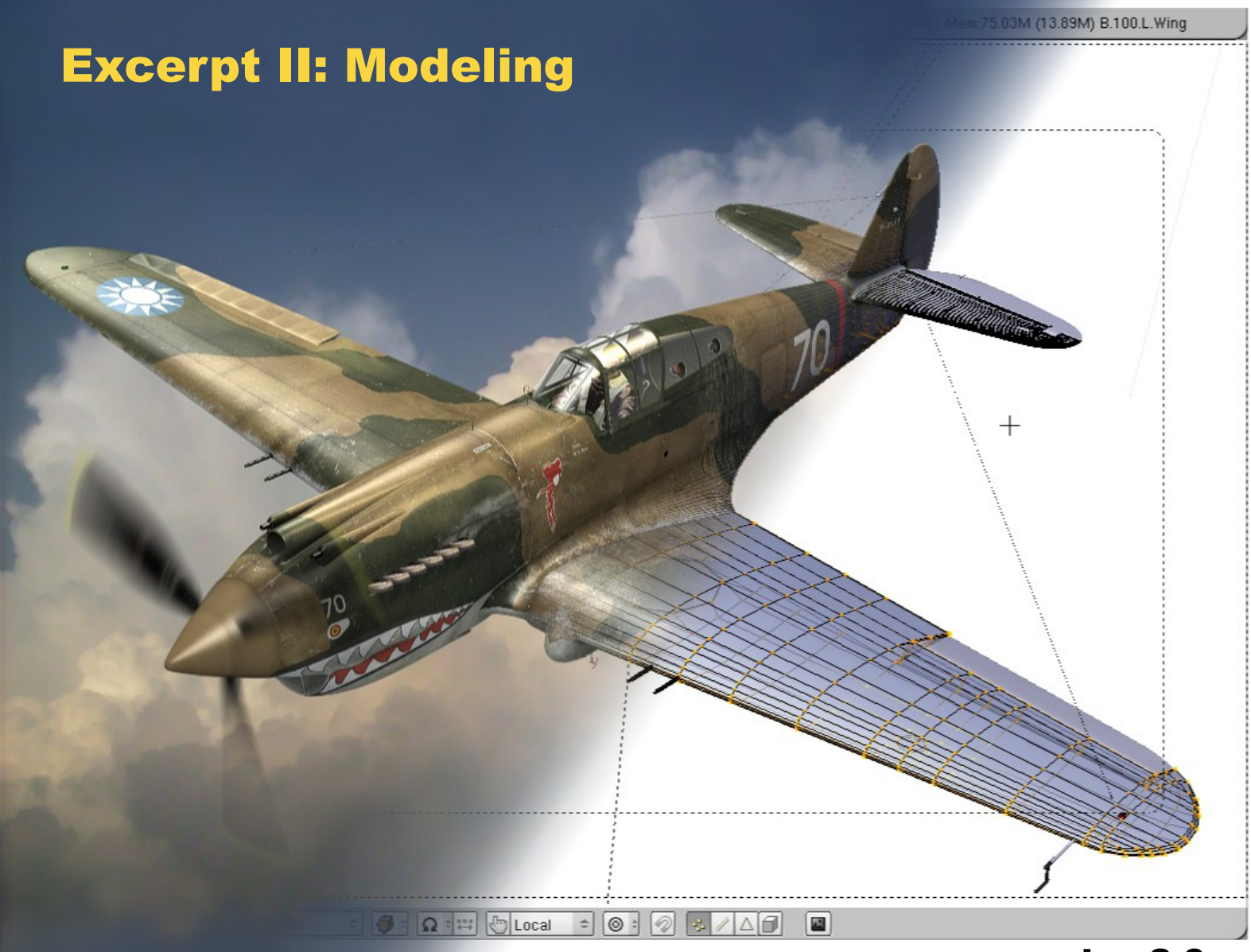
Witold Jaworski

Virtual Airplane

Create realistic aircraft models using free software: Blender, GIMP, and Inkscape

Excerpt II: Modeling



version 2.0

Virtual Airplane

To my wife
for her forbearance

Witold Jaworski



Virtual Airplane

Create realistic aircraft models using free software: Blender, GIMP, and Inkscape

version 2.0

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The picture on the previous page:
A pair of P-40B's, from 47th USAAC Pursuit Squadron, which managed to take off to fight the Japanese raid on Pearl Harbor, on 7th December, 1941. They were piloted by Kenneth Taylor (the aircraft with the tactical number "316"), and George Welch ("160").
At that time 47th PS was practicing gunnery at Haleiwa, a secluded field on the North East corner of Oahu Island. This area was not attacked by the Japanese (Pearl Harbour lies on the opposite side of the Island). The runway ran along the sea coast. This is how the fighters could have appeared, shortly after take off. The background, obtained from www.hawaii.gov , shows an authentic part of the shore near Haleiwa.

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Why I have written this book?

Because I always wanted to create a detailed model of an airplane on the computer. When I finally did it — it proved to be a great fun! So I decided to share this experience with others.

A long time ago I was an ordinary modeler, making scale aircraft models. It's a rather special hobby. We work hard for many months on our projects. We try to engrave on a small model tiny rivets, skin panels, and fine details of the cockpit instruments. I think that for an external observer, anglers spend their time in similarly monotonous, but less tiring way. What's more, instead of creating nice, shiny miniatures, we apply to their surfaces (horror of horrors!) trails of dirt and abrasion, to create the impression of an intensive usage. We blemish them to look like real, worn, and in some places rusted, machines. All our reward is to show our works to someone who can appreciate their finesse (we have such an occasion, from time to time). Strangely enough these evaluators are usually the other modelers. Maybe it is just a pretext for the opportunity to discuss on such esoteric topics as the superiority of the Spitfire IX over the FW 190 A4? Or the hot issue, how was the P-40K from 23rd FG painted, in which Witold Urbanowicz flew his combat missions over China in 1943?

I would like to offer fellow modelers entirely new materials and tools. Instead of your own desk, sometimes covered with the spots of the airbrush splashes — a window to another world, in the depths of the computer screen.

In this virtual world you will find very elastic material that can be extruded into any shape. What's more — you will never run out of it! There are paints, for which you can precisely set the colors, shininess, and other properties. It is possible to achieve accuracy there that you cannot get anywhere else, neither in 1:24 nor in the 1:18 scale. When you find out that the engine cowling of your old model should have a different shape, you can always correct this error. You can update it many times! Dust will not cover your computer models. You will never hear complaints from your family that there is no place for your growing collection. You can also create many variants of your airplane (each of them in a different camouflage, for example). Your models can be sent to other hobbyists like yourself, without fear that something will happen to them during transport. You can also quickly build up a whole scene, using your planes.

The only thing you have to get used to, is that you cannot touch anything there. You can only look and select objects with the mouse. At least at the present stage of the technology development, so called haptic devices are still expensive and primitive. There is no chance that they will be available soon at the store around the corner, or on the Internet, at affordable prices. As a consolation, I can say that current versions of these devices allow you to touch everything with just one point — the tip of their "pen".

This world of virtual modeling sneaked into reality in the middle of the past decade. In fact, every computer produced after 2005 is a fully equipped graphics workstation. (You could only dream about such a computing power in the previous century). In 1997 a new mathematical model for surface modeling entered on the scene. They call it “subdivision surfaces” (or, shorter: “SubD”). This technology allowed the first computer animation studios (like Pixar) to create Shrek and dozens other cartoon characters. In the future, subdivision surfaces may replace the older NURBS solution in CAD/CAM systems. Using the SubD you can create a very complex shapes (like a whole dinosaur, or complete engine block, for example). What's more, their mathematical model copes well with holes and cutouts. (Such features are not “natural” for the NURBS surfaces. The NURBS-based CAD/CAM systems still have troubles with special cases of fillets and holes. They were the programmer's nightmare).

What's more, software which uses all these technologies became available for free! It has been created by hundreds of Open Source programmers. These people want to show that they can be at least as good as their best commercial counterparts, and they have begun to achieve it! The reason may lie in the pure intellectual challenge ("I'll do it better!"), and a different pace of coding in such volunteer projects. There is no rush, in this work. On the other hand, the tight schedules are always present in the typical commercial enterprises. These deadlines are primary cause of many errors. In effect, a large enough group of enthusiasts (in Open Source world they often call it "the critical mass") can create a good, stable program.

To sum up — buying an ordinary computer for games, you have bought everything you need to enter the new world of virtual modeling. I will not cheat you: one inherent thing in the work of every modeler is still present here. Creation of an accurate computer model requires several weeks of hard effort. However, I wrote this book to help you, dear Reader, to quickly reach the desired results. Then you can go ahead and do the same thing even better, than I suggest here. Reading the next pages will save you a lot of time, and — sometimes — plenty of frustration. The latter is usually an integral component of work with "this stupid machine": the computer. I will try not to bore, and to show many pictures. I hope that you will find "Virtual Airplane" interesting.

Witold Jaworski

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What this book covers?

“Virtual Airplane” teaches how to create the model, shown on the cover page. To provide the Readers updated fragments of the book as early as possible, I decided to publish extracts from the main text, associated with the subsequent phases of the work. They are: “Excerpt I: Preparations”, “Excerpt II: Modeling”, “Excerpt III: Materials and Textures” and “Excerpt IV: Detailing and Rendering”. As the exemplary airplane I chose for this book the Curtiss P-40B fighter. This machine contains typical solutions used in most aircraft of this period. I chose it because I do not want to deprive you the pleasure of building models of such famous airplanes as the Spitfire, Mustang, Thunderbolt, Focke-Wulf, nor the Messerschmitt!

- You can use methods presented in this book to create any model of the Second World War fighter[1]. It does not have to be the P-40, because all of these airplanes had similar design. In the course of this work you will encounter most of the problems that are described and solved here.

This book is intended for those, who are just beginning their adventure in "3D", as well as for those, who have already some experience on this field. Therefore, I decided to divide it into two parts:

- the first part ("Making of the Model") contains the main text, which describes **what** you should do;
- the second part ("Details of Programs Usage") contains detailed descriptions of **how** to use particular software to obtain the results, shown in the first part.

The entire text of this book has many pages, with "Details of Programs Usage" occupying around 40%. The contents of that second part resembles a context help scheme. It contains plenty of short sections (one or two pages per section), containing no more than a few illustrations. Each of them describes details (keyboard shortcuts, menu commands, results) of a single operation.

Dividing the material of this book between the basic and detailed part, I tried to avoid the excess of phrases like "click here, and then push this button" in the main text. Such hints, although needed, make the narration longer and obscure. In the first part, where appropriate, I placed links to the second part of this book. If you do not know the program, which is used in the main text, just click on such link and it will take you to the detailed description of this particular operation[2]. I prepared chapters of the main text in a sequence that let you gradually learn all of these tools. Once you know **how** to do what I am describing — just stop using these shortcuts.

This book has also the third part: "Appendices". Its content may be interesting for the curious readers. These additional chapters contain a "hodgepodge" of many different articles. You can find there: descriptions of some optic phenomena (like the deformation of the image on the photograph, or the light refraction), a color theory for CG, and the description of airfoil geometry. This part also contains a review of advanced methods for blueprint verification (on the level that allows you to create an improved scale plans), and details of subdivision surfaces mathematics. All of these materials are optional, although I think that these articles may help you to understand better some issues, mentioned in the main text (“Making of the Model").

[1] Well, maybe those with the inline engines. I have not described here, how to model the externally visible components of air-cooled radial engine. All these cylinders, rods and pipes... Maybe I would take up a P-36 model, in the next edition of this book?

[2] I assume that the use of the second part will always be random. Thus most of its sections contains text without further references. This approach means that, for example, the description of the scaling in Blender's Mesh Editor is almost a verbatim copy of the description of similar operation in the Object Editor. They differ only in the illustrations and a few sentences. I just do not know which of these topics you will open as the first, so each of them provides all the information you need.

Conventions

In the tips about the keyboard and the mouse I have assumed that you have a standard:

- US keyboard, with 102 keys (you will find in this book some comments about a non-standard laptop keyboards);
- Three-button mouse (in fact: two buttons and the wheel in the middle. When you click the mouse wheel, it acts like the third button).

Command invocation will be marked as follows:

Menu→Command means invoking a command named *Command* from a menu named *Menu*. More arrows may appear, when the menus are nested!

Panel:Button means pressing a button named *Button* in a dialog window or a panel named *Panel*. Panels are parts of Blender screen (for more explanations — see page 57). Sometimes I may also mention other dialog controls, like a checkbox or a drop-down list.

Pressing a key on the keyboard:

Alt-K the dash ("-") between characters means that both keys should be simultaneously pressed on the keyboard. In this example: while holding down the Alt key, press the K key;

G, X the coma (",") between characters means, that keys are pressed (and released!) one after another. In this example type G first, then X (as if you would type „gx").

Pressing the mouse buttons:

LMB left mouse button

RMB right mouse button

MMB middle mouse button (mouse wheel **pressed**)

MW mouse wheel (when it is **scrolled**)

Last, but not least — the formal question: how should I address you? Typically the impersonal form ("something is done") is used in most manuals. I think that it makes the text less comprehensible. To keep this book as readable as possible, I address the Reader in the second person ("do it"). Sometimes I also use the first person ("I've done it", "we did it"). It is easier for me to describe my methods of work in this way[1].

[1] While working on this model I thought about us — you, dear Reader, and me, writing these words — as a single team. Maybe an imaginary one, but somehow true. At least, writing this book I knew that I had to properly explain you every topic, with all details!

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How to read this book?

This guide is an electronic publication. To make it more readable than a classic book, I moved most of the detailed instructions out of the main text, leaving there just their hypertext references. Use them for “digging into details” and then jump back to the general subject. To not “clutter” the text, these links are not distinguished neither by the color nor by underline. You can recognize them by the context (“see page …”) and the behavior of the mouse pointer. When you hover it over a link, its shape changes into the "pointing hand" (Figure 1.1.1):

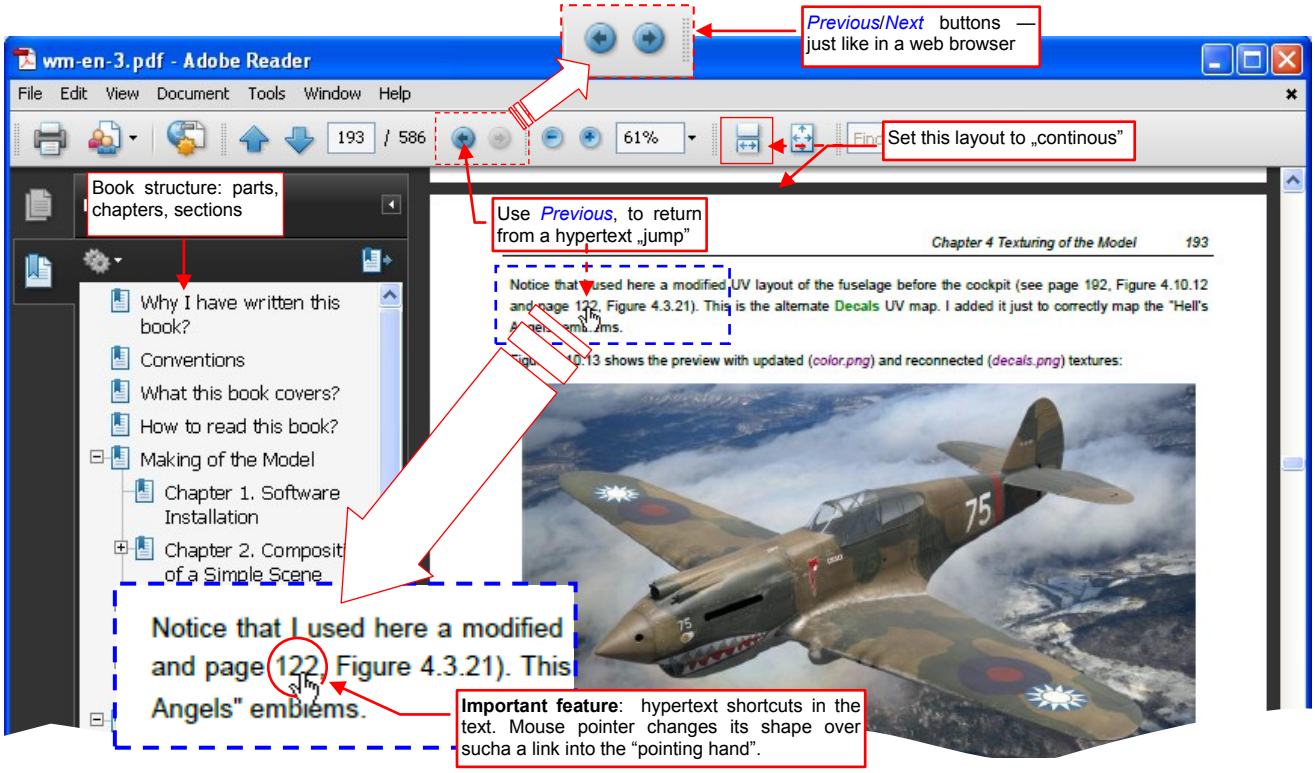


Figure 1.1.1 Reading this book in a PDF reader (Adobe Reader**)**

Click the link, to go to the referenced page. To return to the previous location, use the ***Previous*/*Next*** buttons. In Figure 1.1.1 they are located on the toolbar at the top of the screen, and work just like in the web browser. To make subsequent pages more readable in your PDF reader, you can also switch their display mode to “continuous” (Figure 1.1.1). I think that this mode is better for the online reading.

I tried to make this PDF document as portable as possible, thus I published it in so-called PDF/A format (it contains embedded fonts and color information). Be aware that the popular **Adobe Acrobat** reader by default ignores all hypertext links in such files (Figure 1.1.2):

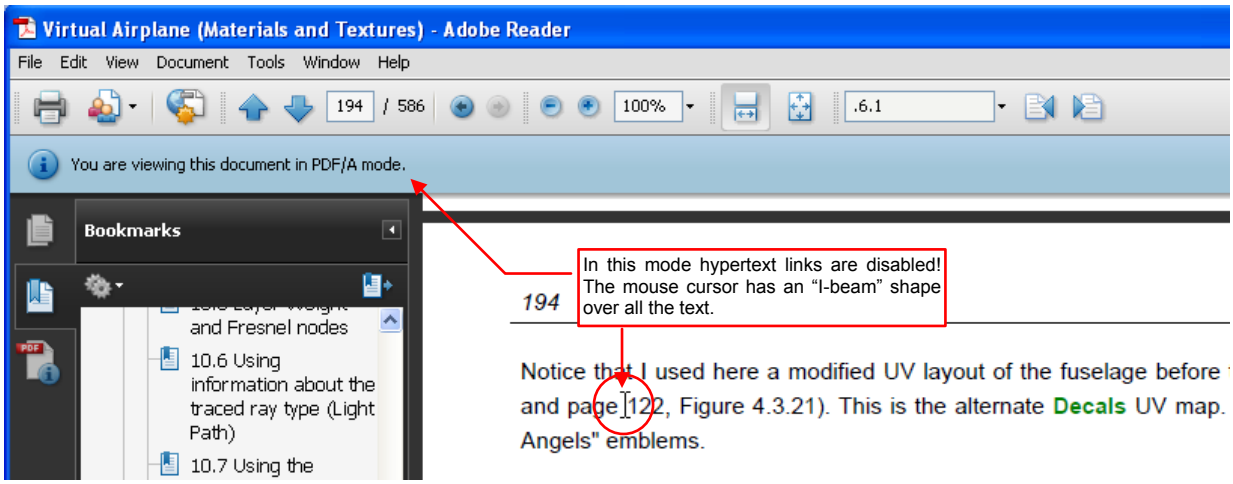


Figure 1.1.2 Inactive hyperlinks in the PDF/A mode (Adobe Acrobat**).**

To enable hypertext links in a PDF/A document, you have to change **Adobe Acrobat** *Documents* settings (Figure 1.1.5):

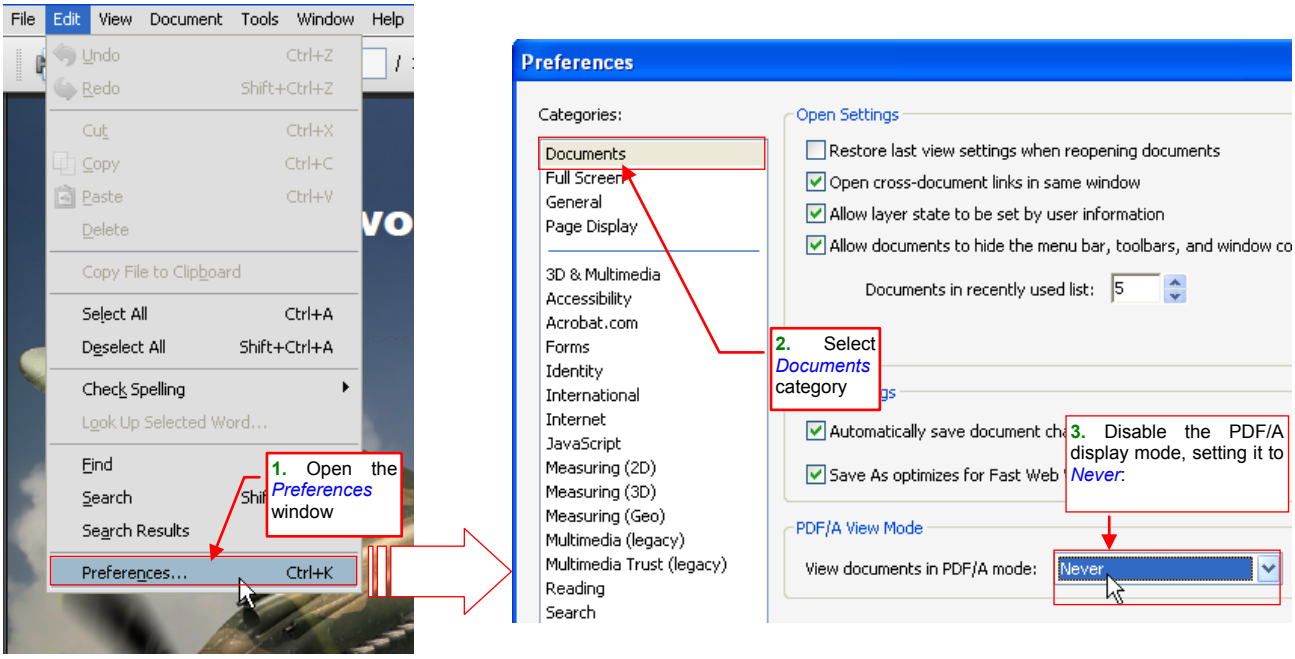


Figure 1.1.3 Enabling hypertext links for this document (Adobe Reader, version 9.0)

Open the ***Preferences*** dialog window from the ***Edit*** menu. Select ***Documents*** on the category list. This brings up appropriate controls on the right side of the window, as shown in Figure 1.1.5. Disable the *PDF/A View Mode* selecting ***Never*** from its drop-down list.

Subsequent versions of **Adobe Acrobat** differ from each other. For example their toolbar may appear at the bottom the screen (as it happened to the version 8.0). What's more, the *Previous*/*Next* buttons, useful during the hypertext "jumps", may be absent in the default configuration of this program (Figure 1.1.4):

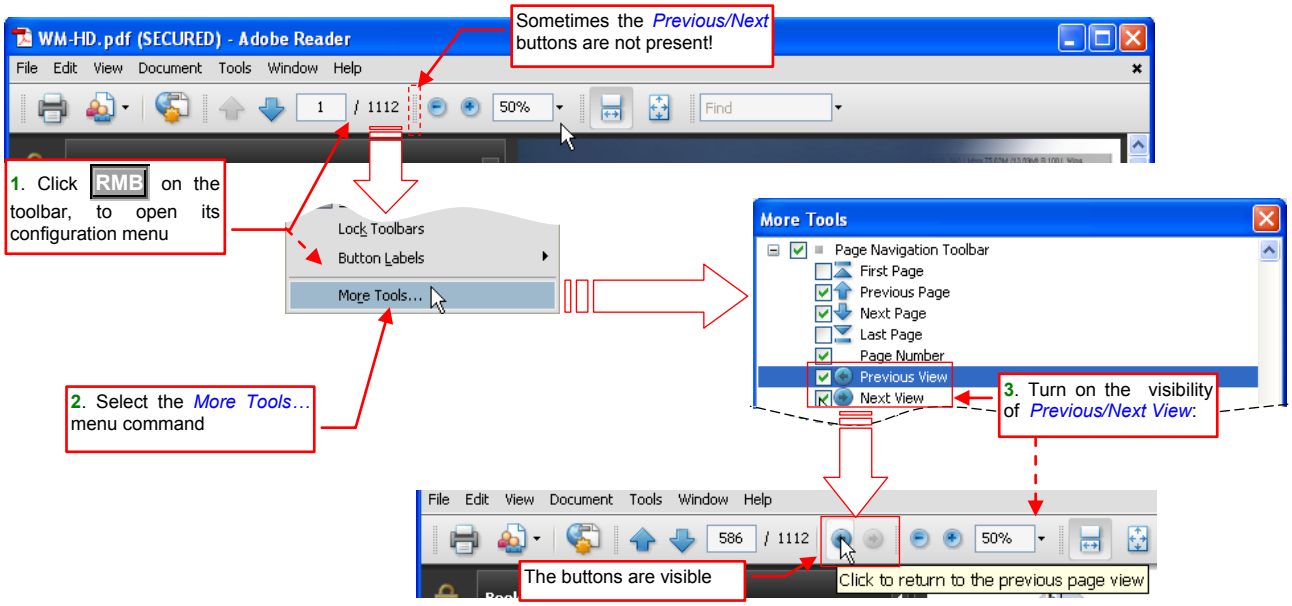


Figure 1.1.4 Adding the *Previous/Next* buttons to the toolbar (Adobe Acrobat).

Although you can always use their keyboard shortcuts (*Previous*: Alt-←, *Next*: Alt - →), it is always better to see these buttons. Click RMB on the toolbar, to pull down its context menu, and invoke from it the *More Tools…* command. In the *More Tools* window find and mark the ***Previous View*** and ***Next View*** items. It will bring their buttons back to the toolbar (Figure 1.1.4).

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In this book, illustrations are very important. You can find them on almost every page. (Actually, this guide can be described as a partial "comic book"). Unfortunately, their presence significantly increase the PDF file size. To keep it on a reasonable level, I had to turn on image compression, which decreases their quality (especially the vivid red color of the model materials). What you see is the result of a compromise between the file size and the accuracy of the pictures it contains. For **Adobe Acrobat** reader I would suggest to alter a few parameters which can improve the quality of these illustrations. They are not set by default, so you have to change them manually in the configuration of this program (Figure 1.1.5):

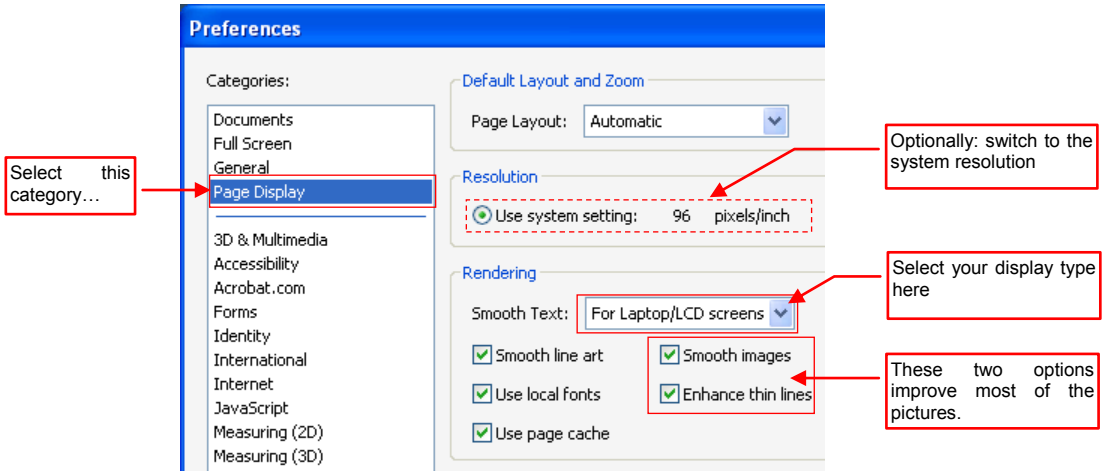


Figure 1.1.5 Optional settings, to improve the display quality of document images (Adobe Reader version 9.0)

In the *Preferences* dialog select from the list the ***Page Display*** category. This brings up appropriate controls on the right side of the window, as shown in Figure 1.1.5. Select the appropriate text smoothing method from the ***Smooth Text*** list. (The *Monitor* mode is selected by default). Perhaps you are using a kind of LCD computer display. In such case you should select the ***For Laptop/LCD screens*** option.

In addition, in the *Resolution* area you can also select the ***Use system setting*** option. (The other option — *110 pixels/inch* — is selected by default). Personally, I think that the pictures look better in this "system resolution"[1]. Do not worry, if in your program you can see a different value than the 96 pixels/inch (Figure 1.1.5). It depends on the text size, which you have set up in your Windows system settings.

Finally, in the *Rendering* area there are two check boxes: ***Smooth images*** and ***Enhance thin lines***. In most cases you better keep them turned on (as in default settings). However, if the airplane on the cover image of this book has slightly wavy edges of the wings, you can try to disable these image anti-aliasing settings. Decide yourself, whether it looks better without these options.

* * *

You may always print a copy of this book for your own use. However, it is also possible to read it directly from the screen, while working on the model. In the latter case you can save some paper, preserving a few more trees in this way. What's more, you will have all the detailed descriptions at hand, through the hypertext links.
Of course, if you prefer to page through a traditional, paper book — print all its pages[2]. Even if your printer supports duplex printing, you have to prepare entire ream of A4 sheets for the full book! I assure you that this was not my intention ☺.

[1] In this resolution the letters are somewhat smaller. It is especially obvious in the callouts, placed on the images!

[2] This e-book contains all pictures in color. Therefore, many of them will have a low contrast in the print. As a remedy for this effect, I changed the color of callouts on some illustrations to darker or lighter one. It makes them to look better, when they are printed on a monochrome printer.

In the XX century you could make an aircraft model from cardboard or plastic. At the beginning of the XXI century the time has come for yet another variation of this hobby: computer models. This new branch of scale modeling was born quietly. Few people could spend several thousand dollars of their private money to buy a complete 3D design environment just for an amusement. Ten years ago the only alternative was the usage of an “inappropriate” software — nothing to boast about... So the first enthusiasts were sitting at their monitors and creating models, learning from their own mistakes.

The times are changing, and now all the necessary software is available for free (it is GPL-licensed). So if you bought your computer after 2005, you already have everything you need to get started! This book provides the essential know-how. I will show you step by step, how to make such models as the one shown on this cover.

„Virtual Airplane” was written not only for the scale modelers. It may be also useful to all those who want to learn the three most popular Open Source graphic programs: Blender, GIMP, and Inkscape.





Visit **www.airplanes3d.net** to ask a question or obtain free trails!

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A P-40B from the 3rd squadron of AVG („Hell’s Angels”), Kunming 1942. (Background photo: © Tomo Yun, *www.yunphpto.net*)