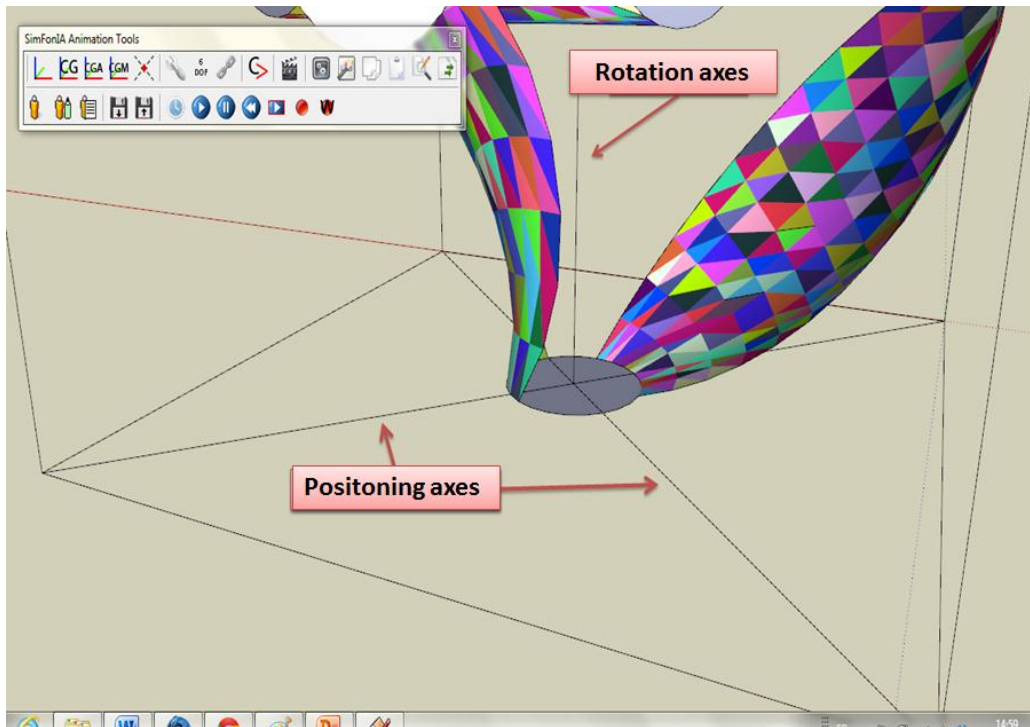


Figure 13 : Creation of the axis of rotation

The rotation is then set as in the previous examples (the origin and the vector are defined directly in the drawing). We use a relative rotation. Press play: the object turns!

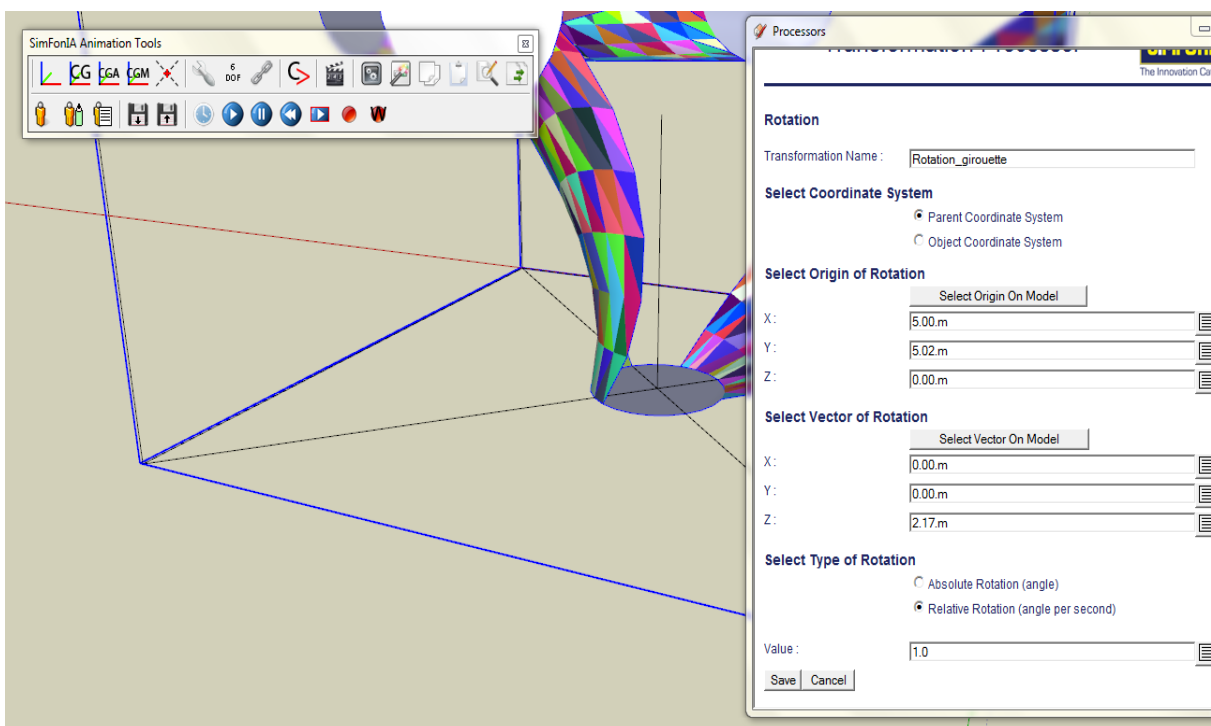


Figure 14 : SAT definition of the rotation

3.2 Simple rotation: object coordinate system

In the previous example, the axis of rotation is defined in the "parent coordinate system". This means that if the object is shifted, its axis of rotation will not follow the displacement. This can be problematic. To be convinced, just translate the object and then restart the animation.

This is why it is interesting to define the center and the axis of rotation directly in the object coordinate system. To do this, simply select "object coordinate system" in the interface of the transformation processor and re-make the definition of the vector and the origin of the rotation.

It is sometimes useful to manually set the object coordinate system. For this, you need to select a group and click on the dedicated icon on the SAT toolbar (see figure below). One must then define the center and the direction of both red and green axes. Once the operation is done, simply enter into the group to realize that the axes have been modified.

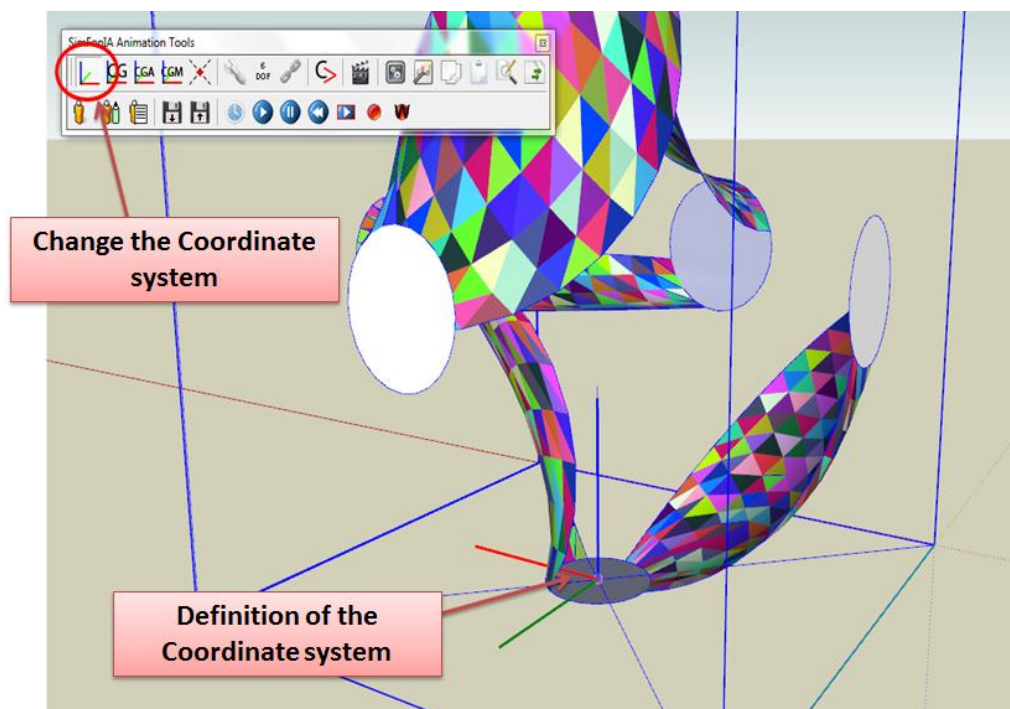


Figure 15 : SAT definition of the object coordinate system

3.3 Compound motion

A slightly more complex exercise helps to account for the interest of the hierarchy management

- 1) Starting from the rotating weathervane defined in its object coordinate system
- 2) Draw a new object (see Figure 16)

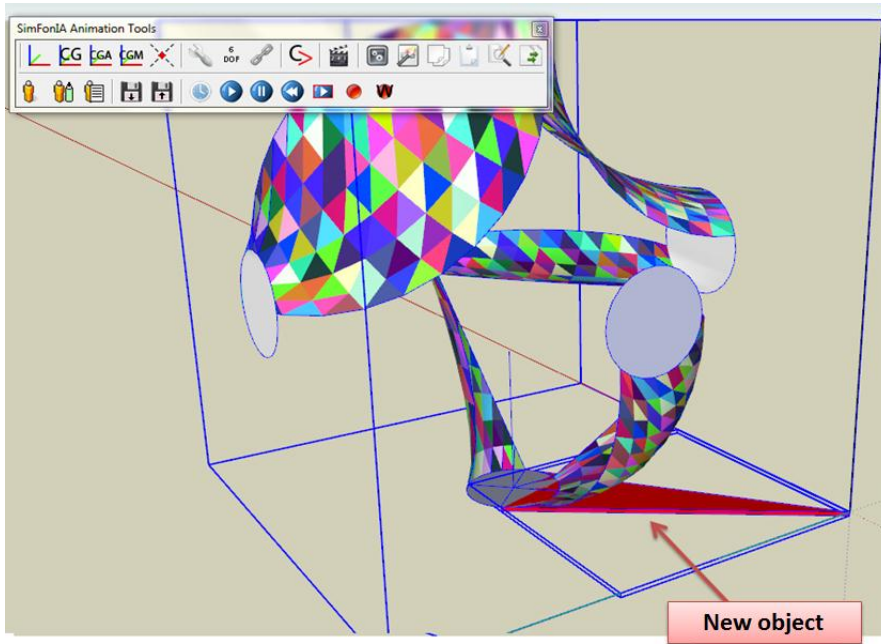


Figure 16 : SAT definition of the object coordinate system

- 3) Create a new group with the two objects
- 4) Define a rotation for this new group as suggested in Figure 17
- 5) Start the animation

The final model is available in the folder that accompanies this document:
"girouette_mouvement_composé.skp"

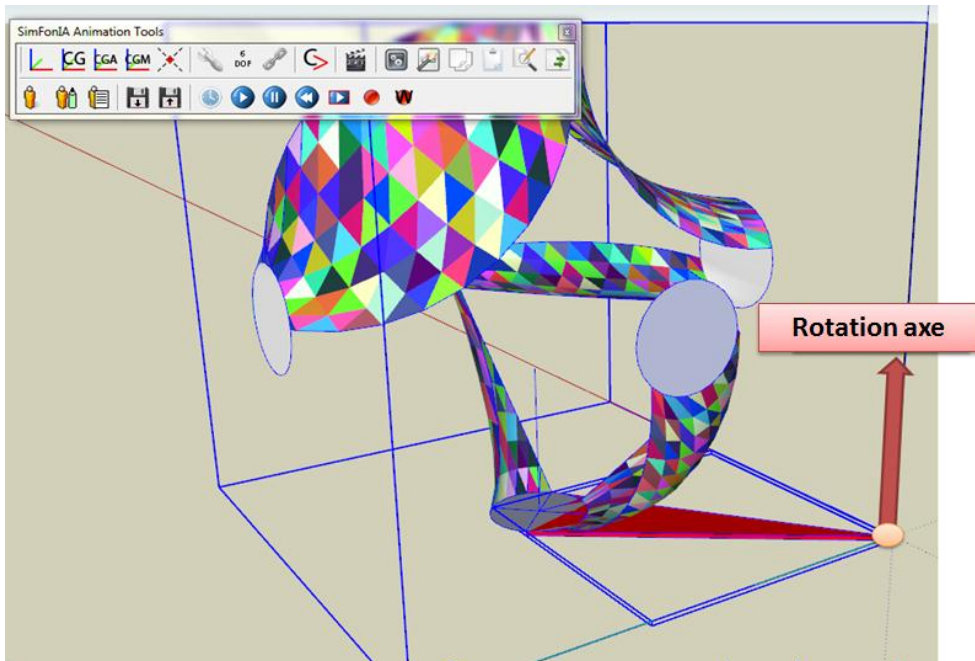


Figure 17 : Rotation of the main group

4 Complementary documentation

- To deepen the drawing in SketchUp, we strongly recommend the following document: http://www.simfonia.fr/SAT/documentation/en/SAT_V1_SketchUp_References_en_V1.04.pdf
- The complete documentation of SAT and examples are available at the following address: <http://www.simfonia.fr/SAT/index.php?page=documentation>