

Witold Jaworski

Virtual Airplane

Updated for
Inkscape 1.0

Volume I: Preparations



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

Virtual Airplane

To my Wife
for her forbearance

Witold Jaworski



Virtual Airplane

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

Fourth edition

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Picture from previous page:

A pair of P-40B's from 47th USAAC Pursuit Squadron, which managed to take off and fight the Japanese raid on Pearl Harbor, on 7th December 1941. They were piloted by Kenneth Taylor and George Welch.

At that time 47th PS was practicing gunnery at Haleiwa, a secluded field near the northeastern tip of Oahu Island. This area was not attacked by Japanese airplanes (Pearl Harbor lies on the opposite side of this island). The runway ran along the sea coast. This is how these two fighters could appear shortly after taking off. The background is based on a part of the authentic shore near Haleiwa.

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Why did I write 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 great fun! So I decided to share this experience with others.

A long time ago I was an ordinary scale modeler, building aircraft models. This is a hobby that requires a lot of attention to detail. We spend long hours on our projects, engraving tiny rivets and skin panels, or recreating fine details of the cockpit instruments. (I suppose that fishing is a similarly monotonous, but less fatiguing hobby.) What's more, instead of completing nice, shiny miniatures, we are applying to their surfaces smudges of dirt and abrasion, creating more or less convincing impressions of “war-weary” machines. We are rewarded when we can show our work to someone who appreciates its finesse. Strangely enough, most often these are other modelers. Maybe this is just a pretext for discussing 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?

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

In this virtual world you will find a unique material that can be extruded into any shape. What's more – you will never run out of it! You can precisely set not only its color, but also shininess, transparency, and many other optical properties. There you can achieve unsurpassed accuracy, which is not possible even in the largest 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! Your computer models will not accumulate dust, as their real counterparts. You will never hear your family complaints about the place for your growing collection. You can also recreate many variants of your airplane, each of them in a different camouflage. These models can be copied and send to other hobbyists like yourself, without fear that something will happen to them during transport. You can also quickly build up whole scenes (i.e. dioramas), using your virtual planes.

There is just only thing you must get used to: you cannot touch anything in this virtual world! You can only select objects with the mouse. More advanced haptic devices are still as expensive and primitive as they were ten years ago. On the other hand, we currently observe fast development of affordable, accurate 3D printers. This means that you can start making your own plastic kits!

This world of virtual modeling sneaked into reality at the beginning of 21st century. These days, every computer is a fully equipped graphic workstation. In the 20th century you could only dream about such a computing power. What's more, software that uses all these technologies is available for free! It has been created by hundreds of Open Source programmers. These people want to show that they can be as good as their best commercial counterparts, and they are pretty successful in achieving it! There is no rush in such projects, no “tight deadlines” which are primary cause of many errors in the commercial software. In the effect, a self-organized community of enthusiasts can create and maintain a good, stable program.

To sum it up – having a four- or five-years old PC, you got everything you need to enter this “brave new world” of virtual modeling. Of course, this kind of work still requires the virtues common to all modelers: precision and patience. Creating a detailed 3D copy of an aircraft usually means several weeks of hard effort, just like in the case of building a real-world model from scratch. I wrote this book to help you, Dear Reader, in reaching these results somewhat even faster. I hope that this guide will save you a lot of time, and sometimes – plenty of frustration. The latter is unavoidable when you work with “this stupid machine” (a computer). I will try to avoid long descriptions, showing many pictures instead. I hope that you will find “Virtual Airplane” useful.

Witold Jaworski

What this book contains

“Virtual Airplane” teaches you how to create a 3D aircraft model¹ and its realistic visualizations, such as the one shown on the cover page. This is a vast subject, so I decided to split it into volumes associated with the subsequent phases of this work. They are: “Volume I: Preparations”, “Volume II: Modeling”, “Volume III: Materials and Textures” and “Volume IV: Detailing and Rendering”. As the example for this book I picked the Curtiss P-40B fighter. This design contains typical features, which you can encounter in most aircraft of this period. I chose this one because I do not want to deprive you the pleasure of recreating the most famous WW2 fighters, as the Spitfire, Mustang, Thunderbolt, Focke-Wulf, or the Messerschmitt!



You can use methods presented in this guide to recreate any Second World War fighter. It does not have to be the P-40, as all of these airplanes shared similar design solutions. In the course of this work you will encounter most of the modeling problems, which I described (and solved) here.

“Virtual Airplane” is intended for those who are just beginning their adventure in “3D”, as well as for those, who already have some experience in this field. Therefore, in the main text I will describe **what** you should do. You can find the detailed descriptions of **how** to do it in separate reference parts (“Details of Drawing Programs”). They contain detailed instructions about using particular functions for obtaining the results shown in the main text. These reference pages span over half of this book. Their contents resemble a context-sensitive help used in the programs. There are plenty of short sections (one or two pages long), containing just a few illustrations. Each of these sections describes details (keyboard shortcuts, menu commands, results) of a single program command/function.

Dividing contents of this book between the “basic” and “reference” part, I tried to avoid detailed command descriptions (“click this button, select this item”) in the main text. Such hints, although needed, make the narration longer and obscure. Thus, most chapters of this guide contain just links to the reference sections. If you have encountered in the main text a tool which is new for you, follow these links and read detailed description of this operation². I prepared chapters of this guide in a sequence that lets you gradually learn all the software tools that I use. Once you know **how** to do what I am describing – feel free to skip these shortcuts.

At the end of this book, you can also find another part: “Appendices”. There is a “hodgepodge” of many different articles: discussion of some optic phenomena (like barrel distortion of the photo images, or the light refraction), a color theory for the CG, or airfoil geometry details. This part also contains a review of advanced verification of reference drawings, and details of subdivision surfaces mathematics. All these materials are optional, although I think that they may be helpful in better understanding some issues mentioned in the main text.

¹ It does **not** cover 3D printing issues, nor the issues specific to game/flight simulator models. If you are going to 3D print your models, read the first parts of this guide dedicated to reference drawings and modeling and skip the remaining pages, dedicated to visualization details: materials, textures, and composition. In the case of the game/simulator models the information from this book can be useful, but you should also follow in your project specific requirements of the target game engine (for example: using the same UV coordinates for all textures).

² I assume that you will use the reference part in a random fashion. Thus, most of its basic sections contain text without further references. This approach means that, for example, the description of the scaling in Blender [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 one, so each of them provides all the information you need.

Conventions

For the tips about using 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 non-standard laptop keyboards).
- Three-button mouse. (In fact: two buttons and the wheel in the middle. When you click this wheel, it acts like the third button.)

Command invocations are 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 clicking a button named *Button* in a dialog window or a panel named *Panel*. Sometimes I may also mention other dialog controls, like a checkbox or a drop-down list. In similar way I will also denote hierarchical relationship between layers, but in such a case I will use green letters.

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 comma (“,”) 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 one of 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? The impersonal form (“something is done”) is used in most of the guides. 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 workflow in this way¹.

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, I knew that I should explain to you every of the issues described in this book, with all details!

How to read this book

This book is a digital publication, delivered as a PDF file. Below you can see it opened in the popular **Adobe Acrobat Reader** (Figure 1 shows the MS Windows version of this program):

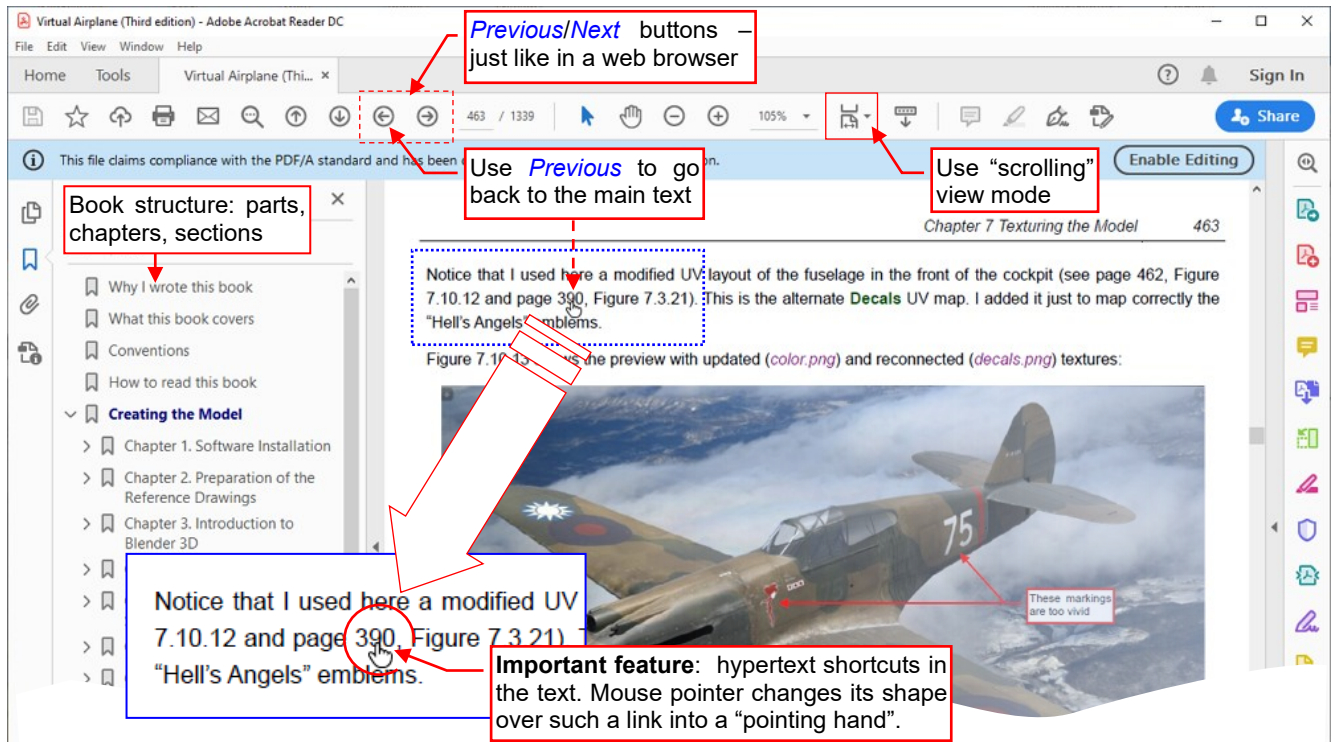


Figure 1 Reading this book in a PDF reader (Adobe Reader)

To make it more readable than a printed guide, I moved most of the detailed instructions out of the main text, leaving only their hypertext references. Use these links for “digging into details” and then jump back to the general subject. To avoid additional “clutter” on the pages, hypertext shortcuts are not distinguished either by the color or by underlines. You can recognize them by the context (“see page ...”) and the altered shape of the mouse pointer. (When your mouse hovers over an internal link, its cursor shape changes into a “pointing hand”, as shown in Figure 1). If you click such a link, you go to the referenced page. To return to the previous location, use the **Previous** button. In Figure 1 **Previous/Next** buttons are located on the toolbar at the top of the screen, just like in the web browser. However, in the **Adobe Reader** default configuration they are hidden. Figure 2 shows how to place them on the toolbar:

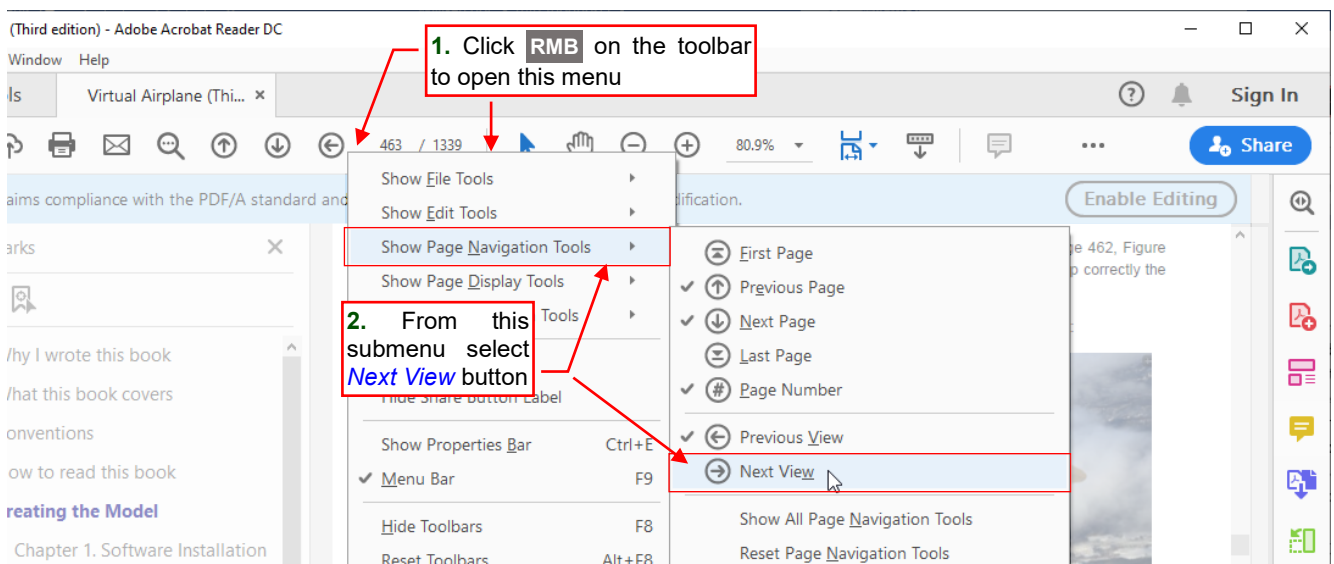


Figure 2 Adding the **Previous/Next** buttons to the toolbar (Adobe Reader)

To display *Previous/Next* buttons¹, click **RMB** on the toolbar to pull down its context menu, and open the sub-menu named **Show Page Navigation Tools**. Select there (click) the **Previous View** and **Next View** items (one at time), as shown in Figure 2.

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). Adobe Reader signalizes this fact by a message displayed in the bar at the top of the window (Figure 3):

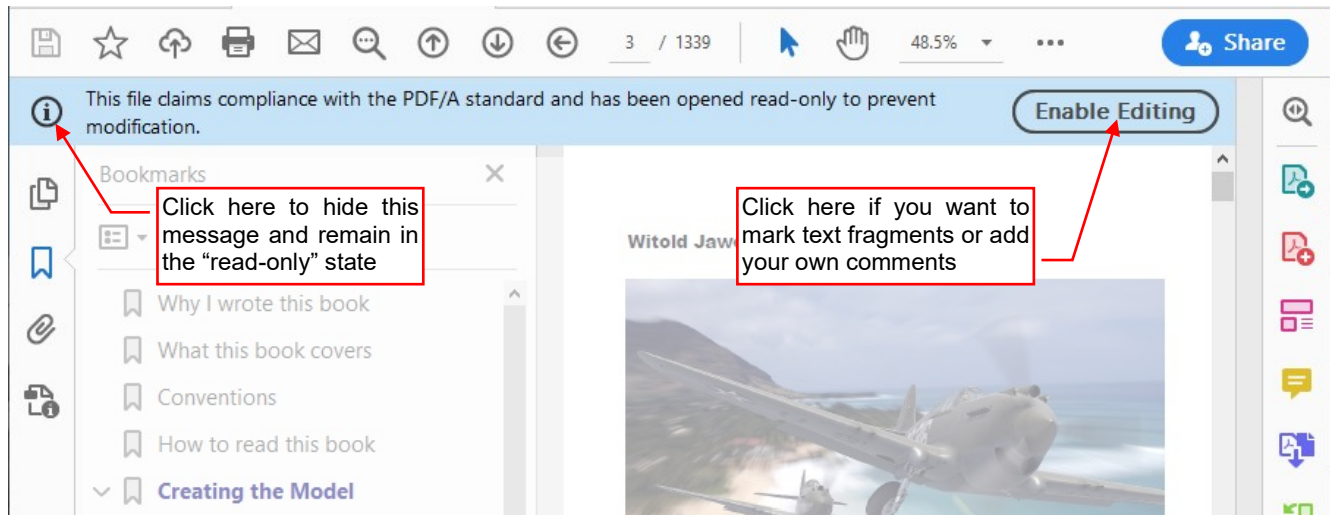
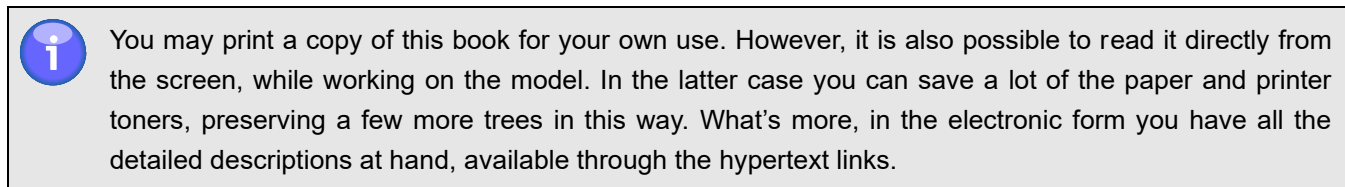


Figure 3 Closing the PDF/A message (Adobe Reader).

If you want to keep this book in the original form, click the (i) icon on the left (Figure 3). However, if you want to personalize your copy with additional notes, comments, and markings – click **Enable Editing** button on the right.

* * *



Of course, if you prefer to page through a traditional, paper book – print all its pages². Even if your printer supports duplex printing, you should prepare two reams of A4 sheets and a new toner for the full, four-volume copy of this guide! I assure you that this was not my intention 😊

* * *

¹ You can also use keyboard shortcuts (*Previous*: **Alt** - **←**, *Next*: **Alt** - **→**), but it is more convenient to see these buttons in the toolbar.

² This e-book contains all pictures in color. Therefore, many of them will have a low contrast in 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.

You can also read this book on a tablet, especially the larger ones. For the Android devices I recommend **Adobe Acrobat Reader** app (Figure 4):

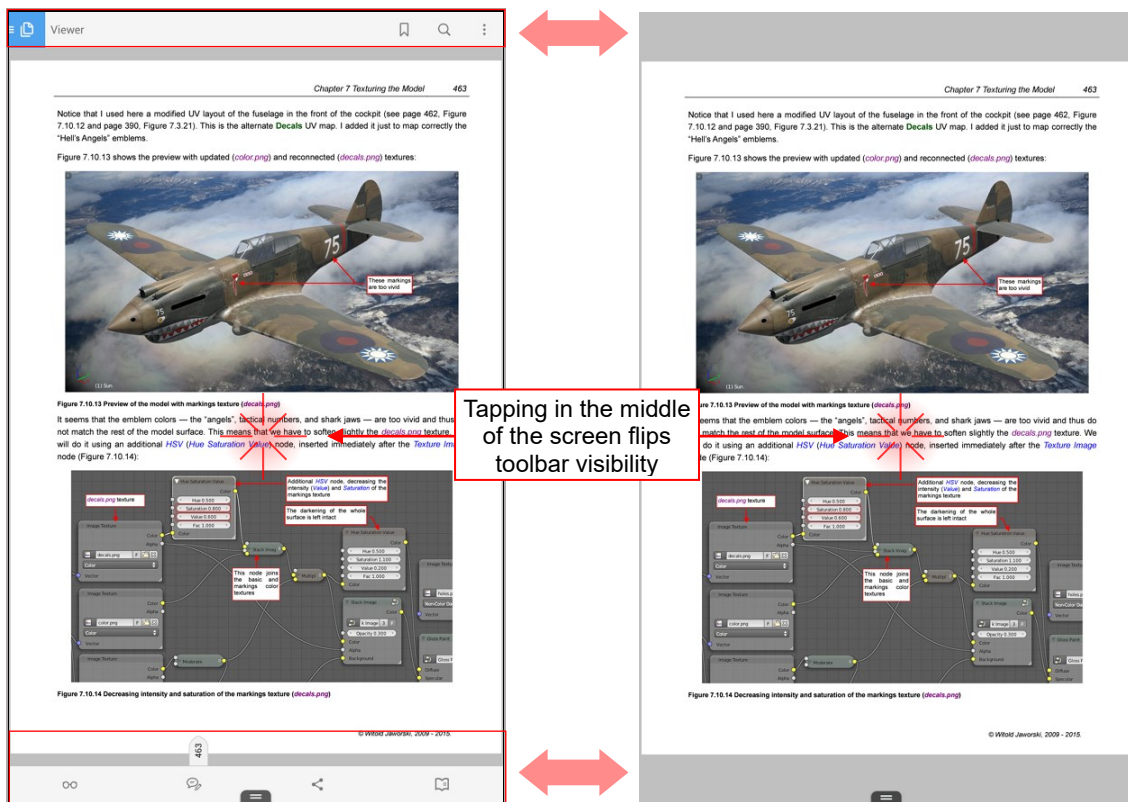


Figure 4 Reading this book on Android tablet (in Adobe Reader, mobile version)

Comparing to the PC/Mac version (presented earlier in this section), this “mobile” **Adobe Reader** has a simplified user interface (Figure 5):

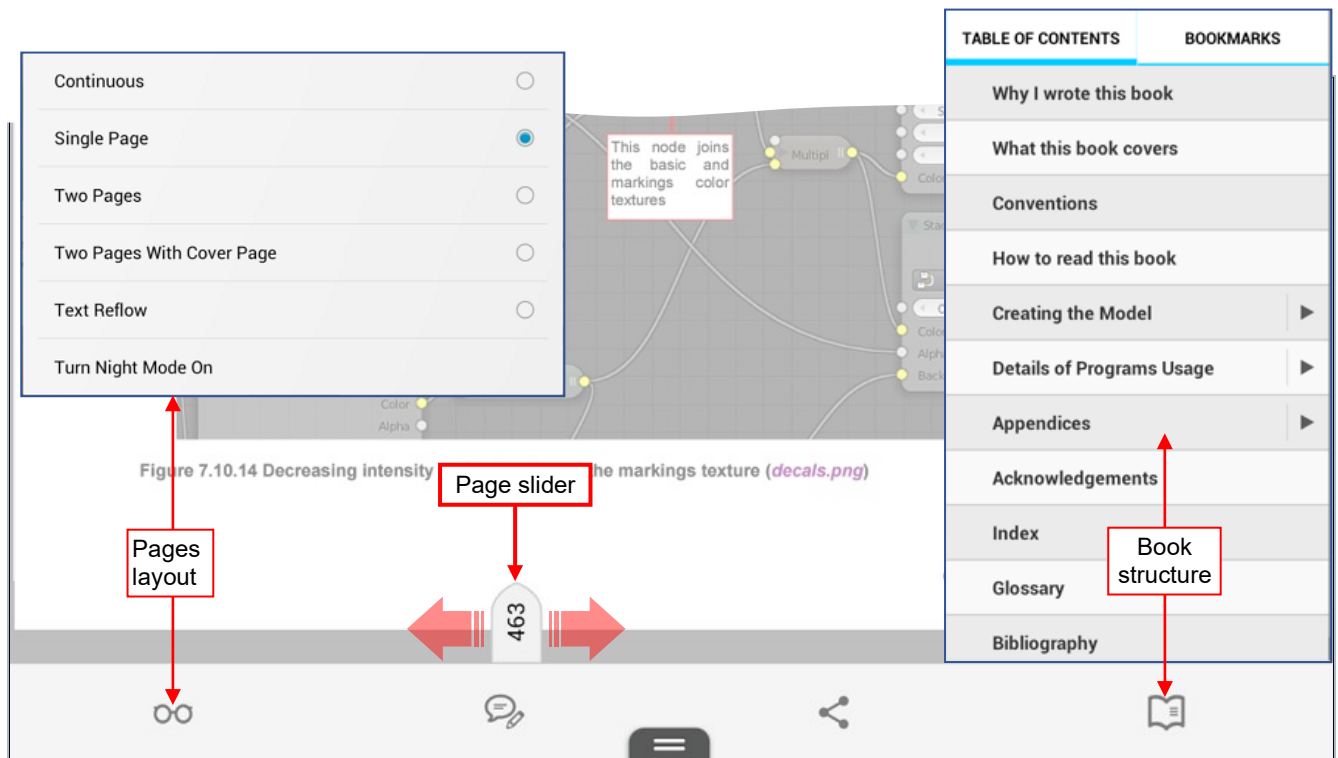


Figure 5 Adobe Reader user interface

You can still set here a continuous page layout (**Pages layout**→**Continuous**, see Figure 5). This option is especially useful for smaller displays.

In this "mobile" Adobe Reader you can also use the internal hypertext links. However, on the tablet touch screens there is no cursor which changes its shape over such a link. Keep in mind that every reference to a page number, figure or chapter contains such a reference. Just tap the relevant text (Figure 6):

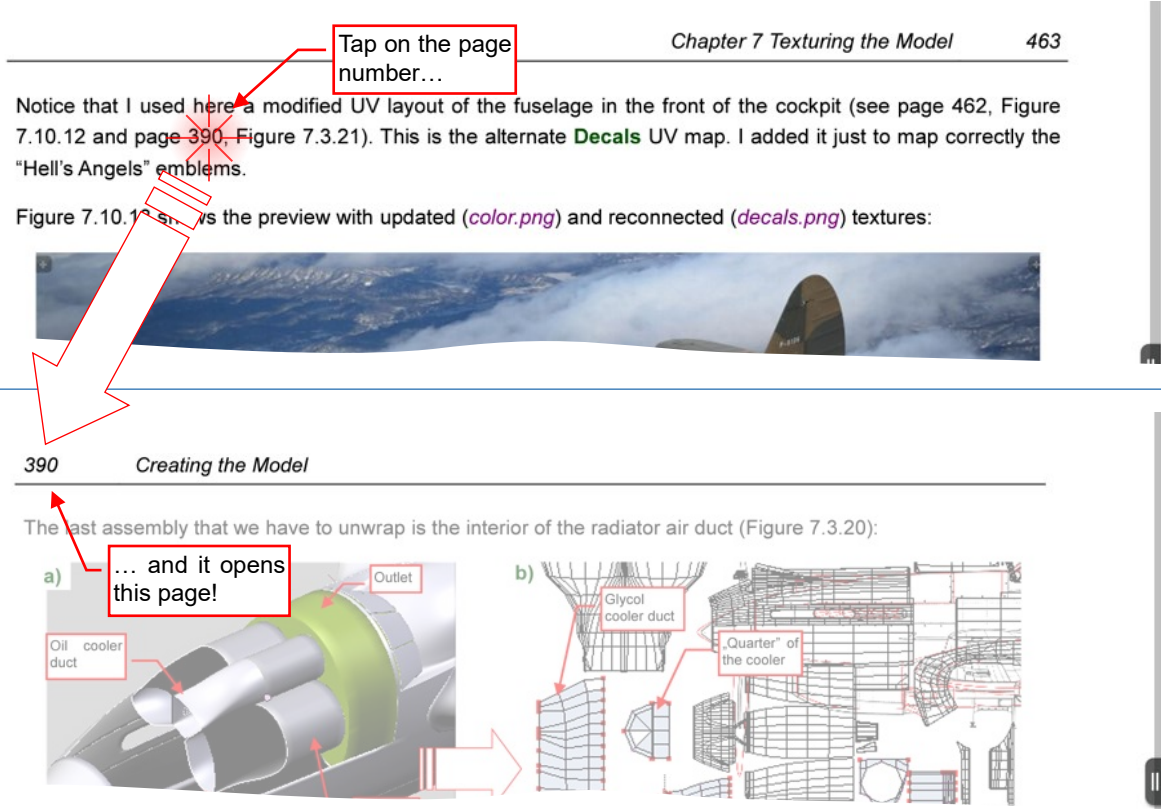


Figure 6 Using the internal hypertext references

To return from such a "hypertext jump" to the previous location, tap the page slider (at the bottom of the page):

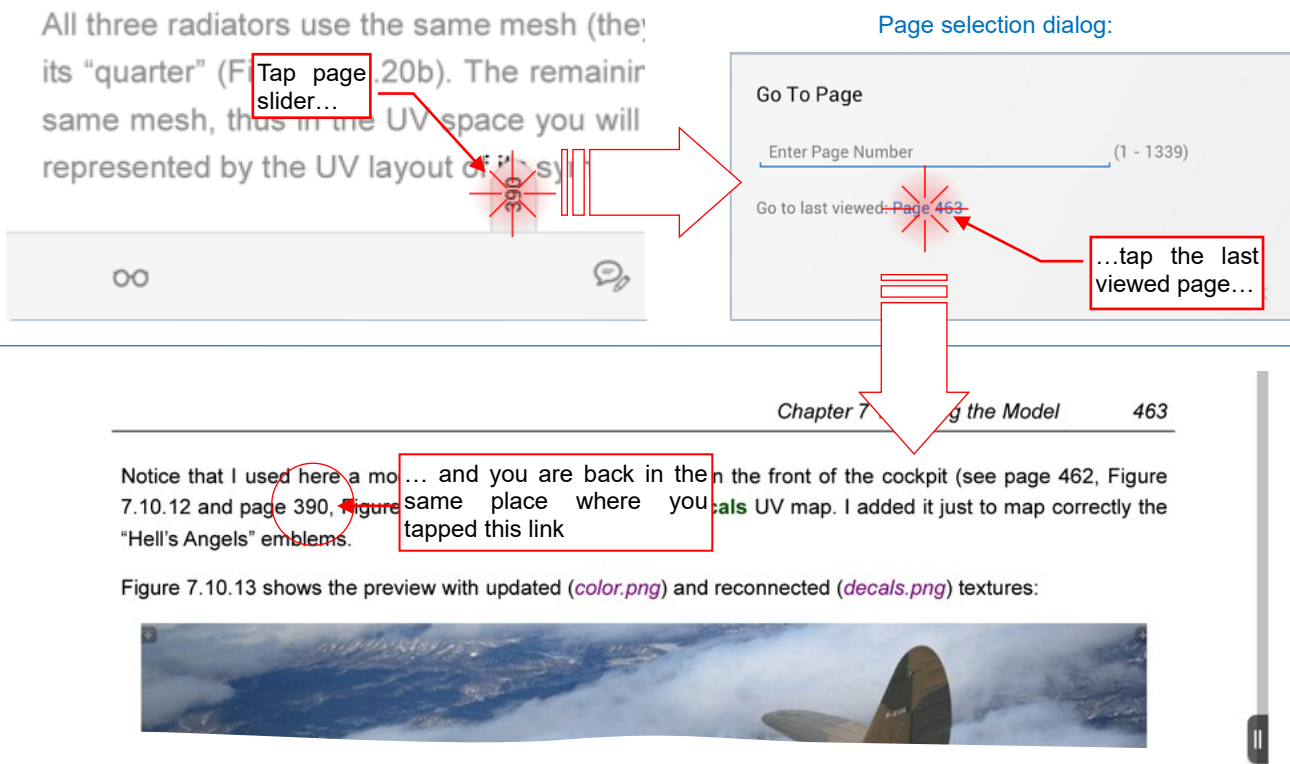


Figure 7 Returning from referenced page (Android)

Figure 7 shows page selection dialog opened by this “click”. Select there the **Go to last viewed** page number, and you are back in the main text. (Frankly speaking, the previous version of this app was more intuitive: it displayed a direct “back” button at the current page number).

Adobe Acrobat Reader for **iOS** looks nearly identical as the Android version. However, there is an unexpected problem in the iOS variant: no “Go to last viewed” item in the **Go To Page** dialog! (Figure 8):

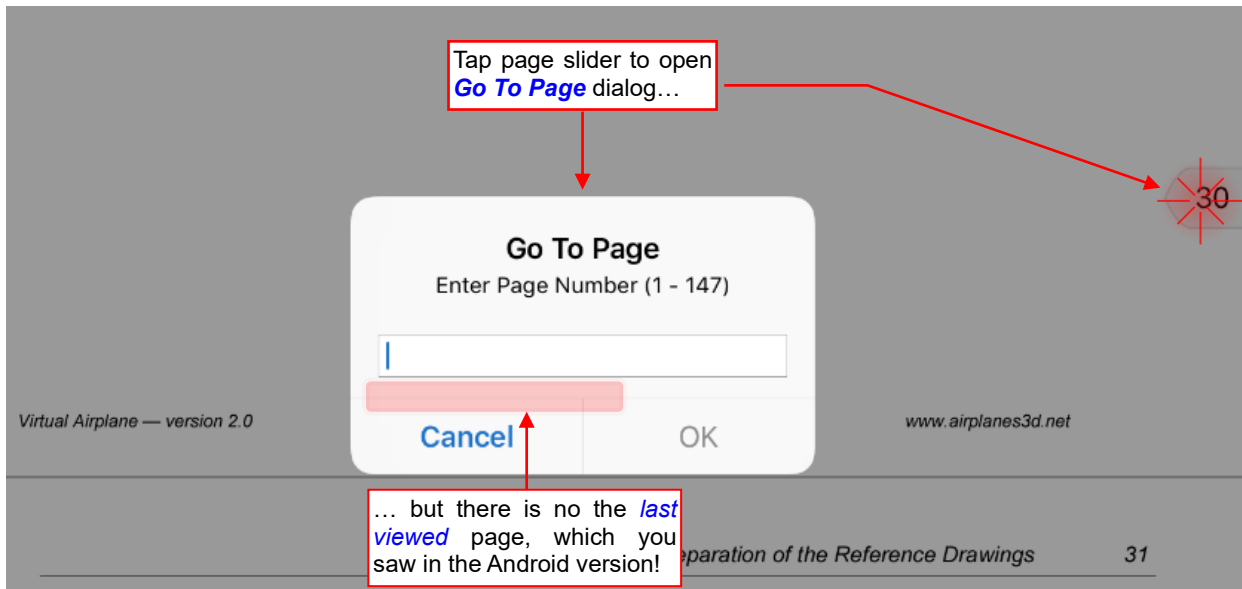


Figure 8 **Go To Page** dialog in **Adobe Reader** for **iOS**

That’s why I am forced to recommend for **iOS** another program: **GoodReader**. This is a paid app (5.99USD), which provides superb reading experience (Figure 9):

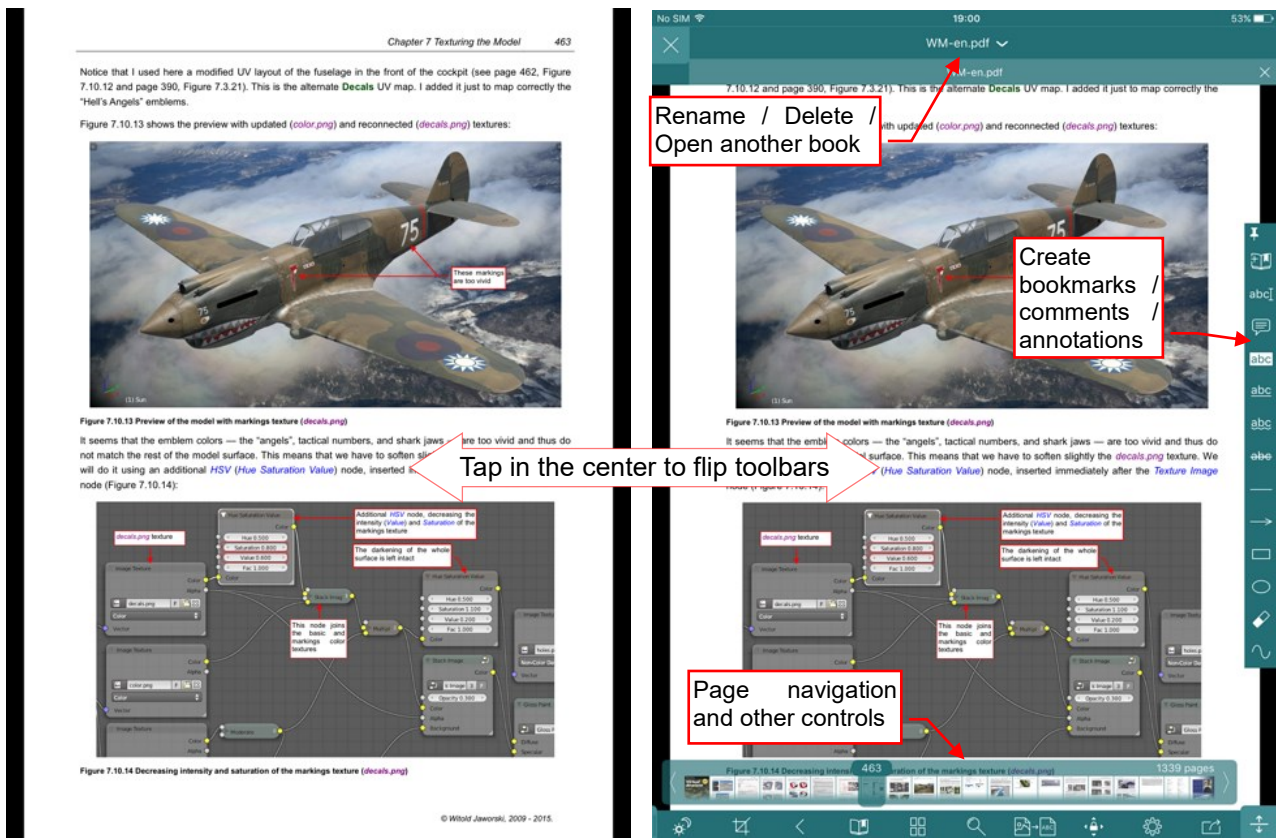


Figure 9 **GoodReader** for **iOS**

Except reading, **GoodReader** is also a powerful tool for managing your book files on the local device and in the clouds. It even contains its own web browser for dealing with the external links you can find in the book.

At the bottom of the screen you will find the most important **Back** button, but also many other “gadgets”, like the page slider (Figure 10):

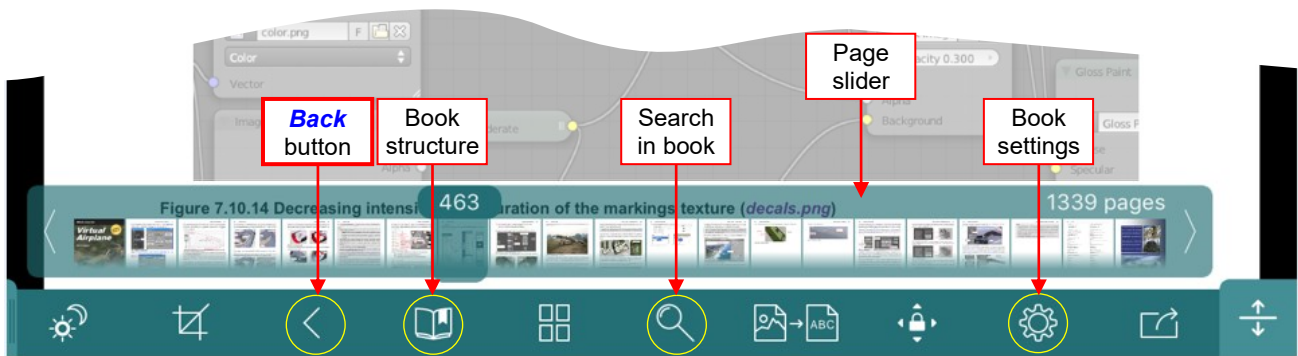


Figure 10 GoodReader: Page navigation panes

While the **Back** button enables you to return from a linked page, **GoodReader** can also mark all the internal links in the text. Just turn on the corresponding option in its PDF settings (Figure 11):

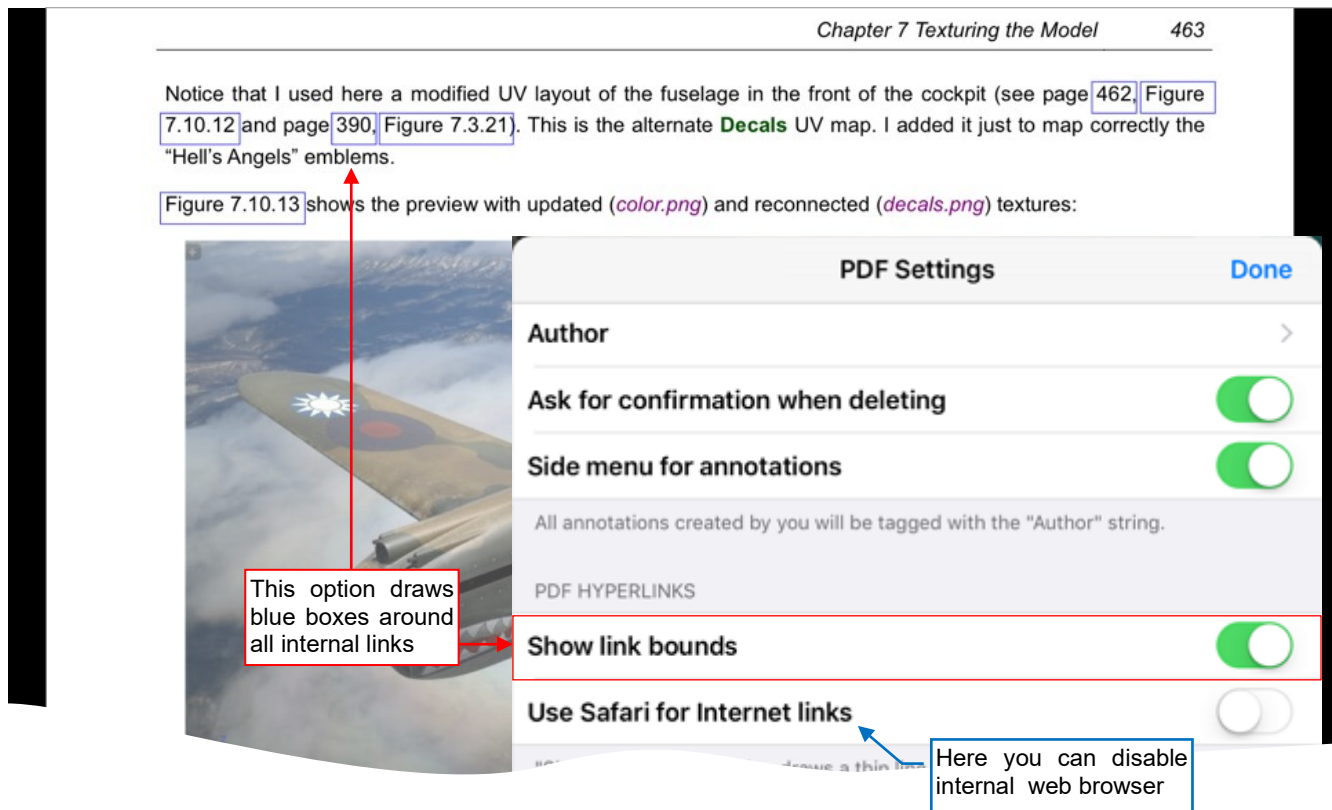


Figure 11 GoodReader: some useful book reading options

However, as I previously noted, I prefer to read text without these markings.

In the 20th century you could make a scale model from paper or plastic. In the 21st century the time has come for yet another variation of this hobby: computer models. The birth of this new branch of scale modeling passed unnoticed. At the beginning of this century few people could spend several thousand dollars of their private money for a complete 3D design environment, bought just for the amusement. The only alternative was using an “inappropriate” software – nothing to boast about... Thus, the first enthusiasts were quietly sitting at their monitors, creating their models without much publicity.

Today all the necessary programs are available for free (they are GPL-licensed). So, if you bought your computer less than 5 years ago, you 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 P-40 shown on this cover.

“Virtual Airplane” was written not only for the modelers. It can be also useful for anyone who wants 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.yunphoto.net)