

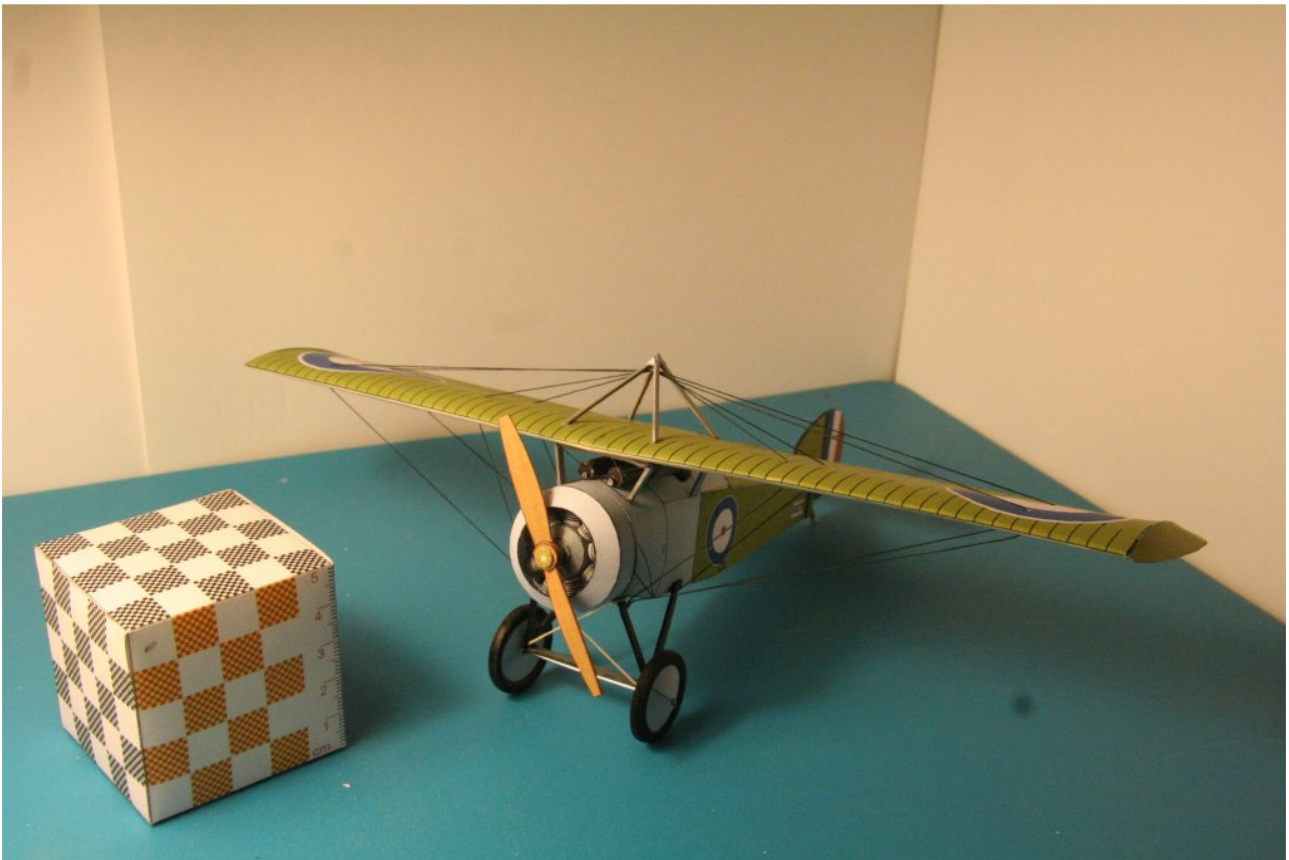
Sopwith Swallow

Scale 1/33

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**How to design a paper model
Using
Sketchup, Pepakura, Paint.net**

This is what I designed and built using softwares that are free or cheap and I would like to share with all of you my latest adventure.



First of all I invoke your patience for my basic English, for me will be a challenge to describe the whole process, but I hope the pictures could help.
I waited to have completed the process, before showing the main steps that I did, because I wanted to be sure that the road taken was the right one.

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The Tools

The thing that has always fascinated me is the ability to design the models, using software available for free, and the possibility to build models that are not available on the market. I bought the book of Roman Vasyliiev "World War One - Card Model Design: A Step-By-Step Guide."

The book inspired me a lot, and it's done really well, but describes the use of Rhinoceros for modeling and Adobe Illustrator for coloring and finishing. These softwares are very expensive for me, so I had to choose other SW available for free, to use later in the process of design and finish of the model: the prototype Sopwith Swallow.

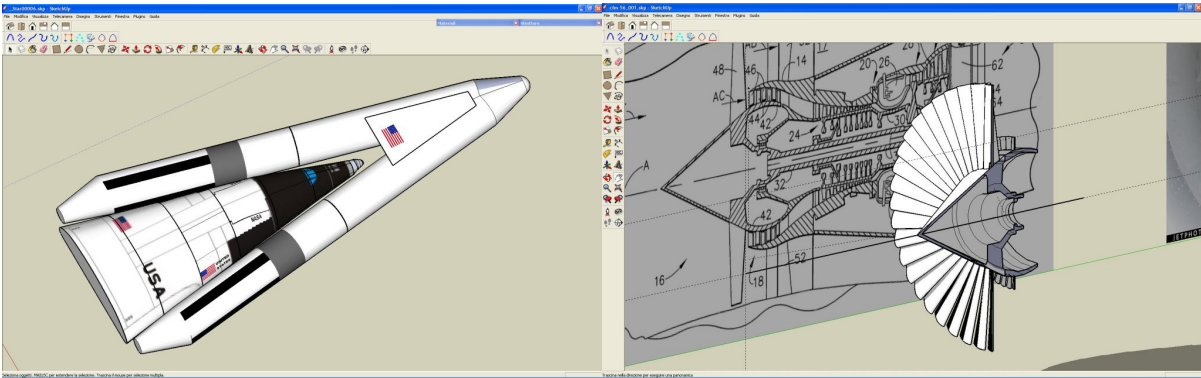
Finally I chose:

- Google SketchUp 6.0 for modeling
- Pepakura Designer for development in flat surfaces
- PDF995 and PDFEdit995 for format conversion
- Paint.Net for the graphical finish of the model

Sketchup

I chose Sketchup, because for a while I was trying to use it, and because on the net is available an enormous amount of information and tutorials.

Here some example of my previous attempts.



Pepakura

Same for Pepakura and Software995.

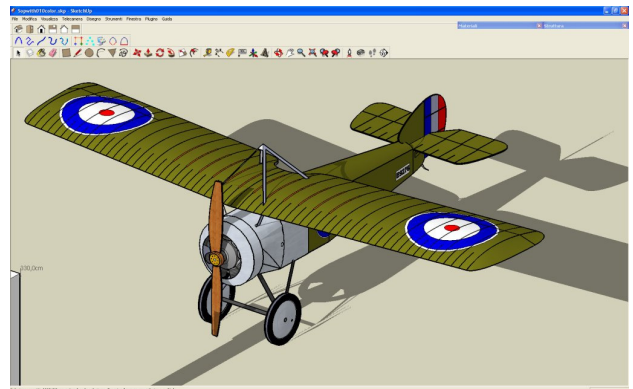
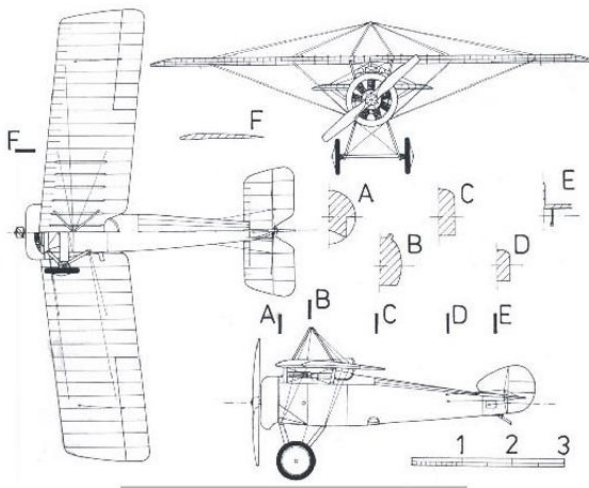
Paint.net

The reason why I chose Paint.Net is different. I'd like to use vector graphics, exporting from Pepakura model in EPS format, and using the Gimp software in combination with Ghostscripts or Inkscape, but I failed and I will be eternally grateful if anyone can help me. So I chose Paint.net, a program bit-map oriented , and, finally, the model is not scalable.

The Roadmap

Here is where I started from (an image capture from the Roman's book).

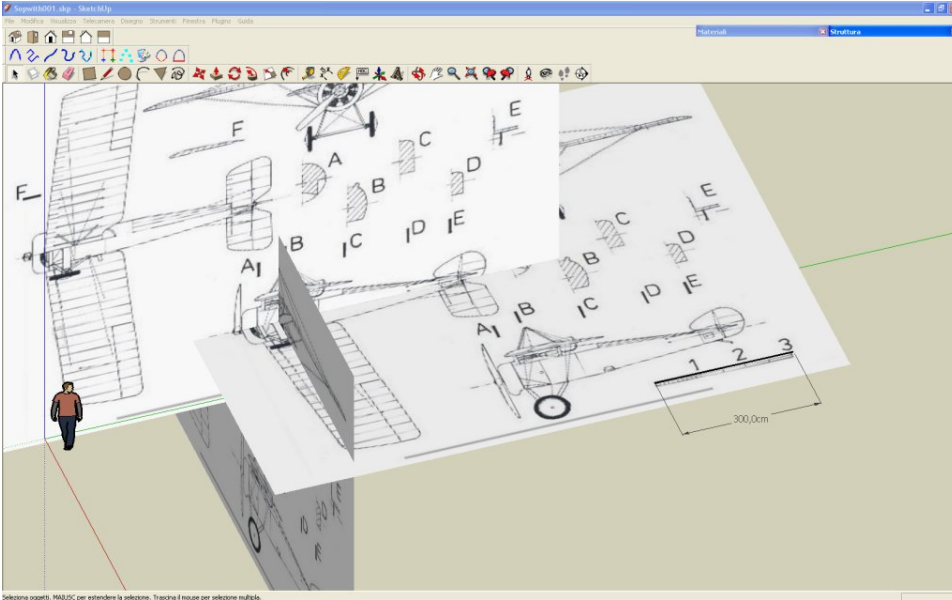
Here is where I started from (an image capture from the Roman's book) This is what I designed.



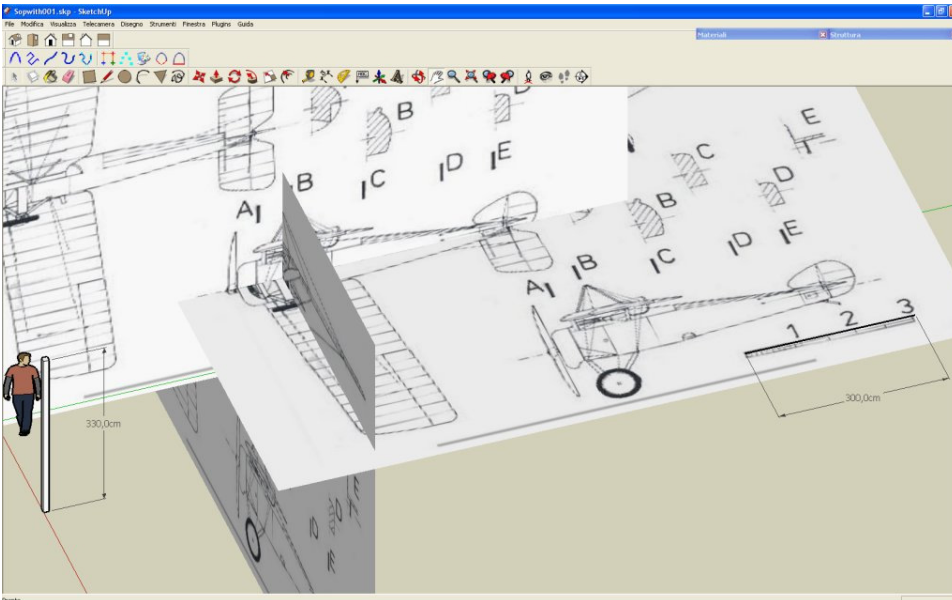
The Scale

And now I'm going to describe the steps of this process of design and construction, showing the general methodologies, strategies for organizing work, and the tricks to avoid the biggest problems. I will not go into details of the design and development of each individual component because it's too long, but I will give an indication of where to find the information for further study, where possible.

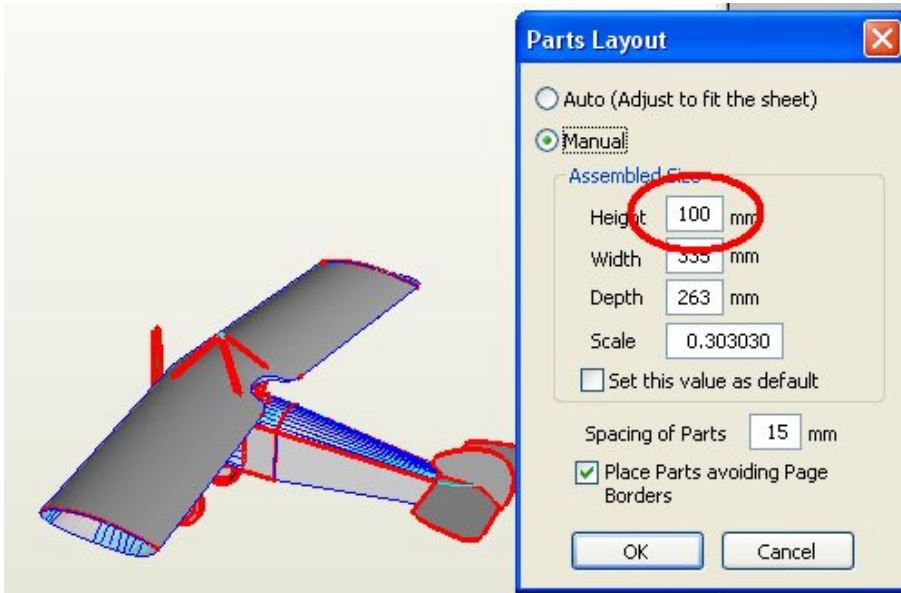
At the very beginning, I chose Pepakura to obtain flat surfaces from the 3D model: because of that I decided to exploit the possibility of using the manual way to unfold, by defining the maximum height of the final model. In the drawing, that I decided to use, there is a scale reference bar, which indicates the actual size of three meters (I suppose). So I brought in Sketchup the image size so that the bar reference measured three meters also in the drawing. Then I created two copies of the drawing and I placed them squarely.



I chose the scale 1 / 33, so what in the model is 10 cm high, in the drawing (reality) is 330 cm high. That is why in all my drawings there will be a box 330 cm tall as a reference.



Then in Pepakura, to Unfold the model, you have to uncheck the option "Auto" next to the button "Unfold", and in the panel "Parts Layout" and to set to 100 mm the Height in the "assembled size" frame.



Obviously in the design we have to put no part of the model higher than 330 cm!

Thickness

Before starting with the design we should define the thickness of the materials that we intend to use in the building process, to be sure that, when we go to assemble, all the parts fit perfectly.

So I took 10 small pieces of paper that I then used (160 g/m²) and I measured the thickness of the stack. The same with one small piece of cardboard.

With these measures, I calculated the thickness that would have in reality for a given scale, and I then used that measure in the sizing of the parts in the drawing. Remember that we design the model in SketchUp at actual size!

Sheet 160 g/m ² Thickness x 10			
			1,75 mm
Sheet 160 g/m ² Thickness x 1			
			0,175 mm
scale	1/ 33		
real	1/ 1		5,775 mm
			0,5775 cm
Cardborad thickness x 1			
			0,45 mm
scale	1/ 33		
real	1/ 1		14,85 mm
			1,485 cm

So, in the drawing, the paper will be about 0.5 cm thick and the cardboard about 1.5 cm. Now we have the plan, the scale, the thickness, and we can start by drawing the parties.

Groups / Components

Before I show a way to design a model I'd like to highlight a fundamental concept in Sketchup. The magic word with SketchUp is **GROUP**.

Each group is independent and the drawn objects (lines, circles, rectangles, etc..) remain separated from the surface of the objects in the group.

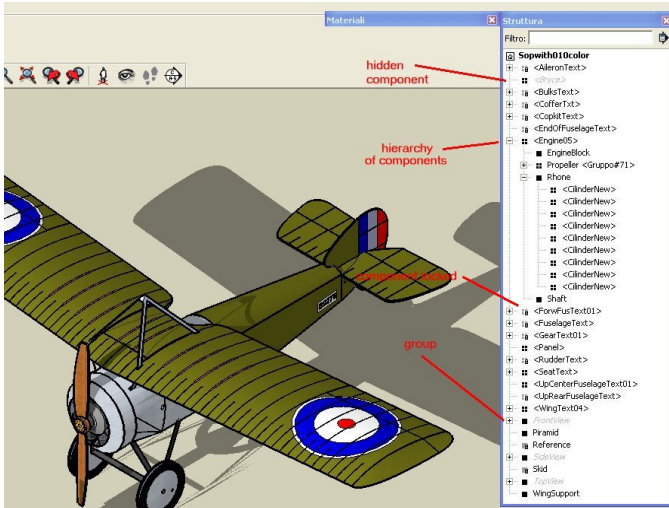
So we have to organize our project into groups (components), to split the complexity of the project in more simple and manageable subsets (eg, fuselage, tail, gear, wings, etc..). To keep track of the organization of the model is useful to visualize the window of the structure (outliner).

Here we can hide / display, lock / unlock, select / deselect, rename, rearrange the hierarchy and ultimately save the components as separate projects.

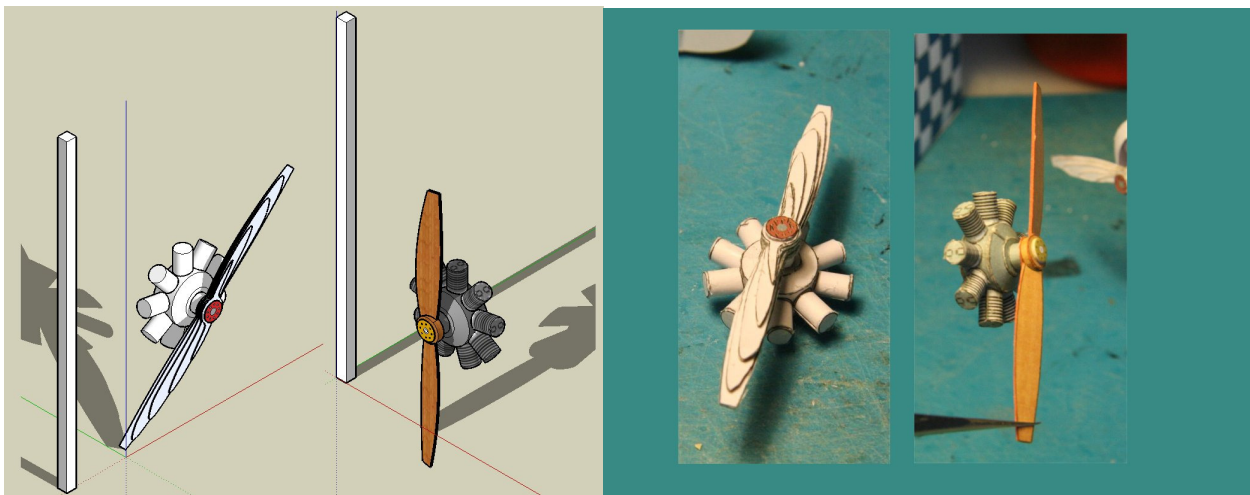
The ability to save individual parts as separate projects is extremely useful. When we have designed the model geometry, we could then work on individual sub-projects to develop their unfold in Pepakura and to apply textures.

When we completed a component (unfold & texture), we can import the new component in the model, substituting the old version.

Below is an example of an organization of the model and an example of the directories where I stored the files of the sub-projects.

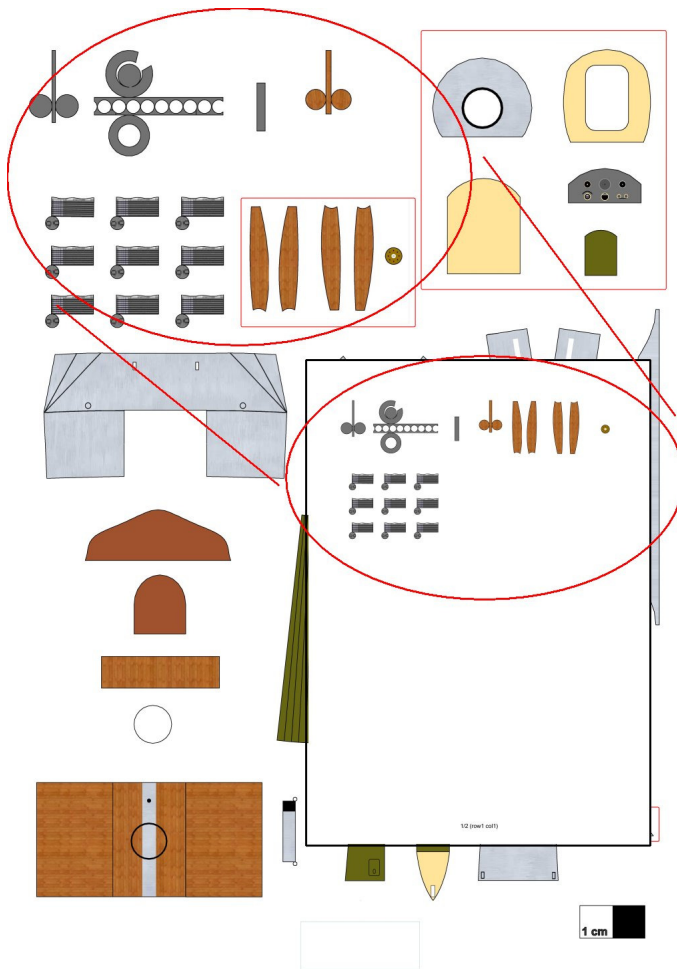


Further below is an example of a sub-project (the engine) how has been exported from the model on the left and then completed and ready to be imported back into the model on the right.



The Groups and Components are useful also because you can unfold and print the single sub project and test if everything fits good.

Then You can assemble the unfolded parts, any way you want, in the final version of your model. Here below the unfolded parts of a single component (the engine) inserted and arranged in a sheet of the other parts of the model.



Finally I imported the last version of the component in the sketchup model.

A hint: It's a good practice to name in a different manner each version of the component, at less before you import it in the model, for distinguish it from the original one, but if you want to maintain the same name you have first to purge the unused versions in the model, selecting in the window menu the model information and then the statistics. Otherwise apparently you cannot import the last version, because sketchup keeps memory of the previous version deleted.

Process Summary

Now I can summarize the process to design, unfold and build the model step by step.

1. design the general geometry
2. Define the Groups and Components
3. Work on the subprojects for refine and for engineer the geometry
4. test to unfold the single component, if necessary return at the previous step (3.)
5. test build the unfolded component, if necessary return at refining the project (3.)
6. apply a texture and colorize the component
7. unfold and build the component
8. put the unfolded component in the general model sheet
9. return to work at next subproject until the model will be complete (3.)

The first two steps actually are contextual, because while I was designing one part of the model, at the same time I had in mind that this one could become a component.

I choose the Roman's model, not only because I would to follow approximately the steps of his book, but also because in this manner I could avoid "to invent the whell again", as in Italy we

say. Not only the geometry of the model is simple (no much curved surfaces) but Roman already solved the problem of how to decompose the model. I therefore advise you to carefully choose the model to test this technique, so as not to overlap the difficulty of learning the tools with the difficulty of designing.

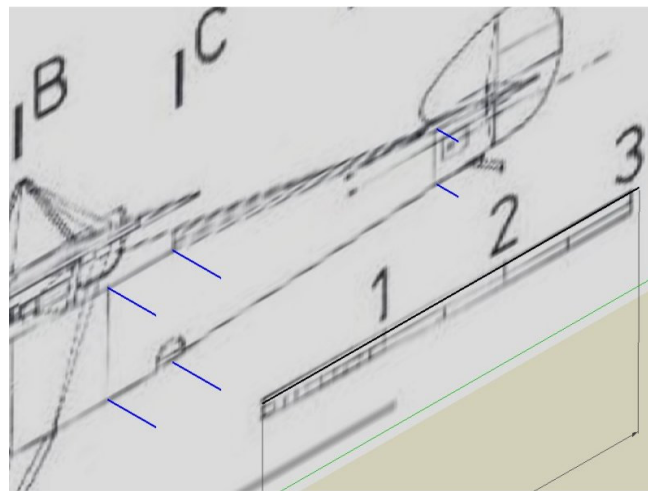
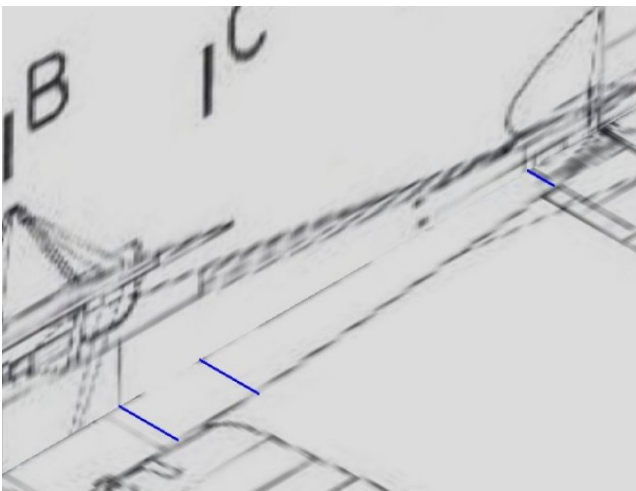
Drawing the fuselage

I can start now by showing how to draw the fuselage, at least the rear part of the fuselage. This part is simple, into this I have to put some bulkhead and finally I have to colorize it and put on it the nationality mark. With one component I can summarize a lot of techniques.

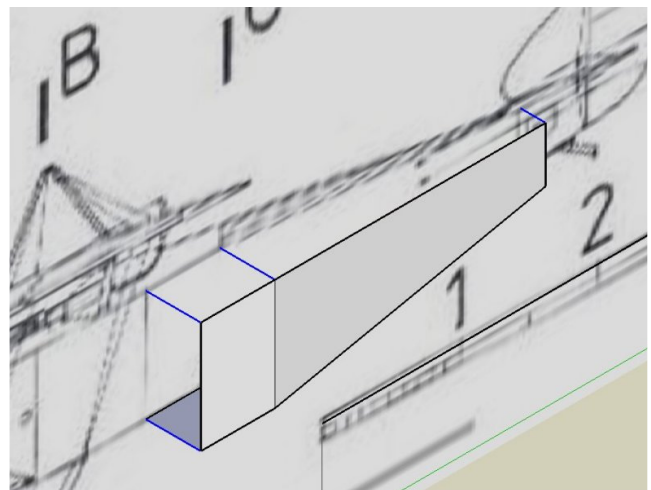
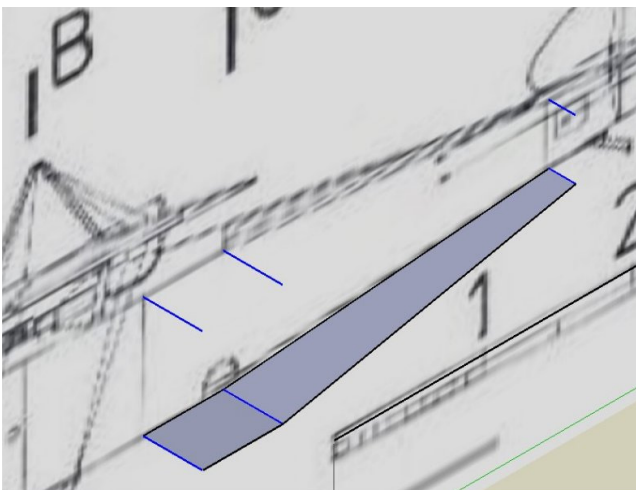
Let's go!!

I start drawing some line on the surface of the TopView to score the width of the fuselage at the major points. The TopView is a group so the lines are free from the surface.

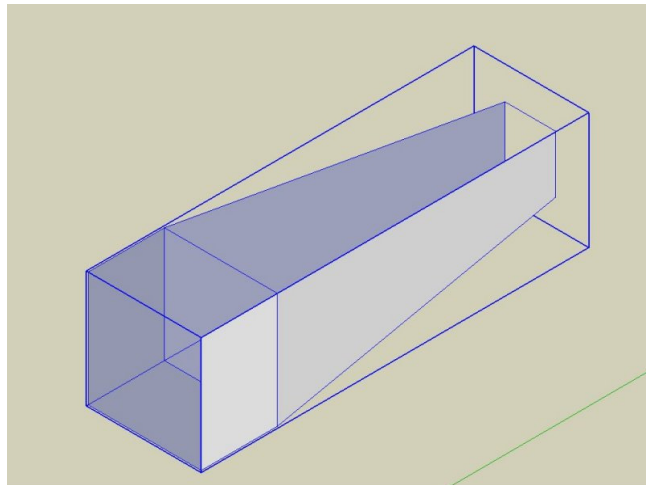
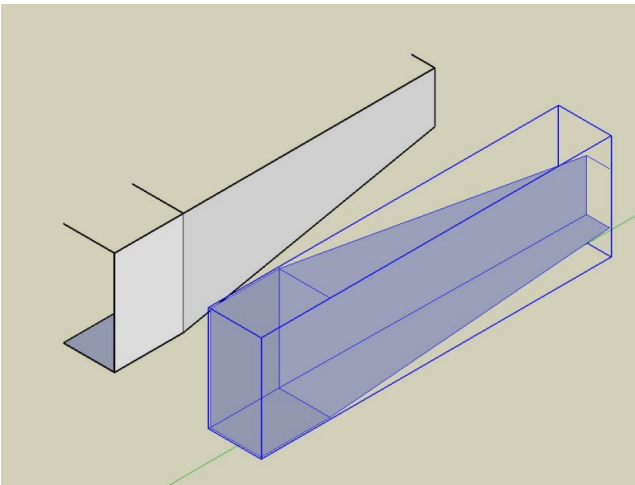
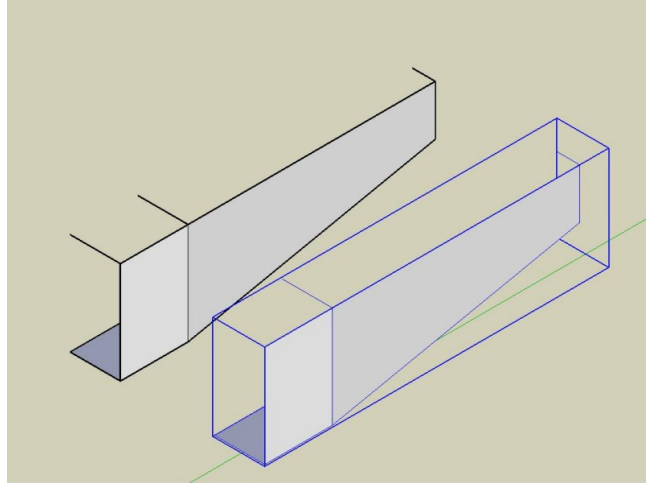
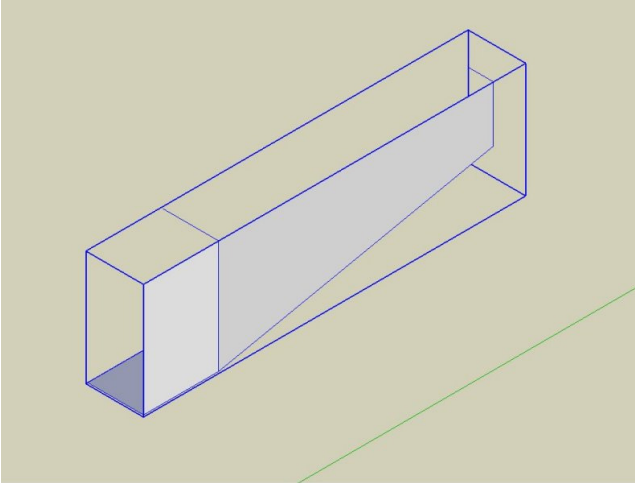
Then I hide the TopView and I move and copy the lines I drawn to score the major points on the SideView. The SideView is also aGroup so ...



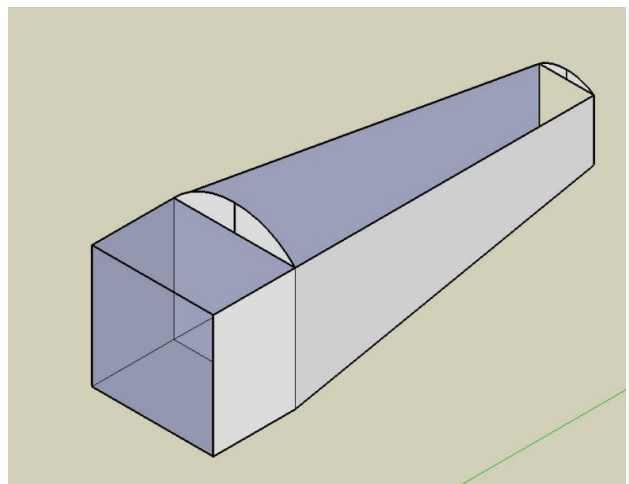
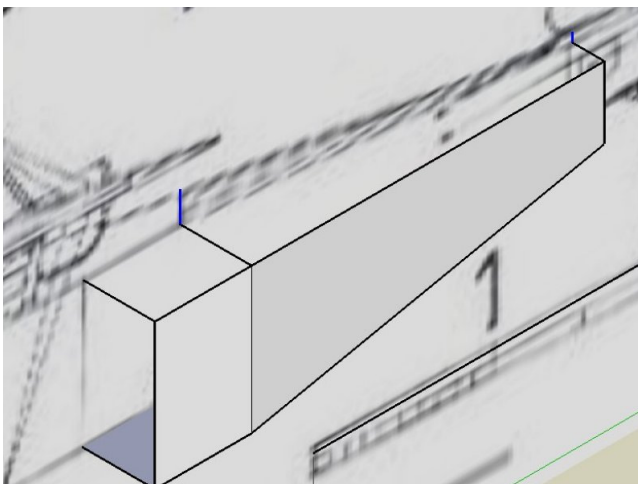
Now I can join the extremities of the lines to build the flat surface of the fuselage.



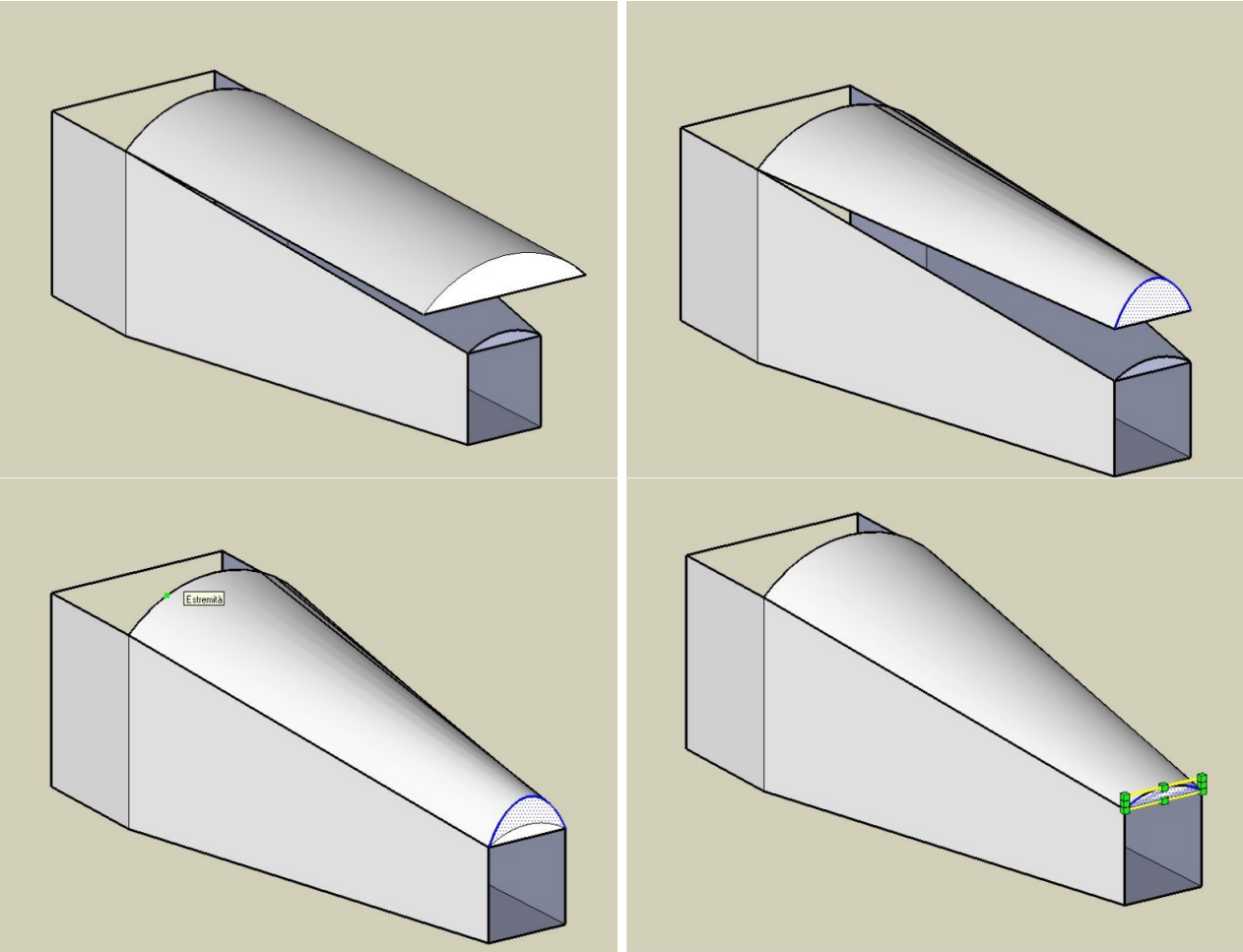
I hid the SideView and I group the lines and the surface that I drawn. Then I created a copy of the group, I mirrored it, and finally I grouped the two copies together.



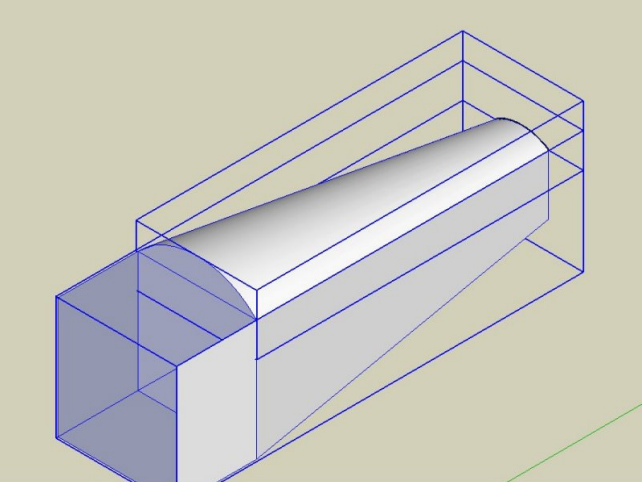
Then I draw two lines (blue) to score the height of the upper curved surface of the fuselage on the SideView, and I used those lines to draw two arcs.



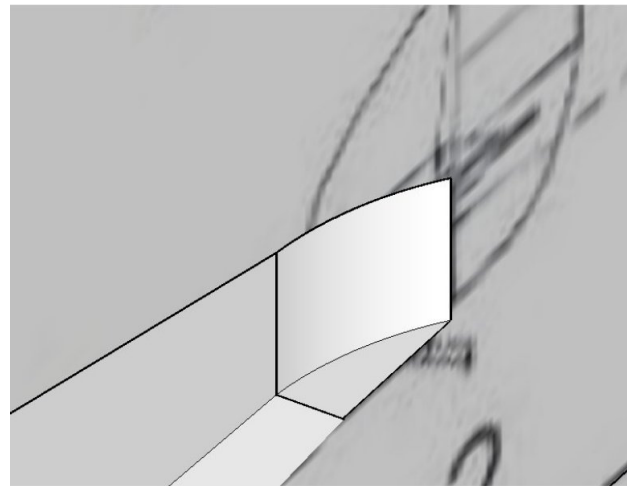
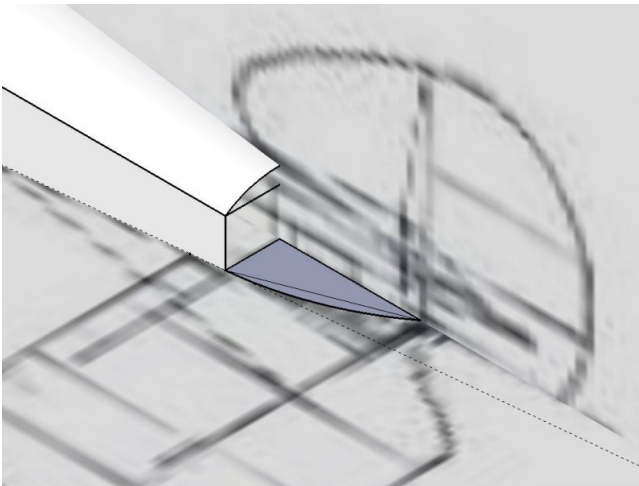
Then I used the "Push/Pull" tool onto major arc to create the upper surface as a solid. Next I used the "Scale" tool to fit the width, then the "Move" tool to fold the small extremity, and the "Scale" again to reduce the height of the arc. Use the inference!



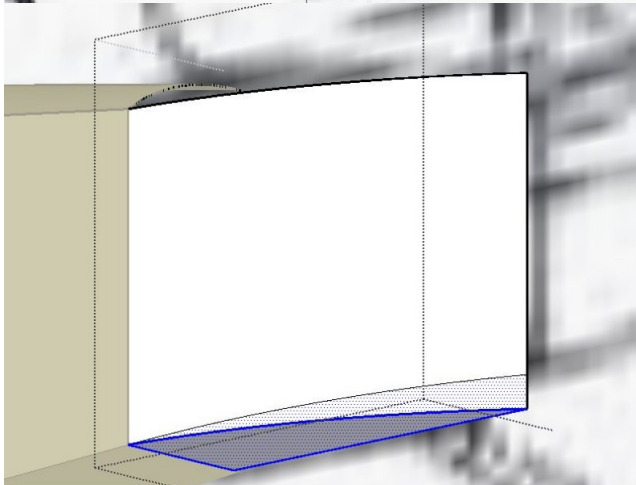
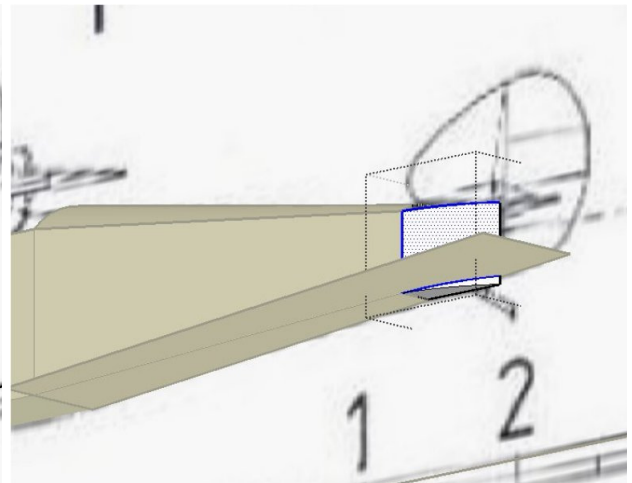
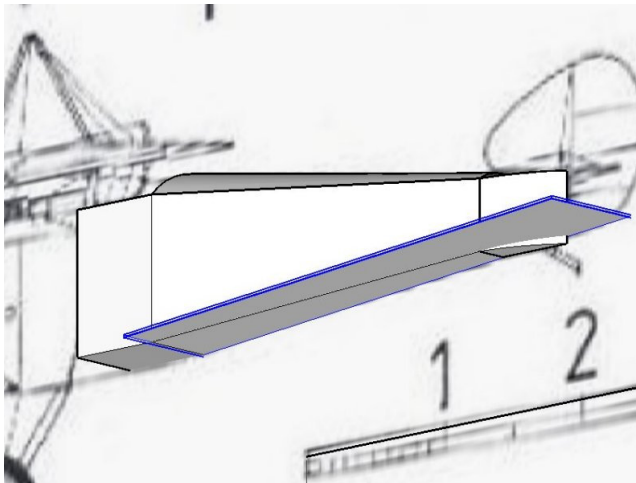
Now I can clean the surface from the useless elements and create a group.



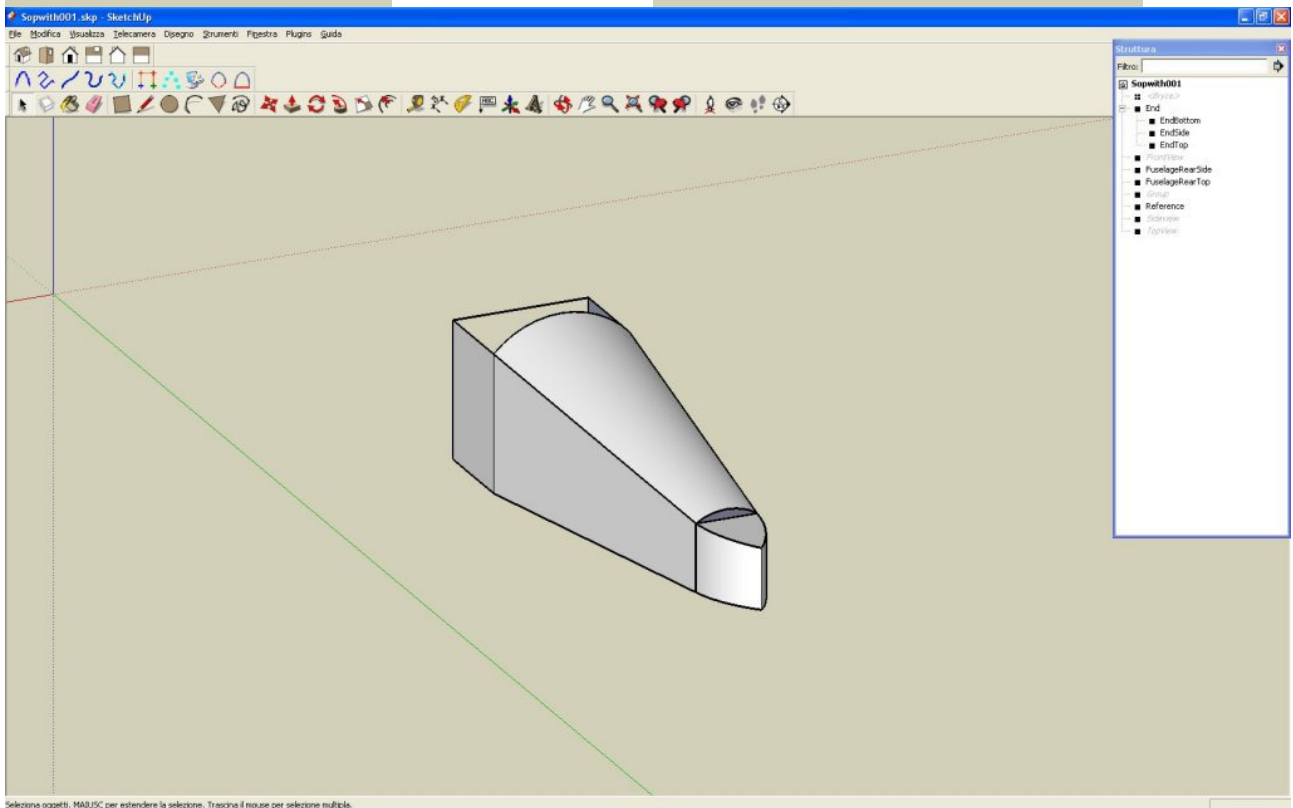
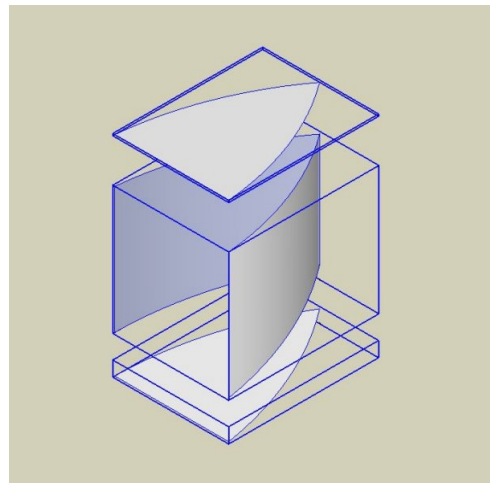
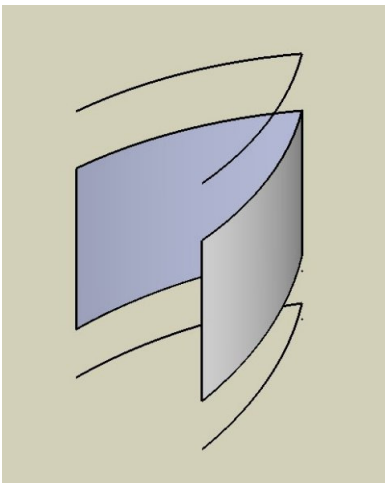
The final part of the fuselage allows us to show how to trim a part.
First I draw the shape (the half) on the TopView and then I pulled and grouped it.



Now I drawn a rectangle, I grouped it, I rotated It against the lower surface of the fuselage.
Now I can modify the group of the end of the fuselage, intersecting it with the model. So we can delete the lower part of the shape (the selected one).



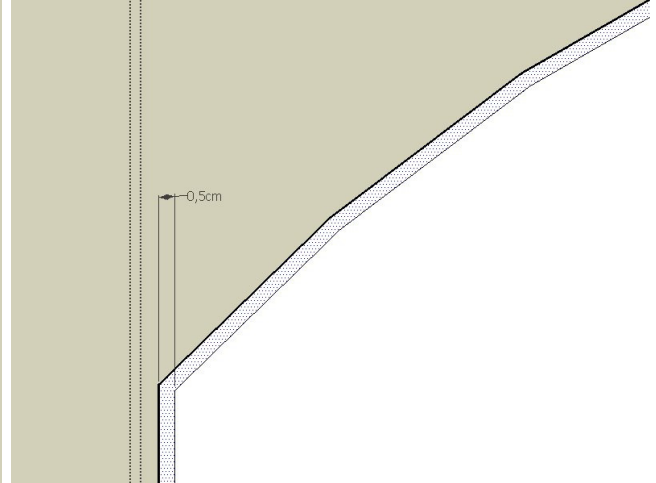
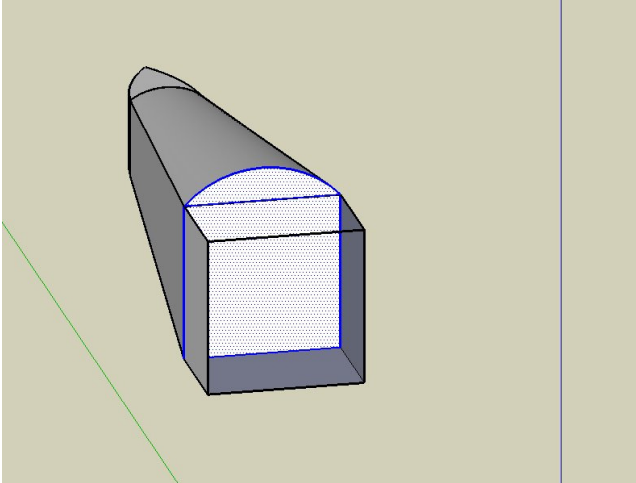
I exploded the group and copied the upper and lower edges, and I used those lines to make the upper and lower surface. I grouped the single surfaces and all together. At last the fuselage completed.



Bulkheads

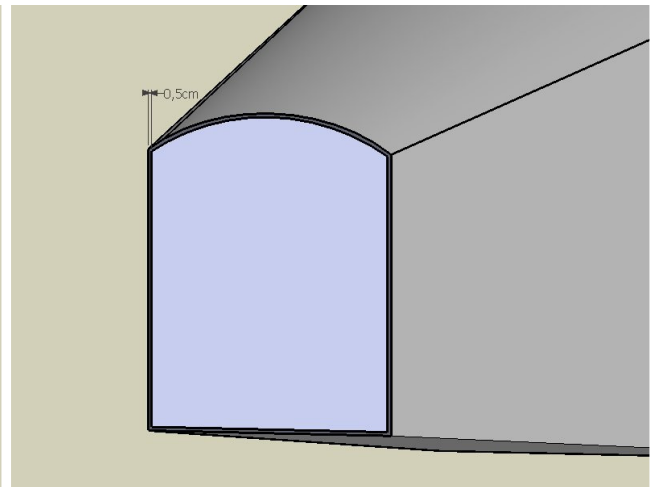
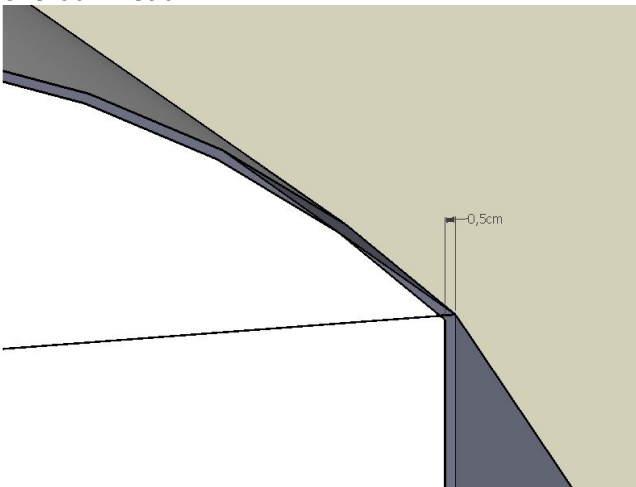
When the general geometry of the fuselage is completed, I go to design the bulkheads. I draw the first bulkhead into the fuselage group, drawing one rectangle and one arc, then I select and group both.

Now I have to modify the bulkhead I just created, deleting the useless lines and shrinking the general dimensions to fit the bulkhead with the thickness of the paper. To do so I use the “offset” tool and I set the distance at 0,5 cm



Then I deleted the external border of the bulkhead. Now I created a gap between the fuselage and the bulkhead.

The same for the other bulkhead.



Pepakura

Pepakura is a wonderful tool to unfold and to organize the parts of your model. As You can see at the Tamasoft site: “Pepakura Designer allows you to easily create papercraft models from 3D data you create from your favorite 3D software.”

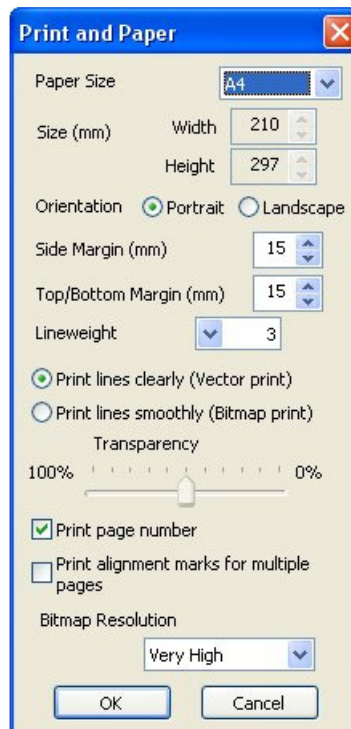
WARNING: pay attention at the version of Sketchup. The current version of Pepakura Designer (v. 3.0.7a) is compatible only till the version 7.0 of Sketchup, the current version is 7.1 and the previous free one is available in other sites other then Google.

Step 1: Export from Sketchup the 3D model in the .KMZ format (Google Earth).

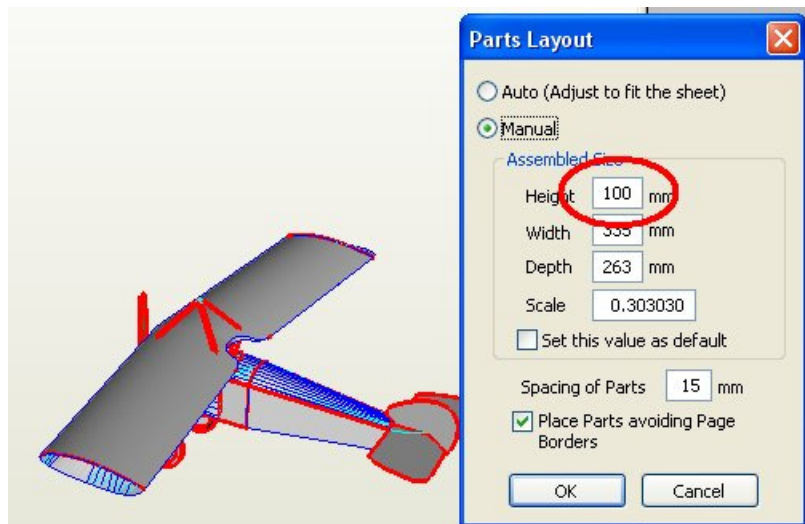
Step 2: Open the exported file with Pepakura Designer

Step 3: Settings

set the “Other settings” like this

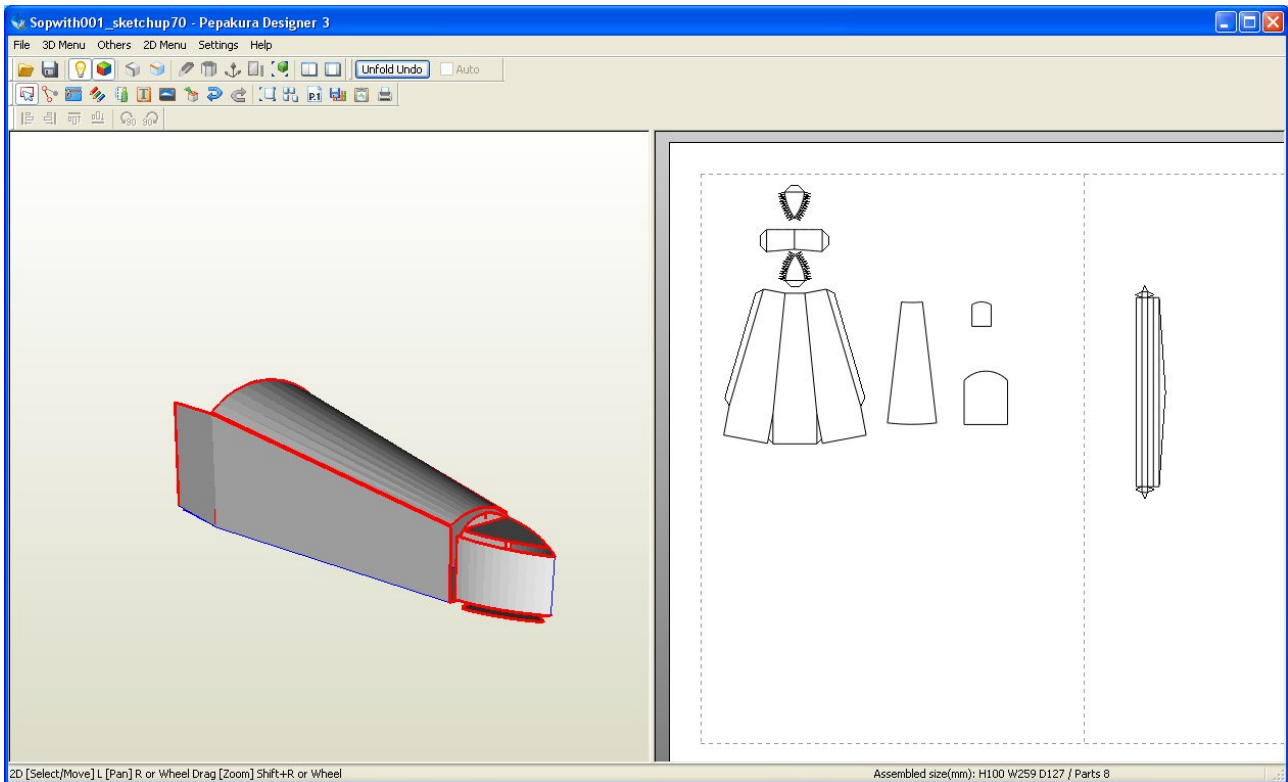


Set the Unfold options like this



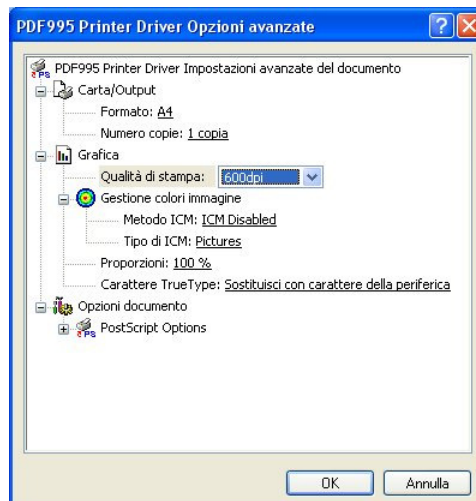
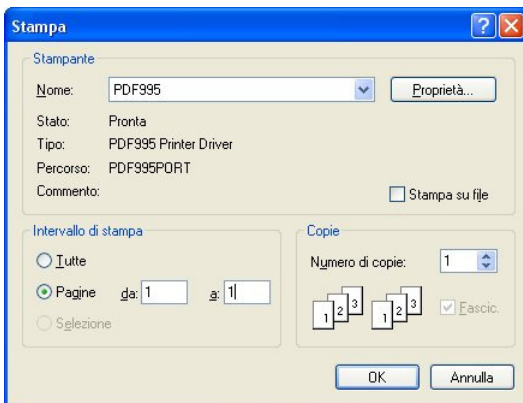
Step 4: Unfold

I unfolded the model. I set the Flap's Height to 3 mm, I arranged the parts editing flaps, joining and disjoining rotating and moving the faces, to obtain an acceptable layout, and I put the unfolded reference pillar in the second page. This is the result.



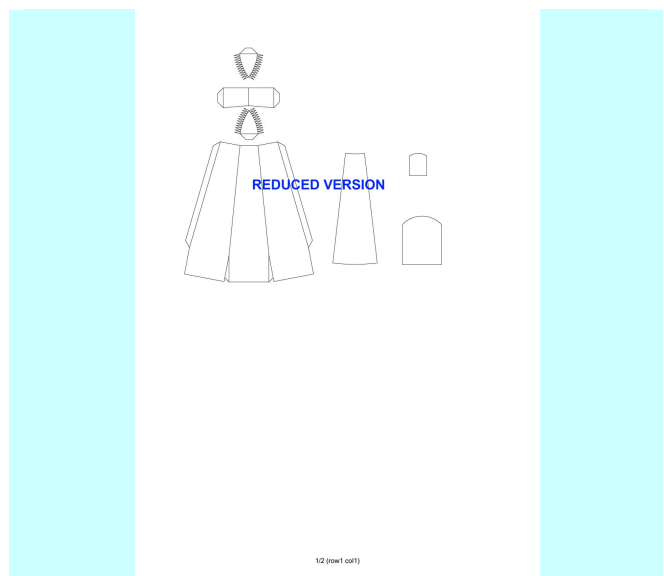
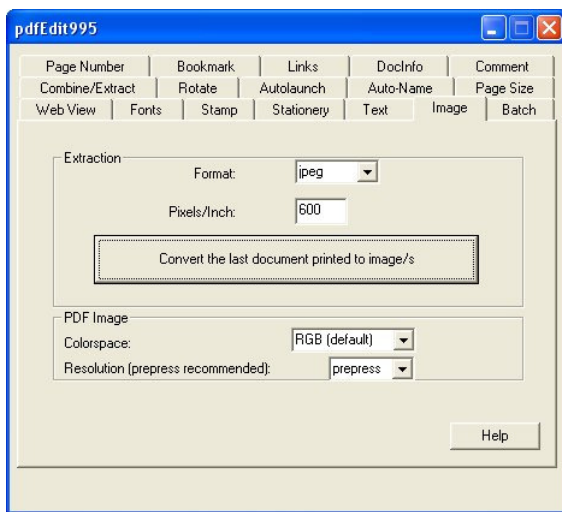
Step 5: Print/Export

Now I can print directly the first page only, and try to build to verify the fitting. Otherwise I can print using PDF995 virtual printer to obtain a .pdf file. Those are the settings



And then I can convert the .pdf file in an image file using PDFEDIT995 software, by setting the Pixel/inch value at 600, to be conform with the value that I before set in PDF995.

So I obtain an editable image file like this:



Texture and Color

There are two ways to texture and to color a model, at least from what I know:

- design the model and apply color and texture on it, then unfold and correct details on parts
- design the model, unfold and then apply textures and colors on the parts

I chose the first mainly because i didn't find a viable way to use vectored graphic and because i liked to obtain a preview of the completed model directly in Sketchup.

The ways to apply colors and textures in Sketchup that I used are:

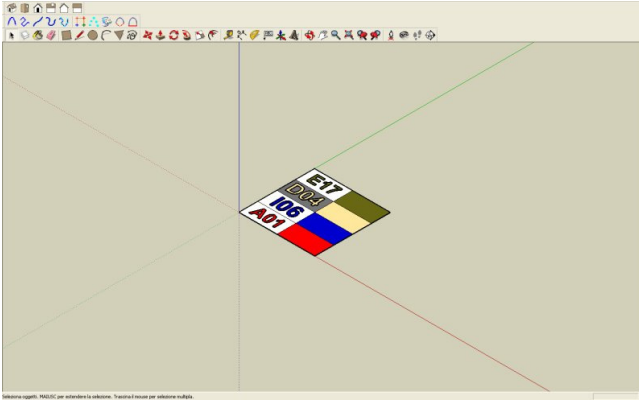
- apply materials/texture directly on the surfaces
- use the "stamp" method

Materials

It's the simplest way to colorize a surface, using the "paint bucket" tool.

Since I have chosen to decompose the model in subprojects, I had had the problem of use the same color / material into each subproject.

I solved the problem, creating an independent component that I imported in each subproject as a palette. Below an image of this palette.



When I need to colorize some surface, I can use the "paint bucket" with the Alt-Key depressed (eye dropper) to select the color / material that I want, and then I can use the color with the same tool (Alt-Key released) on the selected surface.

Texture

With the previous method I can colorize the surfaces but I cannot put on those any particular. There are two types of surfaces on this model: the round and flat one.

In particular I had the problem to texture the cylinders of the engine. To do it I used a method I found in the tutorial 3D Gallery ([How to wrap a texture around a cylinder](#)).

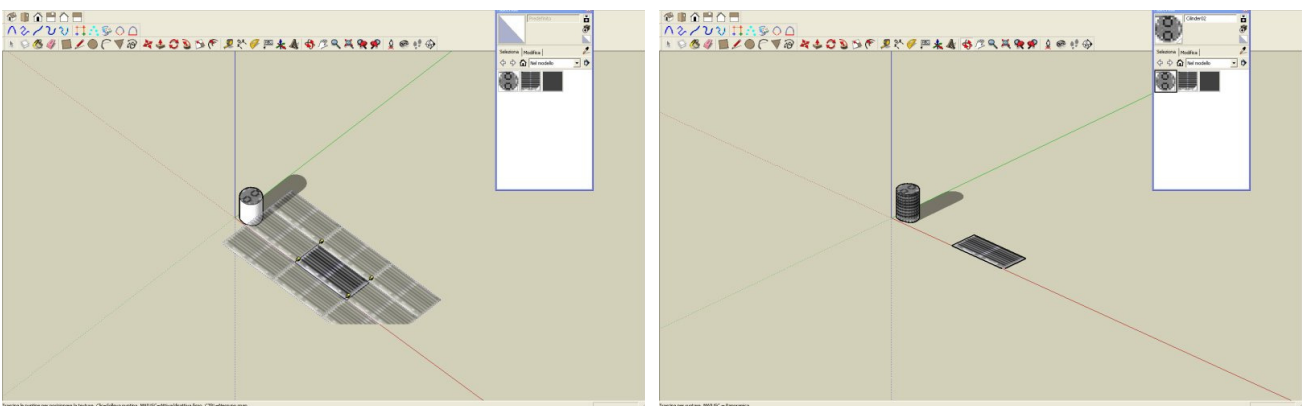
Following the instructions I did a pair of images for the round and top surface of the cylinder.



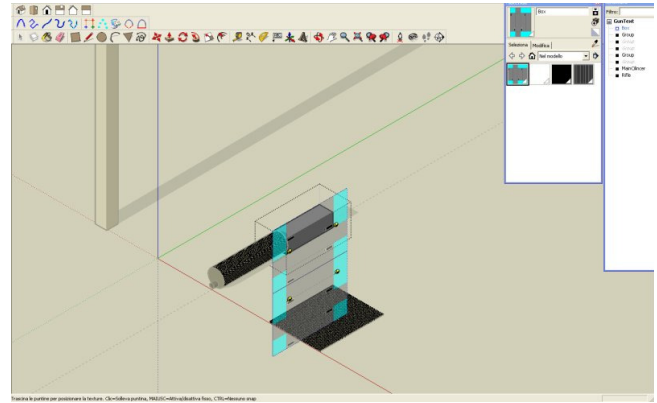
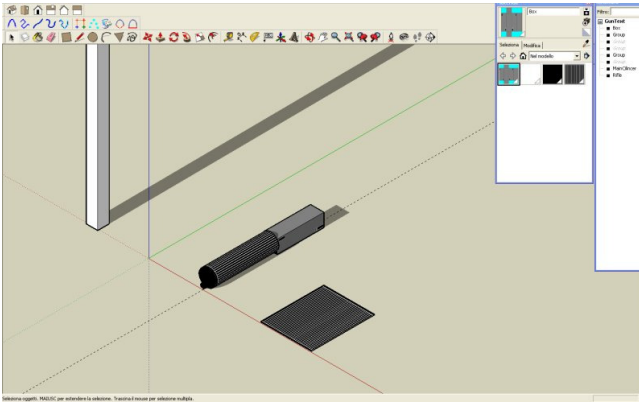
Then I imported the images in the Sketchup file of the cylinder. Those are the following steps:

- 1) create a face with the exact size of the surface of our cylinder
- 2) Import the image as texture and carefully apply it on the face by scaling it to totally fit.
- 3) right click on the face and go to Texture > Position. All sorts of positioning pins appear, but don't touch them just hit Enter (or right click > Done).
- 4) Choose the Paint bucket tool and press Alt (it will turn into an eye dropper tool).
- 5) Sample the positioned texture from the face and release the Alt button
- 6) Apply the positioned and now sampled texture on the cylinder.

The image of the top of the cylinder can be imported as texture and applied on the top surface, well positioning her.



The same I did with the guns, round and square part.



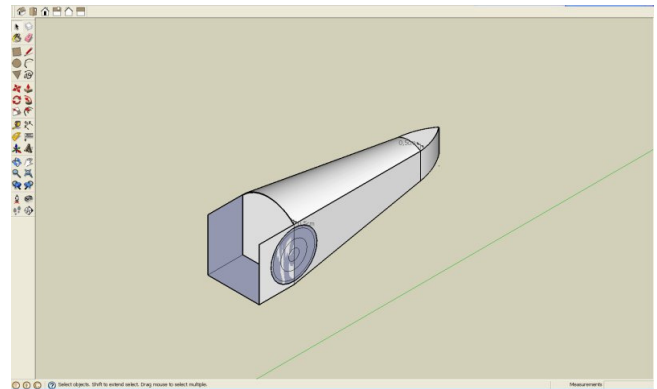
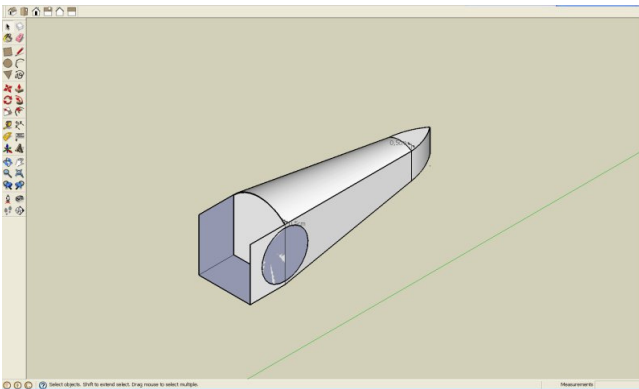
Stamps

This way I did all marks on the model, making the most of the intersection of a group with the model in SketchUp.

You can find some hint in this tutorial that I found (Stampers Tutorial), but I can show to you how I did the national marks on the fuselage.

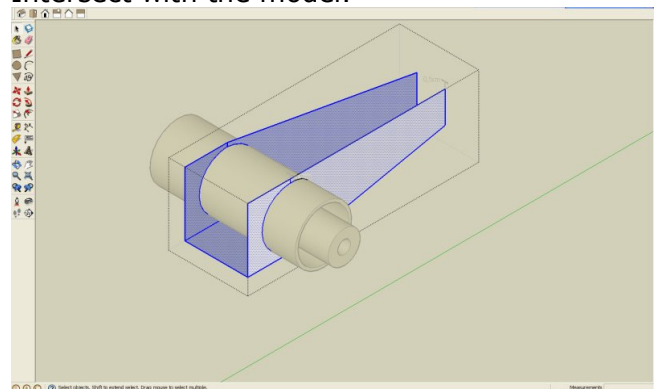
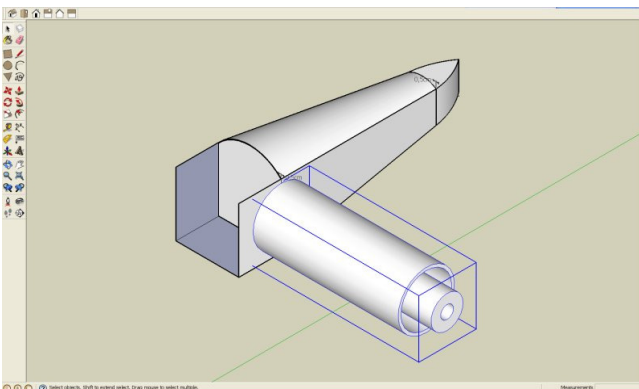
I start drawing a circle on the fuselage.

Then, using the "Offset" tool, I draw other circles inside the first.



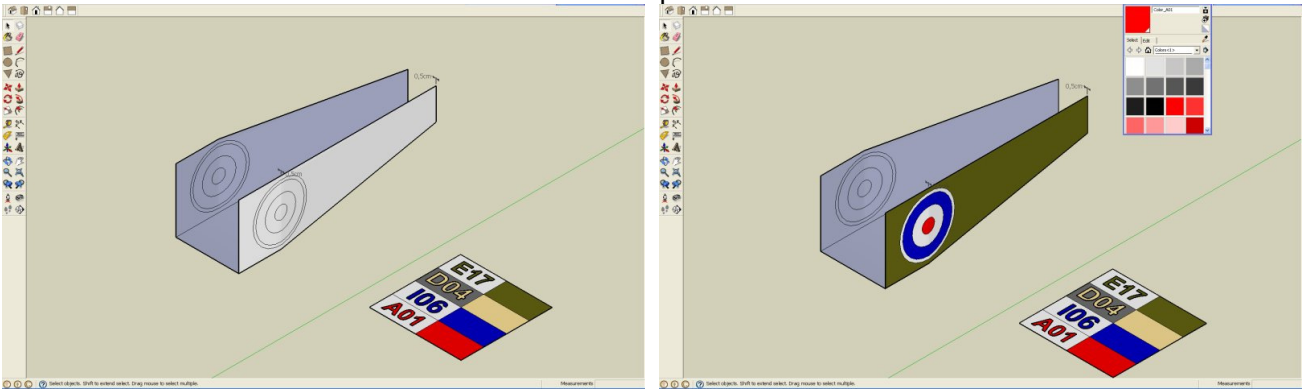
I delete the useless surfaces and using the "Push/Pull" tool, I create the "Stamps" that I need and I make a group, as usual.

Now I hide the components that aren't interested by the national marks, and I push the "Stamp" group into the fuselage. Finally I select the Fuselage group and Intersect with the model.



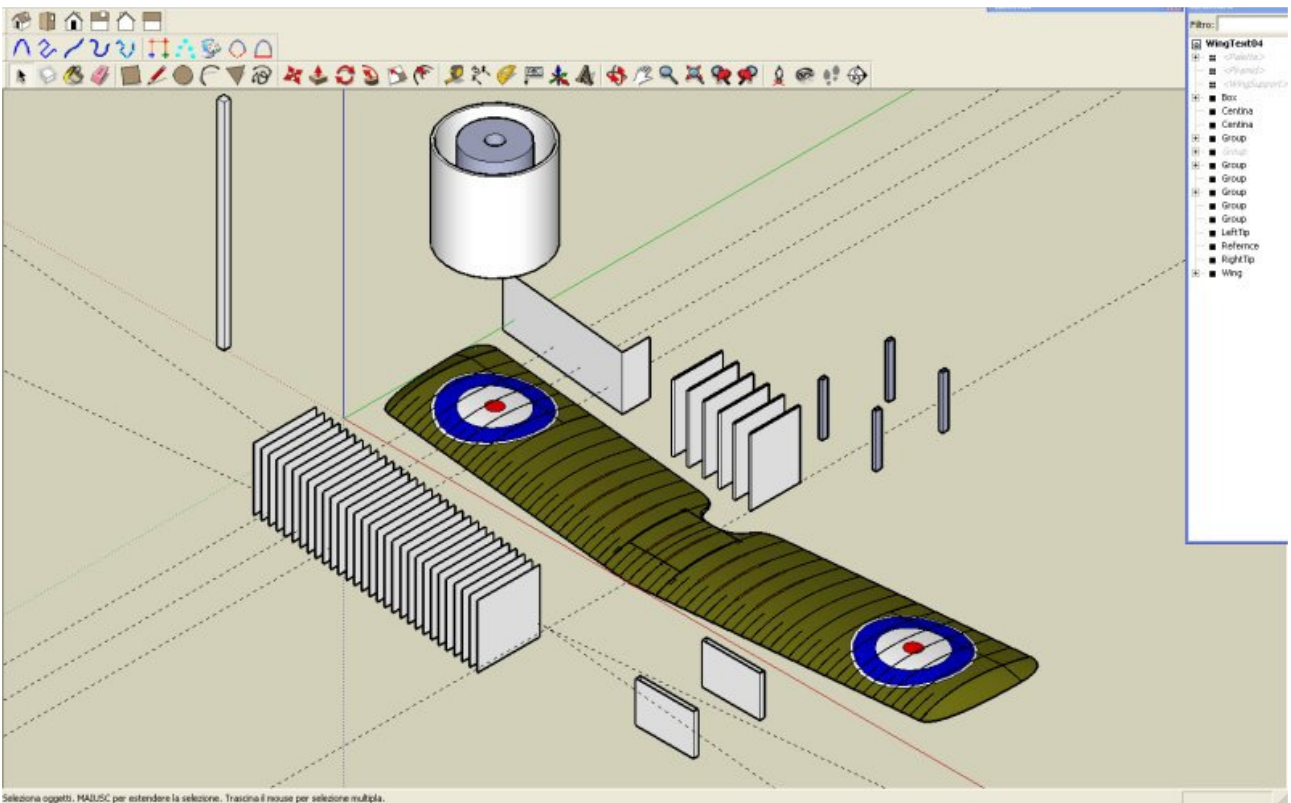
I closed the group, I Hided the "Stamp", and I imported the "palette" component.

Finally I modified the "Fuselage" group, and I used the Palette's Colors on the model. This way I did all the marks and the particulars of the model.



This way I did all the marks and the particulars of the model.

Here eg, the stamps that I used on the wings.



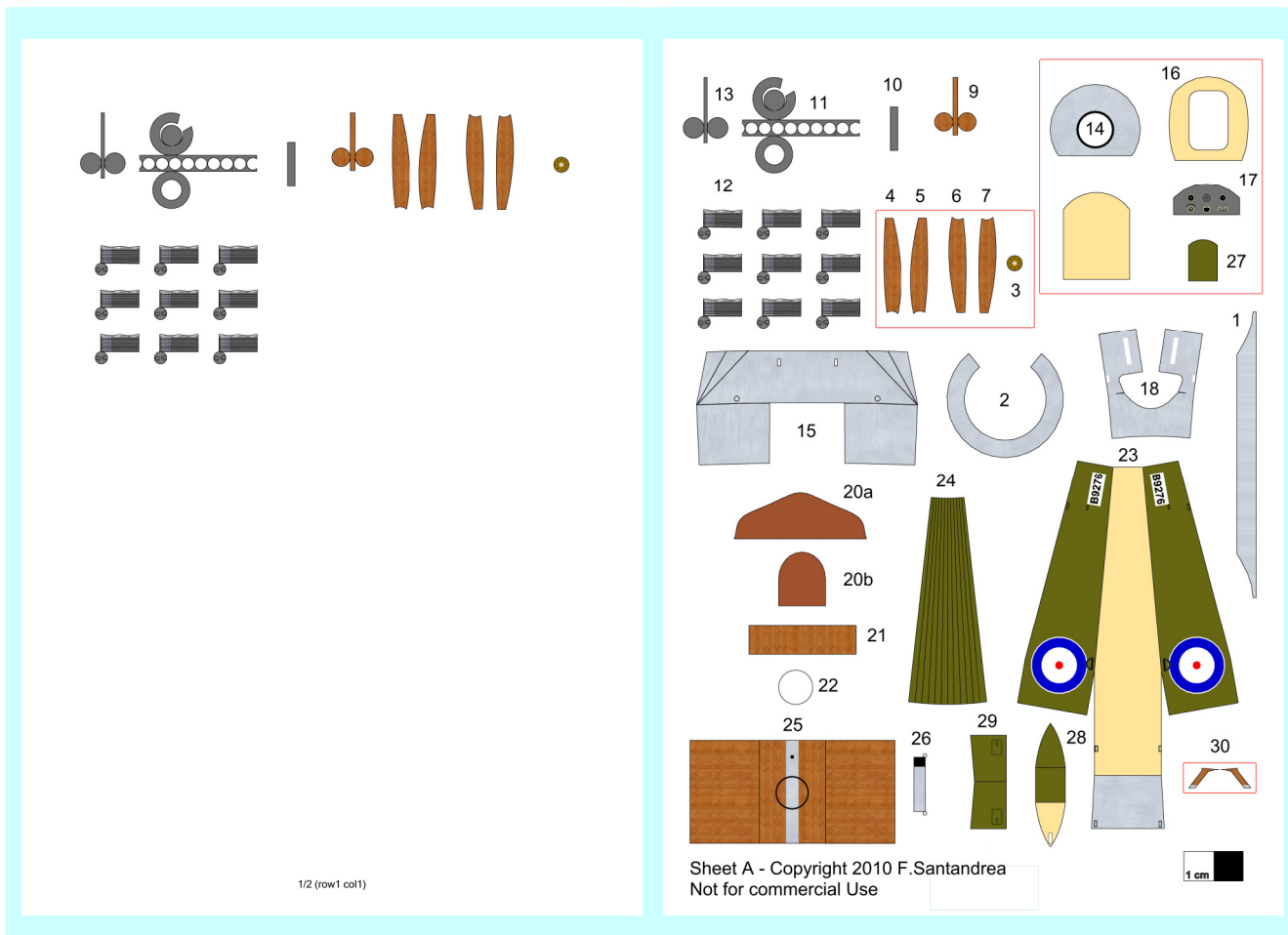
Paint.net

I recall the process summary that I described above, just to underline that now we are between the 6th and 8th step:

1. design the general geometry
2. Define the Groups and Components
3. Work on the subprojects for refine and for engineer the geometry
4. test to unfold the single component, if necessary return at the previous step (3.)
5. test build the unfolded component, if necessary return at refining the project (3.)
- 6. apply a texture and colorize the component**
7. unfold and build the component
- 8. put the unfolded component in the general model sheet**
9. return to work at next subproject until the model will be complete (3.)

I chosen to colorize and to detail the model using Sketchup, but we can choose to detail and colorize the model using a graphic editor like Paint.net. Anyway we have to arrange the single parts in few sheets, and we have to correct and refine what you obtain from Sketchup and Pepakura, like the lines over the round upper surface of the fuselage.

What we have at the end of the process is a collection of graphical files (typically .jpg), each one containing the parts that make up each component. Now we can put each component together the others, and arrange them following the logic of the proximity, or the logic of the material they are made (paper or cardboard).



We can put some title some note and we can associate a number to each part for to refer to them in the instructions.

It is useful in Paint.net to use the level, adding to the file a level each time you add a component with its parts. In this manner You can arrange the new parts so they not interfere with the original ones. When You end to work the parts, You can join the levels and save the file in .jpg format.

When you save the file, you have to choose the 100% quality of the JPG files, and finally the file has to have those properties:

- 4960 x 7017 Pixels
- 51,67 x 73,09 Inches (21,00 x 29,71 cm)
- 600 Pixel per Inch

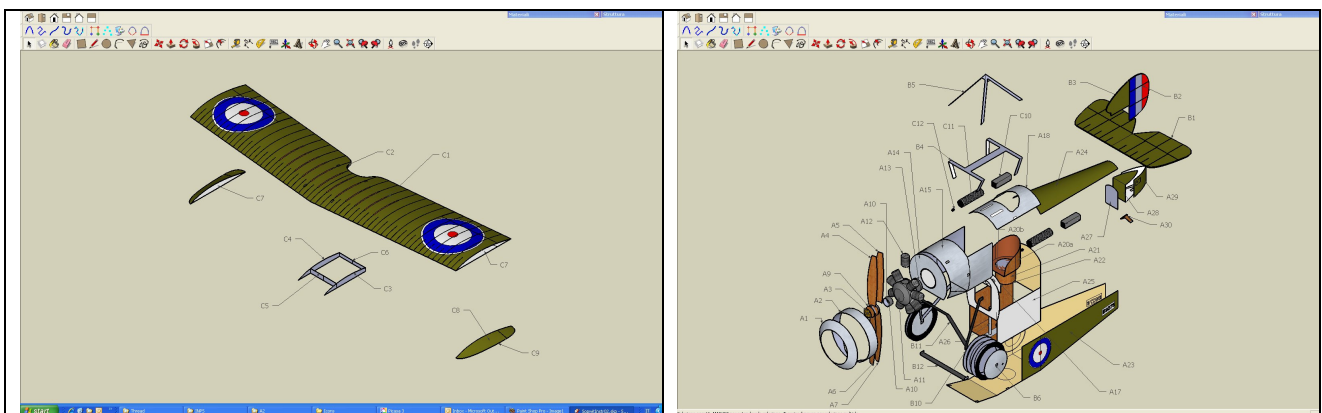
I used Google PICASA (crop to fit, no border no caption, Printer PDF995, 600 dpi) to print with PDF995 each file jpg, with the same setting I used when I printed in Pepakura. In this manner I obtain a pdf file in A4 format that I can combine with the others that I need, using the "combine/extract" function of PDFEDIT995 software.

Cover & Instructions

For the cover You can choose what do you want, but I suggest to put some historical information and the general notes about the way the model was conceived and the instructions applicable in general to the model.

I could choose to make the instructions writing a text that could explain the steps you have to follow to assemble the model, but my English is not so fluent.

I could choose to illustrate by pictures the process of building my model, as I did with others. But I decided to use Sketchup to depict the parts that compose the model in an "exploded" view, with labels indicating for each one the sheet where we can find it (the literal prefix) and number that identify it.



The sequence of the sheets and into each sheet the numerical sequence of the parts could guide through the process of building the model.

That's all folks! I hope You enjoy building my model and if someone could try to design his own, following my steps, I think that it was worth the effort.

The model is available for free at [The Lower Hudson Valley Paper Model E-Gift Shop](#).