

Embedding Interactive 3d Objects into PDF documents

Software used:

- **Miktex portable 2.9 (135 MB)** - TeX / LaTeX distribution (freeware)
- **AccuTrans 3D 2.12.1 (6.9 MB)** - edit and convert 3D files (fully functional shareware)
- **Daz Studio 3D 3.1.2.19 (110 MB)** – 3D modeling (freeware, requires registration in the website)
- **Adobe Reader 8.0** (or higher) - PDF file viewer (freeware)

You need Adobe Reader 7.0 or higher

3D Object

(Viewable only with Adobe Reader 7.0 or higher)

T_EX is a language used to typeset documents, especially ones containing mathematics. The term comes from the root of the Greek word *τέχνη* (*art, technology*). The last letter in the name is a Greek capital *Χ* (chi, pronounced as in Scottish *loch*). It was designed to allow anybody to produce high-quality books and to provide a system that would give exactly the same results on all computers. The version number of T_EX converges to π . The current version is 3.1415926.

T_EX has both programming and mark-up features (like HTML language). A T_EX document is a plain text file (extension is tex) that contains both the text and its formatting instructions.

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For example, the well-known quadratic formula would appear as:

`$-b \pm \sqrt{b^2 - 4ac} \over 2a$`

The T_EX source file must then be compiled and turned in the final document, typically a PDF (or PS – PostScript file), which obviously contains only the formatted text.

Although it is still possible to write in pure T_EX, now you are using languages that rely on it, as **L^AT_EX**, that allow you to automate, through macros, all the common tasks that involve the creation of a document and makes it easier to produce standard documents.

In our case we use the package **movie15.sty**, a macro that allows **L^AT_EX** to include multimedia files (sound, animation and 3D objects) and then will be incorporated into the final PDF document.

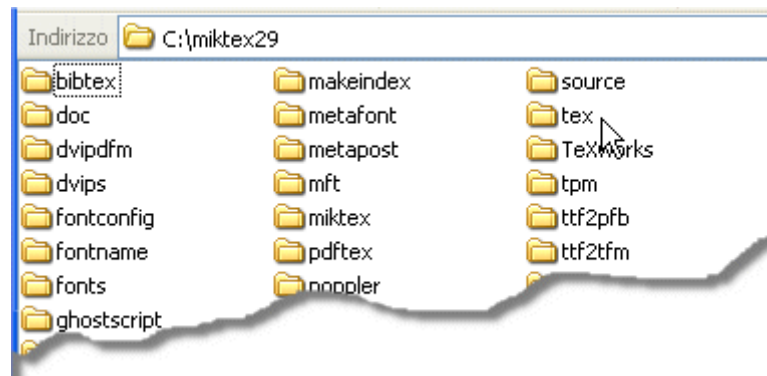
Movie15.sty can be downloaded from CTAN (Comprehensive T_EX Archive Network), the reference site for all T_EX materials.

<http://www.ctan.org/tex-archive/macros/latex/contrib/movie15/>

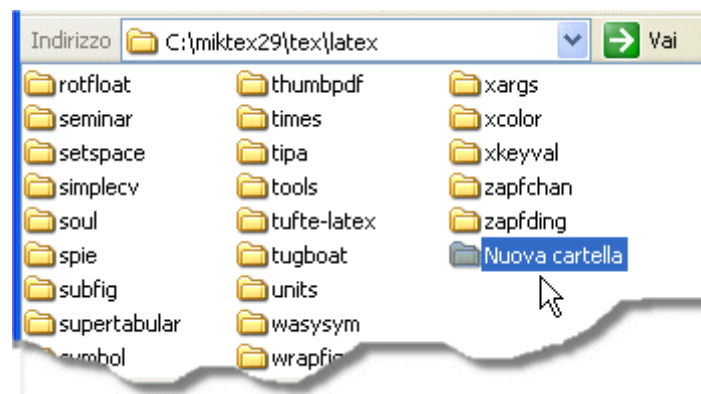
Now let's prepare the T_EX - L^AT_EX environment to use later.

After downloading the portable distribution **MikTeX** version 2.9 (one of the best and most widely used distributions T_EX - L^AT_EX for Windows) from the site <http://miktex.org/>, unpack it to a folder, eg c:\Miktex29\.

Now we must add the file movie15.sty.
Enter unpacked MikTeX folder and click the folder 'tex' to open

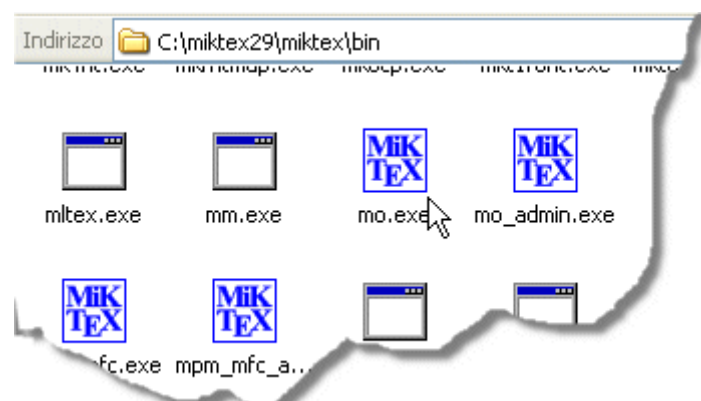


and then open the folder 'latex'. Here create a new folder and rename as 'movie15'

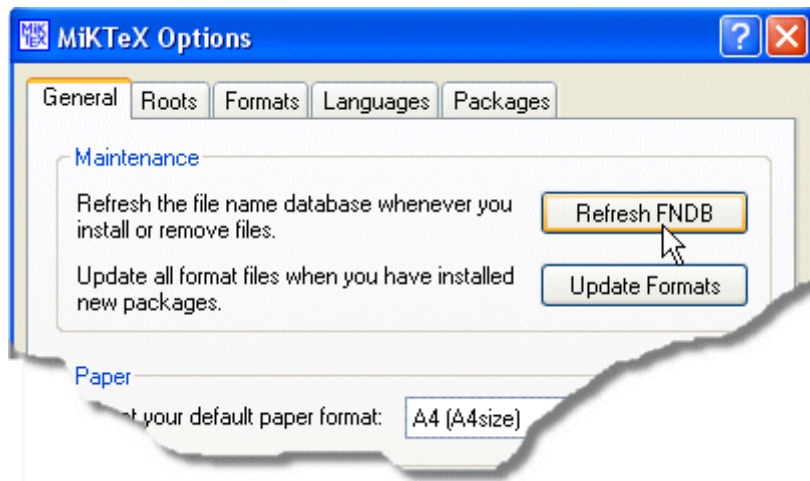


Copy the Movie15.sty file to the folder you just created.

Now we have to update the system to recognize the new package. Enter the folder 'miktex/bin' and launch the file 'mo.exe' which opens the tab 'Options' of MikTeX.



Click 'Refresh FNDB' button and close the tab by clicking 'OK'.



Now let us deal with 3D file.

In a nutshell, a 3D file contains the coordinates (x, y, z) of all points that detect the surface of the 3D object and, possibly, the color and physical characteristics of its surfaces.

There is a very large number of 3D formats, but the only ones that movie15 can embed in PDF documents are **U3D** (Universal 3D) and **PRC** (Product Representation Compact).

We will use the U3D format, viewable only with **Adobe Reader** version 7.0 (or higher).

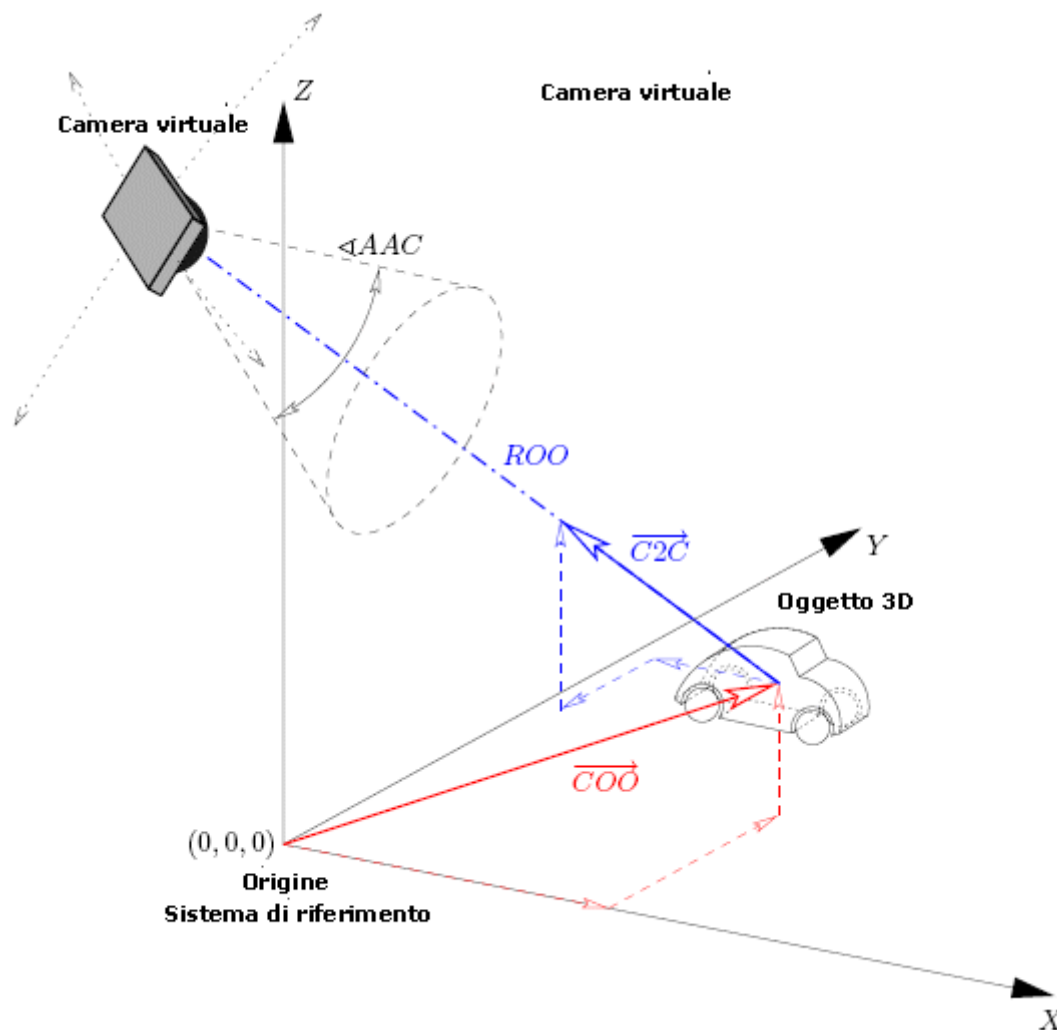
Since a 3D object looks different depending on the perspective of the viewer, you must specify the point of view, ideally replaced by a **virtual camera**.

There are a few options which define how the 3D object is positioned within the view port of a virtual camera, or conversely, how the virtual camera is positioned and oriented within a coordinate system, called 'The World', which bears the 3D object at a fixed position.

One of the problems we face is the object's position with respect to the coordinate system (called "the world") and to the virtual camera. If the 3D object is placed too close or too far away or out of the virtual camera view, the end result will be unusable. The coordinate system bears the 3D object at a fixed position. When we want to observe the object from different points of view, it will be room to move the object.

In Movie15 there are a few options which define how the 3D object is positioned contains the following parameters that define the position and orientation of the virtual camera relative to the reference 3D object.

- **3Daac** (Camera's apertura angle) = sets the opening angle of the camera, measured in degrees. Fixed point real numbers between 0 and 180 are admissible.
- **3Droo** (Radius of orbit) = sets the distance from the center of the circular orbit in which the camera moves (and in which the object must be placed to view it)
- **3Dcoo** (Centrum of orbit) = sets the coordinates (x, y, z) of the center of the orbit.
- **3Dc2c** (Centre to camera) = sets the initial position of the camera within its orbit, through a segment (vector) of arbitrary length that originates in the center of the orbit and passes through the point of coordinates x, y, z defined by 3Dc2C parameter.



We have to place the object in the center of the orbit and determine an appropriate range for the size of the object.

To do this we will use **Accutrans 3D**, a fully functional shareware that still work at the end of the 30 day trial. Accutrans 3D does not require installation.

After unpacking the zip file downloaded from <http://www.micromouse.ca/downloads.html> is ready to work.

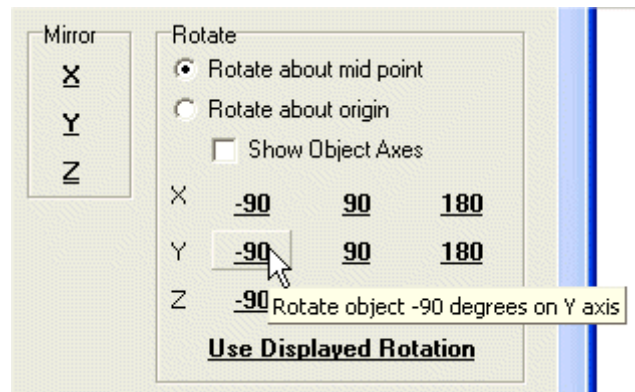
Using the menu command "*File → Open (All Known Formats) ...*" open knight.dxf, present as an example of 3D files in the folder 'Avatar Tutorial' of Accutrans.

DXF (Drawing Exchange *Format*) is an AutoCAD 3D format.

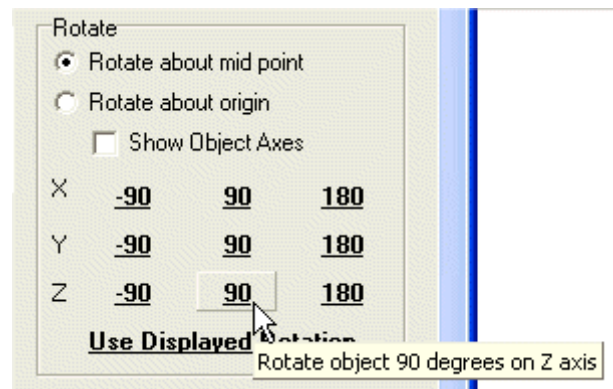
At this point we can change the orientation of the 3D object to fix the position as we like. We can do it manually by turning it while holding down the left mouse button, or we can do it in a more precise way.

From the menu select the command "*Tools → Adjust Object*". On the right side of the window options and commands appear to modify the coordinates of our 3D object.

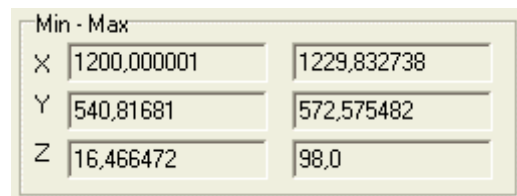
In the 'Rotate' box click the "Y -90" button in order to rotate the object 90 degrees counterclockwise around the Y axis, to put it up.



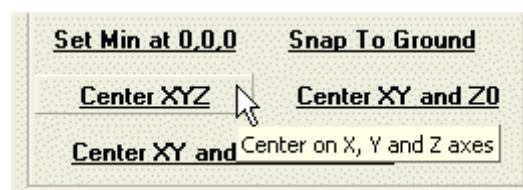
Now click the "Z 90" so as to rotate the object 90 degrees clockwise about the Z axis, to put it in front.



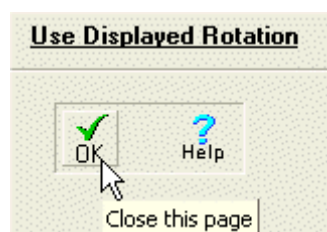
If we observe now the minimum and maximum coordinates of the object in the top right



we can see that object is very far from the origin of the axes (0,0,0).
To center the 3D object on the origin of the axes click the button 'Center xyz'.



Click 'Use Displayed Rotation' and then 'OK'.

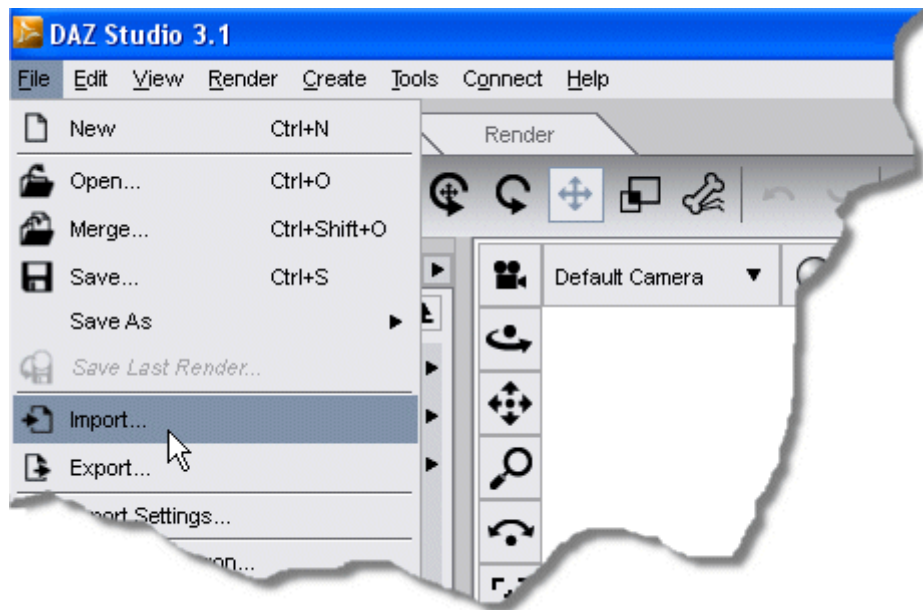


At this point we can save in the **OBJ** format (Wavefront), a format which DAZ Studio 3D can import and convert into **U3D** format. From menu select 'File → Save as ..' and from the window that appears, select Wavefront format.

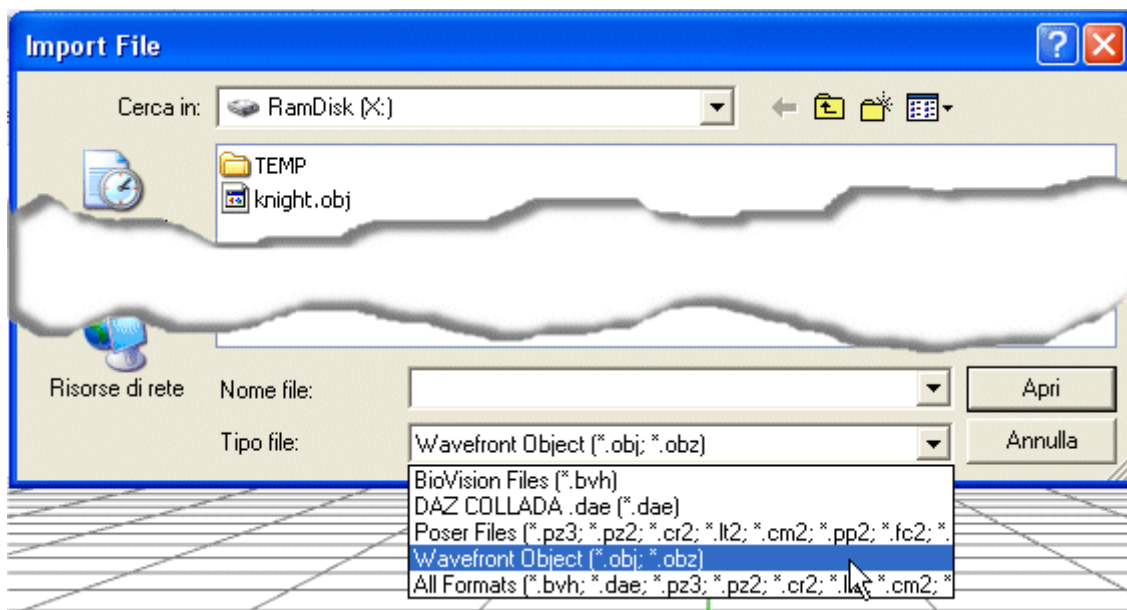
In addition to knight.obj file will be generated knight.mtl that contains information about the material of surfaces.

DAZ Studio 3D is a freeware application, but requires registration at <http://www.daz3d.com/> You will be emailed a serial number to use when you install the program.

After you have installed and launched DAZ-3D, select from menu item '*File → Import..*'

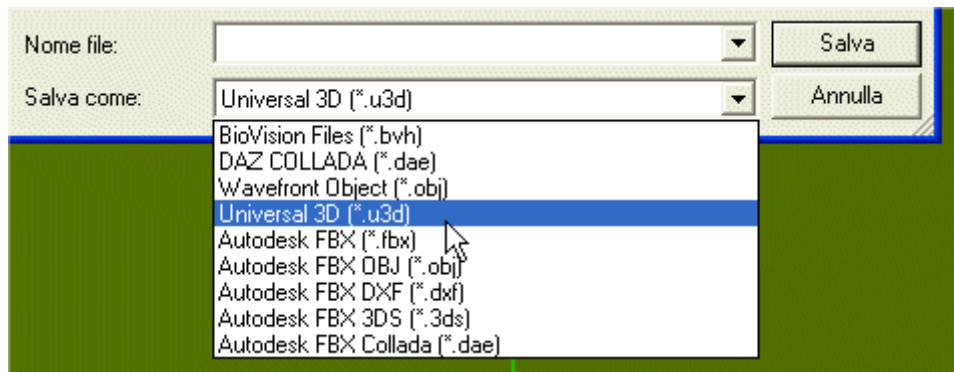


In the window that appears, select the file type Wavefront Object and load the file knight.obj.



The object is too close to be fully displayed. Do not we care. Set later the correct distance.

Select from menu '*File → Export ..*' In window that appears, select the file type Universal 3D and save the file as knight.u3d.



With VAZ3D we're done. We just need it to create U3D files.

Also the freeware **MeshLab** <http://meshlab.sourceforge.net/> is able to export U3D file format, but currently (version 1.2.3) is unable to save the colors of the surfaces. However, it has the advantage that, with the U3D file also generates a TEX file ready to be compiled and converted into a PDF with embedded 3D object.

Let's now create the TEX file necessary to embed U3D file in PDF

In the same folder where we saved the knight.u3d file create a text file (with a right click will show a context menu from which select 'New → Text Document').



Open with a double-click the text file, paste (or write) the following text and save.

```
\documentclass[a4paper]{article}
\usepackage[3D]{movie15}
\usepackage{hyperref}
\usepackage[english]{babel}
\begin{document}
\includemovie[
  poster,
  toolbar, %same as `controls'
  label=knight.u3d,
  text=(knight.u3d),
  3Daac=60.000000, 3Droll=0, 3Dc2c=0.000000 -100.000000 0.000000, 3Droo=100.000000, 3Dcoo=0 0 0,
  3Dlights=CAD
]{\linewidth}{\linewidth}{knight.u3d}
\movieref[3Dcalculate=60]{knight.u3d}{Calculate Camera Distance}
\movieref[3Dgetview]{knight.u3d}{Capture View!}

\end{document}
```

This is a TeX code.

The first four lines tell the compiler which TeX packages are necessary for the compilation (obviously movie15). We then set the parameters of the virtual camera.

- 3Daac = 60.000000 → 60 ° opening angle of the camera
- 3Droll=0 → 0° start rotation angle of the camera around its axis
- 3Dcoo = 0 0 0 → coordinates of the center of the orbit (so we have placed the center of the orbit at the origin of the axes, where we previously focused our 3D object with Accutrans)
- 3Droo = 100 → radius (**temporary**) of the orbit on which the camera moves
- 3Dc2c = 0 -100 0 → The initial position (**temporary**) of the Camera to the center of the orbit, which in this case coincides with the origin of the coordinate system and the center of the object.

Instructions

```
\movieref[3Dcalculate=60]{knight.u3d}{Calculate Camera Distance}
```

```
\movieref[3Dgetview]{knight.u3d}{Capture View!}
```

are temporary and will create two links in the PDF document.

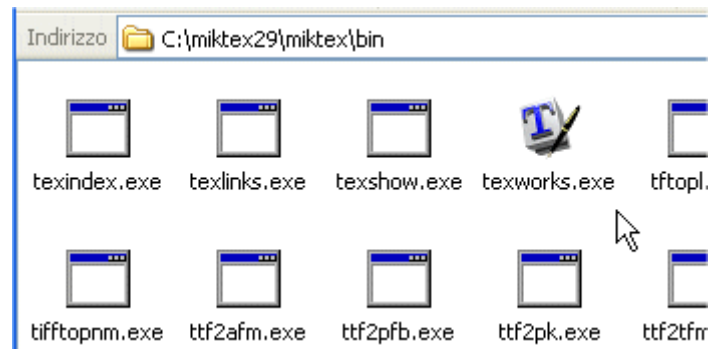
The first (*Calculate camera distance*) will help us to calculate the correct distance of the camera (3Droo)

The second (*Capture View!*) sets the parameters of the particular views of the 3D object that we can later use in the final document.

Note: Links will only work with Adobe Reader 8.0 (or later)

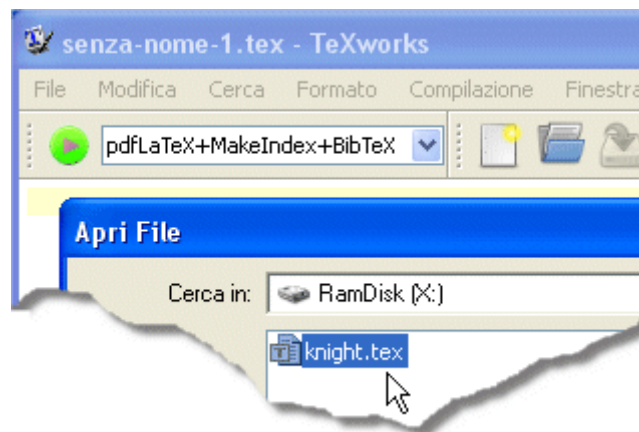
Rename the text file as 'knight.tex' so you can read and compile with MikTeX.

Enter the folder where you have unpacked MikTeX and find **TexWorks.exe** located in the subfolder /MiKTeX/bin

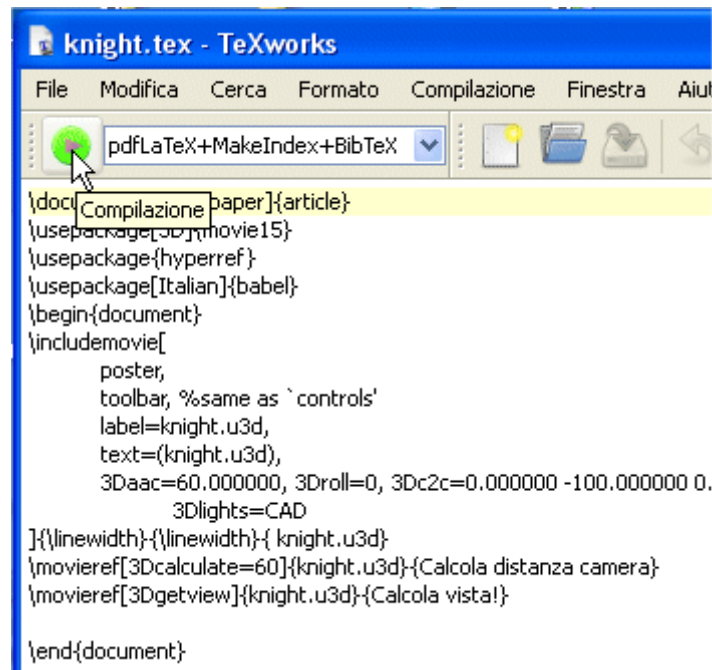


It is a TEX editor and compiler provided with the MikTeX distribution.

Launch it with a double click. From the menu, select 'File → Open ..' and load the file knight.tex.



The source text will appear in TEXworks. If you want you can change it, but we simply compile by clicking the green button in the upper left.



If the compiler finds no errors, will be created in the same folder the file **knight.pdf** that will automatically be loaded and displayed by TEXworks in another window.

However TEXworks PDF viewer is not able to display the 3D object embedded.

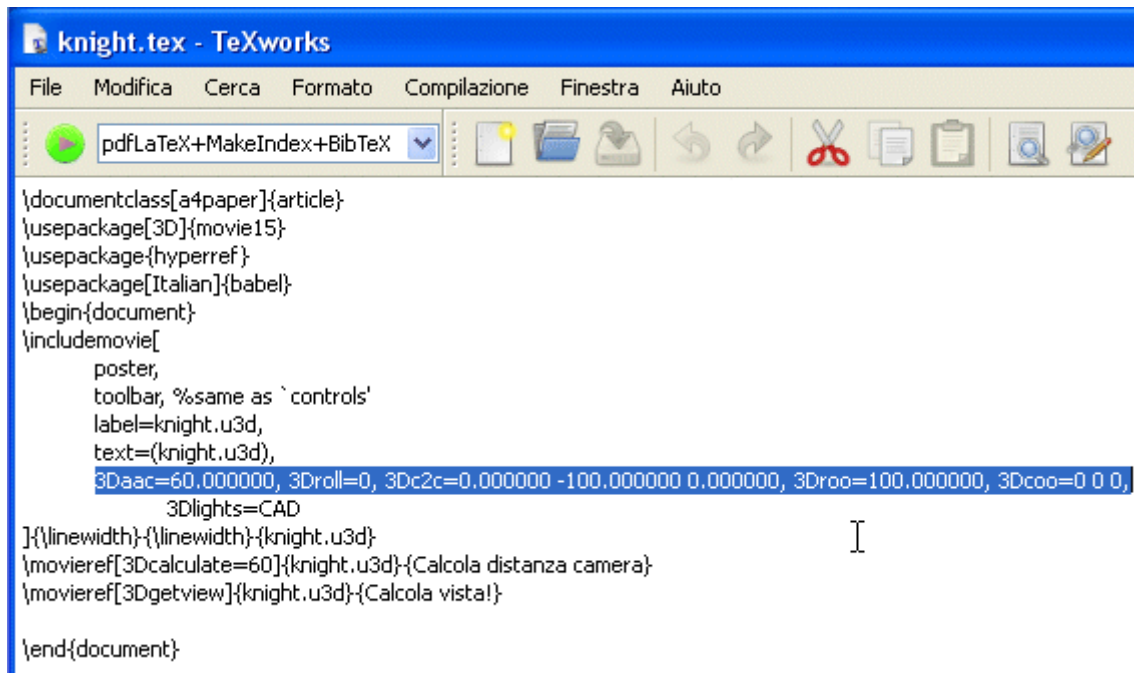
We should therefore view it using Adobe Reader. At this stage you must use at least Adobe Reader 8.0 (or higher). Earlier versions can not properly handle links that we need to calculate the correct distance of the object.

Loading knight.pdf file with Adobe Reader 8.0 embedded 3D object appears, but too close to the observer (so that all will be occupied by a particular view of his green dress)

Click the link (Calculate Camera Distance) located in the lower left, below the 3D image. We get the following dialog response while the 3D object will be positioned at the correct distance.



The only information that interests us is the first, which we round to $3Droo = 22542$. Reopen the source file Knight.tex using the TEXworks editor to correct line 11.



Replace with the following

`3Daac=60, 3Droll=0, 3Dc2c=0 -22542 0, 3Droo=22542, 3Dcoo=0 0 0,`

where the values of camera position and the radius of the orbit that we had temporary set at -100 and 100 are replaced with the newly calculated value (22,542).

From menu 'File → Save as ...' save the modified TEX file as page3D.tex and recompile it to get the page3D.pdf file.

Load the page3D.pdf file with Adobe Reader 8 where the 3D object is now correctly displayed. We can rotate it (by dragging it with the left mouse button pressed), translate and zoom after selecting the corresponding command from the menu that appears above the object.



Let's create some alternative 'view' to be selected directly from the menu associated with the built-in 3D object.

In the same folder where we saved the file knight.u3d create a text file (with a right click will show a context menu from which select 'New → Text Document'). Open with a double-click the text file, copy and paste (or write) the following text and save.

```
VIEW={Front}
C2C=0 -1 0
ROO=22452
AAC=60
END
VIEW={Back}
```

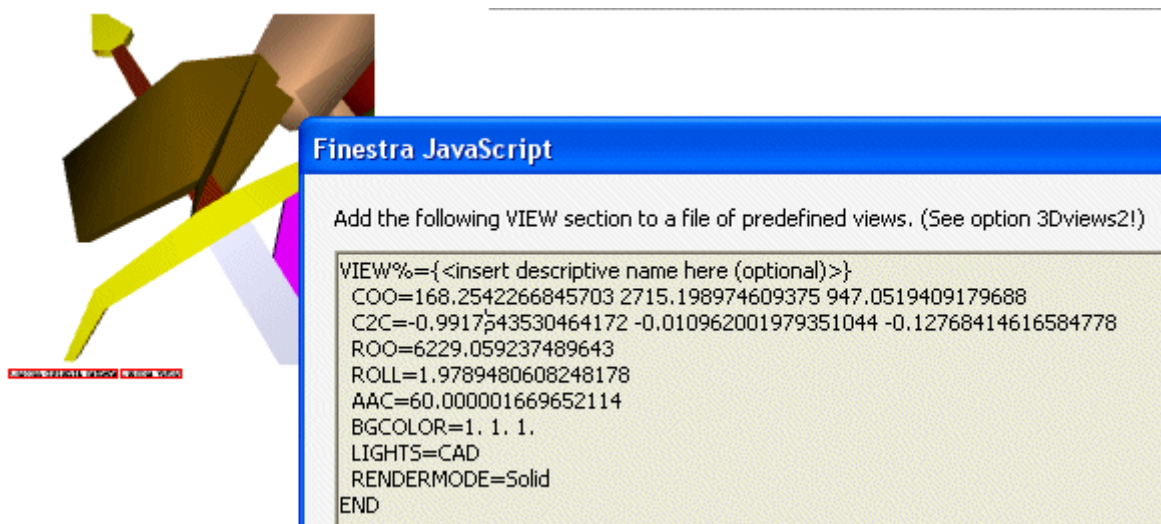
```

C2C=0 1 0
ROO=22452
AAC=60
END
VIEW={Left}
C2C=1 0 0
ROO=22452
AAC=60
END
VIEW={Right}
C2C=-1 0 0
ROO=22452
AAC=60
END
VIEW={Top}
C2C=0 0 1
ROO=22452
AAC=60
END

```

These are standard views in which the object is rotated 90 or 180 °. If we want to add a custom view, reopen knight.pdf the file, rotate and zoom 3D object.

Once we have a shot that seems interesting click the link (Capture View). We'll get a dialog window of this type



Information are already selected. Simply right-click over it to bring up the copy command. Click Copy and then paste informations to the text file before (we round up the decimals). We will get

```

VIEW={Front}
C2C=0 -1 0
ROO=22452
AAC=60
END
VIEW={Back}
C2C=0 1 0
ROO=22452
AAC=60
END
VIEW={Left}
C2C=1 0 0
ROO=22452
AAC=60
END
VIEW={Right}
C2C=-1 0 0

```

```

ROO=22452
AAC=60
END
VIEW={Top}
C2C=0 0 1
ROO=22452
AAC=60
END
VIEW={Sword detail}
COO=168.254 2715.199 947.052
C2C=-0.9917 -0.01096 -0.12768
ROO=6229.0059
ROLL=1.9789
AAC=60
LIGHTS=CAD
RENDERMODE=Solid
END

```

Now save the new text file and rename it as '**views.vws**'.

Load page3D.tex file again with the TEXworks editor and modify it by deleting the links and adding an instruction to load the file views.vws. The final text will be

```

\documentclass[a4paper]{article}
\usepackage[3D]{movie15}
\usepackage{hyperref}
\usepackage[english]{babel}
\begin{document}
\includemovie[
poster,
toolbar, %same as `controls'
label=knight.u3d,
text=(knight.u3d),
3Daac=60.000000, 3Droll=0, 3Dc2c=0.000000 -22452.000000 0.000000, 3Droo=22452.000000, 3Dcoo=0 0
0,
3Dlights=CAD,
3Dviews2=views.vws,
]{\linewidth}{\linewidth}{knight.u3d}
\end{document}

```

Recompile the TeX source (click the green button at the top left of TEXworks) to get the final version of the **page3D.pdf** file.

Note. When TEXworks compiles a source must generate a PDF file. If this file exists, overwrites it, but if this file is already open (eg Adobe Reader), TEXworks crashes and errors.

Now when we open the PDF file with Adobe Reader 7.0 (or higher), we can choose from the menu of the 3D object the preset views.



Possiamo modificare anche le dimensioni standard del riquadro che occupa l'oggetto 3D. We can also change the size of the standard box that 3D object takes.

If we want a box 70% smaller

```
{0.7\linewidth}{0.7\linewidth}{knight.u3d}
```

For a box 25% larger

```
{1.25\linewidth}{1.25\linewidth}{knight.u3d}
```

For a box that has a width of 5 cm and a height of 10 cm

```
{5 cm}{10 cm}{knight.u3d}
```

Obviously, in this way we will incorporate a 3D object on a white PDF page. If we put it on a page that contains more text and graphics we have to compose the entire page using TeX.

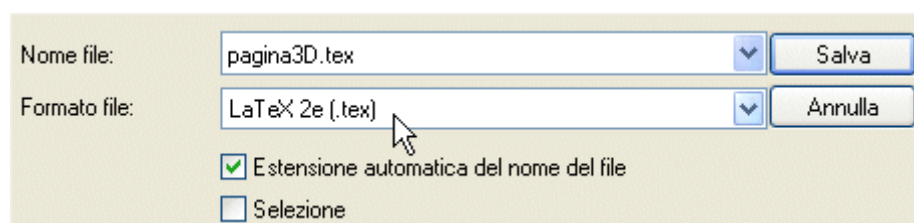
One way to put 3D objects in pages written with normal wordprocessor.

OpenOffice (but AbiWord too) does have the ability to export your documents in TeX format. Older versions of OpenOffice (up to 2.0) had this feature by default. The latest versions require that you install the extension **writer2latex.oxt** downloadable from

<http://extensions.services.openoffice.org/it/project/writer2latex>

Once you've downloaded the extension, launch **Writer** (OpenOffice word processing program). From menu select 'Tools → Extensions Manager' and in window that appears click 'Add ...'. Find the file writer2latex.oxt and load it.

We can now export the document written in Writer to TeX source, by selecting 'Export ...' from 'File' menu and choosing TeX file type.



Once generated the TeX file, open it with TEXworks and add to the preamble (the initial list of LaTeX packages that the compiler should use) the line

```
\usepackage[3D]{movie15}
```

We should also add, in the position where we want it to appear, the instruction for the inclusion of the 3D object

```
\includemovie[
```

```
poster,
```

```
toolbar, %same as `controls'
```

```
label=knight.u3d,
```

```
text=(knight.u3d),
3Daac=60.000000, 3Droll=0, 3Dc2c=0.000000 -22452.000000 0.000000, 3Droo=22452.000000, 3Dcoo=0 0
0,
3Dlights=CAD,
3Dviews2=views.vws,
]{\linewidth}{\linewidth}{knight.u3d}
```

Finally you have to compile the TEX file.

You need Adobe Reader 7.0 or higher

Interactive 3D Object
(Viewable only with Adobe Reader 7.0 or higher)

In this way I have built this PDF document!!