

## How to create Radiology Papers and Presentations in Windows™ with Open-Source Software

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To illustrate the availability, effectiveness, and practical use of Open-Source tools in developing a radiology paper from its beginning to its presentation and publication. Practical use of a complete set of Open-Source applications for writing, e-mail corresponding, slide show, image retrieval, and manipulation is shown by simulating a scientific paper development. Open-Source software proved to be an inexpensive, effective, widely compatible, and user-friendly alternative to commercial toolkits in developing and deploying a scientific paper, either on paper or on slide show.

**KEY WORDS:** Open source, imaging informatics, web technology, user interface

### INTRODUCTION

It is common practice to create office documents, like scientific papers and slide shows, by means of a very narrow set of personal computer (PC) applications, independently from their final purpose.

The most widely spread and used software suites are commercial. They typically need the purchase of a license, whether for personal or professional use.

However, there are several free alternatives to commercial computer applications. There is a wide unjustified concern that these freely available solutions could be, in some sort of way, less developed or just harder to use. This belief contributes towards keeping the software panorama static and strongly homologated.

Two main prejudices can explain the reasons of such homologation: the hypothetical incompatibility of the free alternatives with the most currently used applications, and the fear of facing a new different user interface and learning curve. Contrary to common wisdom, this is not true. We believe it is a

sign of poor information, which becomes even more evident when we think at the pervasive digitalization of radiology and its rapid evolution.

Therefore, we believe that it is important to discuss the role and rationale of the computer applications that we use daily, without ignoring as well the costs that commercial solutions necessarily implicate.

Open-Source applications, i.e. computer software for which the human-readable source code is made available, stand out in this parallel scenario for several advantages under many aspects such as inexpensiveness, code transparency, and quality of solutions.<sup>1,2,3</sup>

In the last few years, the standardization of file formats as well as the will by the Open-Source communities to create highly competitive yet user-friendly products, succeeded in turning a niche for experts, into an interesting alternative for everyone.<sup>4</sup>

These solutions are developed with the aim to be run transversally on different operating systems, allowing a direct approach, as they are totally compatible with the spread platform Windows™.

Believing that a complete set of Open-Source software could be a valid alternative to commercial applications in a radiologist's daily practice,<sup>5</sup> we

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intend to demonstrate our thesis by deepening the main motivations that lead us to this conclusion.

Therefore, the purpose of this study is to simulate the creation of a scientific radiologic study using only Open-Source resources, with the only exception of the operating system.

## MATERIAL AND METHODS

Counting solely on our personal experience matured over the last few years, we arbitrarily chose a set of applications among the numerous Open-Source alternatives available on the world wide web to match the most common operations performed daily by a radiologist. This is how we build up a working system as follows:

- Windows Vista 32 bit (commercial OS), the last version of the well-known operating system, that comes pre-installed in nearly the totality of the new PCs, laptops included. We chose this platform, preferring Vista to other operating systems such as MacOs and Linux distributions, because they are less distributed and, in the latter case, they require specific competence to install and manage applications.
- OpenOffice 2.4 (<http://it.openoffice.org/>) includes a database tool (Base), a spreadsheet (Calc), a word processor (Writer), an equation editor (Math), a presentation tool (Impress), and an image editing application (Draw). With the OpenOffice suite, it is possible to save and import data, not only into common file formats (.DOC, .XLS, etc. ) but even into international standards (.RTF, .XML, etc.). Older file formats (.CSV, .123, etc.) can be saved and imported into Open-Source ones (.ODT, etc.), as well as other file formats as well (.PDF, .TEX). The suite is perfectly integrated into Windows, and it is not necessary to apply any change to the system.
- JabRef 2.3.1 (<http://jabref.sourceforge.net/>) is an Open-Source reference manager, developed by merging the experiences of two previous open projects: it is a simple yet complete software, capable of importing a wide range of reference file formats, and to generate database files in various formats as well.
- Thunderbird 2.0.0.14 (<http://www.Mozilla-europe.org/it/products/Thunderbird/>) is the

e-mail client of the Mozilla suite. Thunderbird is a robust and trustworthy program, a valid alternative to the better known commercial counterparts.

- Paint.net 3.35 (<http://www.getpaint.net/>) is an image editor that includes some interesting capabilities to the common operations of the standard system editor. It adds support for color adjustments, layers and transparencies, without sacrificing user friendliness.
- FireFox 2.0.0.14 (<http://www.mozilla.com/en-US/firefox/?from=getfirefox>) is a popular free browser thanks to its wide compatibility with international web standards, and its high security profile, guaranteed by means of state-of-the-art technological solutions and advanced protection tools (like the built-in anti-phishing filter, that helps in recognizing fraudulent web sites). It also supports more than 40 languages.
- ImageJ (<http://rsb.info.nih.gov/ij/download.html>) is an image reader and editor which can be run on every JAVA capable PC. It can read images from a large set of different formats natively (including RAW and DICOM) and many others by means of plug-ins.
- This software was installed and configured on a desktop PC based on an AMD Athlon™ 64 X2 Dual Core Processor 5000+ with 2Gb RAM.

## THE SIMULATION

The simulation consists in creating an article and a presentation of a scientific paper. As an example we considered the development of a paper describing the height of the anterior wall of the first lumbar vertebra on plain films in a group of consecutive patients.

The main tasks of the simulation are: to communicate by e-mail to the colleagues of the intentions about the study, to search and collect literature on web, to search and select proper images, to collect and analyze data, to write the manuscript, to choose and edit the iconography, and to create a slide show.

## Communication

For communication purposes we used the e-mail client Mozilla Thunderbird. Thunderbird user

interface and its message management are very similar to those of the most popular clients (Fig. 1). The buttons for the main operations (download mail, write, reply, reply to all, forward) are easily recognizable. It is also possible to import settings, contacts, and messages from other commercial programs after few easy steps. Thunderbird is a complete and advanced e-mail client, featuring a RSS reader, which can provide real-time news from the web, a newsgroup reader, which allows joining discussion forums online, and some useful functionalities such as the anti-phishing filter and the integration with the anti-virus system. Updates are automatic and, every time it is used, the program learns new rules to better recognize mail spam.

### Online References Collection

The online search and collection of literature were performed with the Mozilla Firefox browser,

probably the most famous alternative browser. It puts together advanced web functions (tab navigation, download manager, RSS manager, external plug-ins) and a very high security profile. The interface is very similar to the commercial counterparts and its use is quite intuitive: it allows to quickly consult a search engine, to subscribe RSS feeds and to download very large files by the use of the integrated download manager (Fig. 2). Firefox's updating is automatic, consequently it helps keep a constant stability and privacy protection.

### Collection and Analysis of the Images

We used ImageJ to collect pictures and to perform simple measurements and adjustments; it is a Java-based software that offers a wide pattern of functions, often even more than needed, and yet a simple application. It was possible to open DICOM pictures from CDs, to select the fittest, to adjust window and level, and to make linear

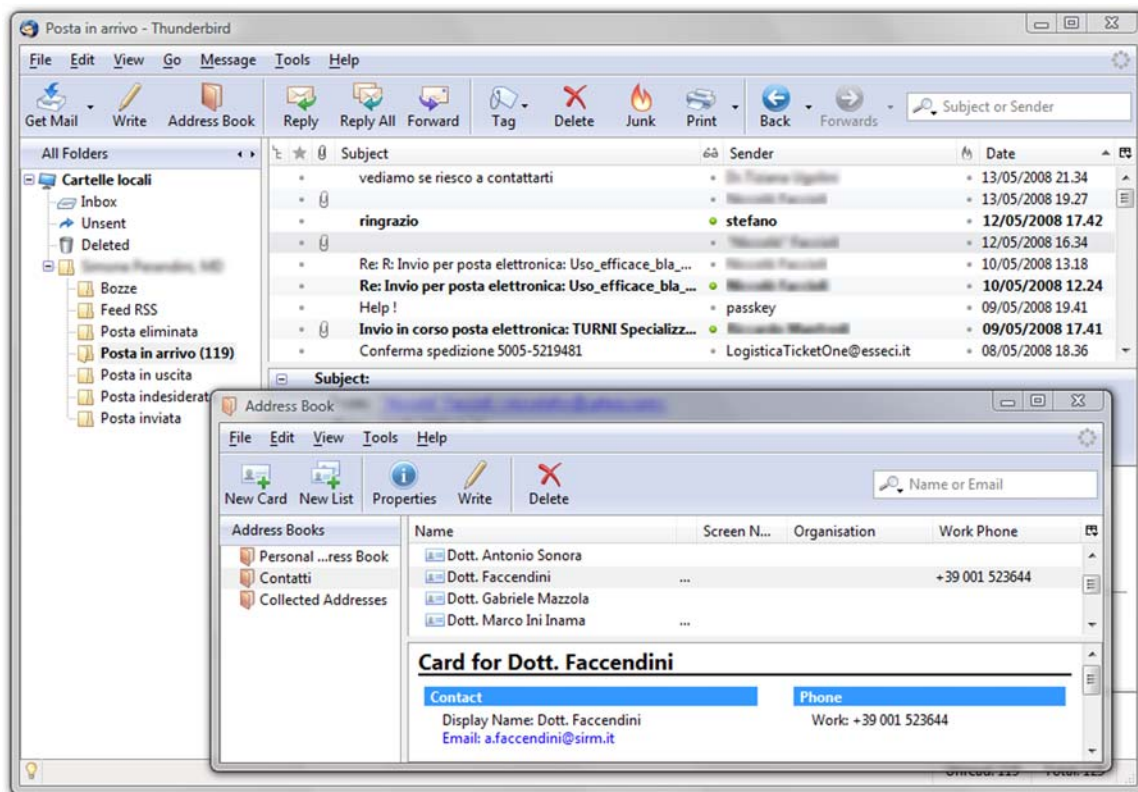


Fig 1. Mozilla Thunderbird graphic user interface (GUI). Messages and contacts are arranged in a simple and intuitive way. Actions such as "Get Mail" or "Write" are reachable directly from the toolbar.

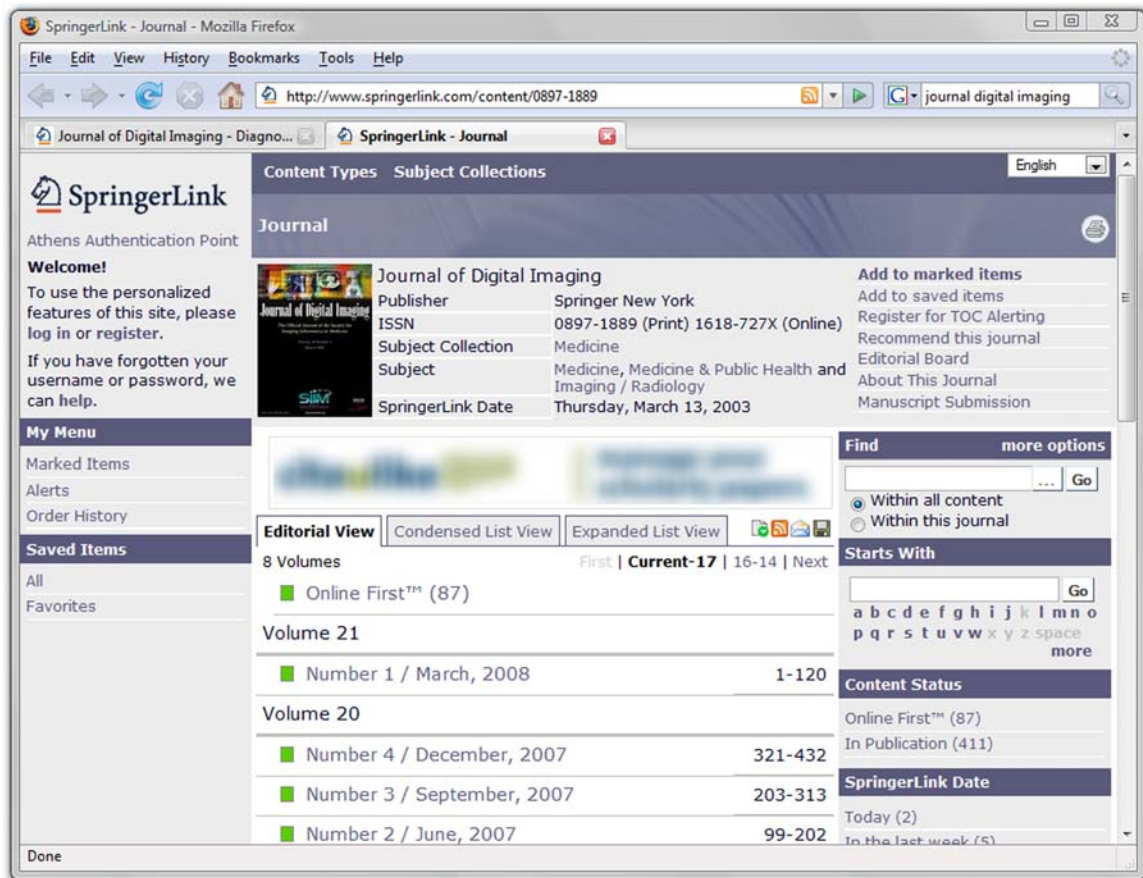


Fig 2. Mozilla Firefox GUI. Firefox looks sharp and handy. A search box is located in the upper right corner to find results on customizable search engines. We looked for "Journal of Digital Imaging" on Google. Multi-tabs navigation is also illustrated. Notice the two tabs, each linking to a different page, just below the location bar.

measurements. The graphical user interface is very clear and the main functions have their own very clear button on the toolbar (Fig. 3).

### Collection and Analysis of Data

Data extracted from radiological images was organized with OpenOffice Calc, which is the spreadsheet component of the OpenOffice.org suite. The entering of data, the creation of formulas, the managements of the sheets and the drawing of charts are similar to the commercial counterparts and consequently they are immediately utilizable even by the beginners (Fig. 4).

We used Calc to organize data, to format the text, to calculate mean values and sums, and to create a chart used to show the fundamental concepts lying behind the data. Calc is compatible with many other competitors, Microsoft Excel® for

instance, and it can import and save data in the commercial software's own native formats. It is also possible to work with Calc and other commercial counterparts at the same time, moving data easily among the sheets.

### The Article

The writing of both the simulated article and this original manuscript itself was possible thanks to OpenOffice Writer, which is a comprehensive text editor, plenty of functions as the commercial counterparts (Fig. 5). The perfect integration between Writer and the operating system allows the simultaneous use of this and other word processors, as well as the possibility to exchange data between them. OpenOffice Writer can create documents starting from templates, but can also import documents created through commercial

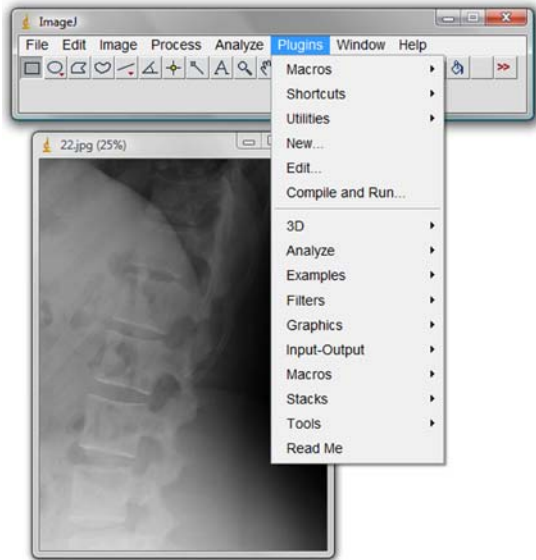


Fig 3. ImageJ: GUI and work area. ImageJ is capable of integrating third-party plug-ins, macros and utilities, making this application truly versatile.

programs, making the migration to this freely available solution very easy. Moreover, this word processor is able to save documents in several formats, which are compatible with on-sale applications. It is important to remember that Writer owns some singular functionalities, such as the ability to export files in Acrobat format (PDF), without the installation of a virtual printer or third-party programs.

The references were downloaded and collected by JabRef (Fig. 6), a free software compatible with the other commercial reference managers. It is also able to create a database, which can be used by OpenOffice.org Writer, to insert automatically refreshing fields, taking the advantage of managing the references and the text with a single program.

In summary, we used Writer and JabRef to type the text, to format and decide the layout, to insert references and pictures, to add figure descriptions

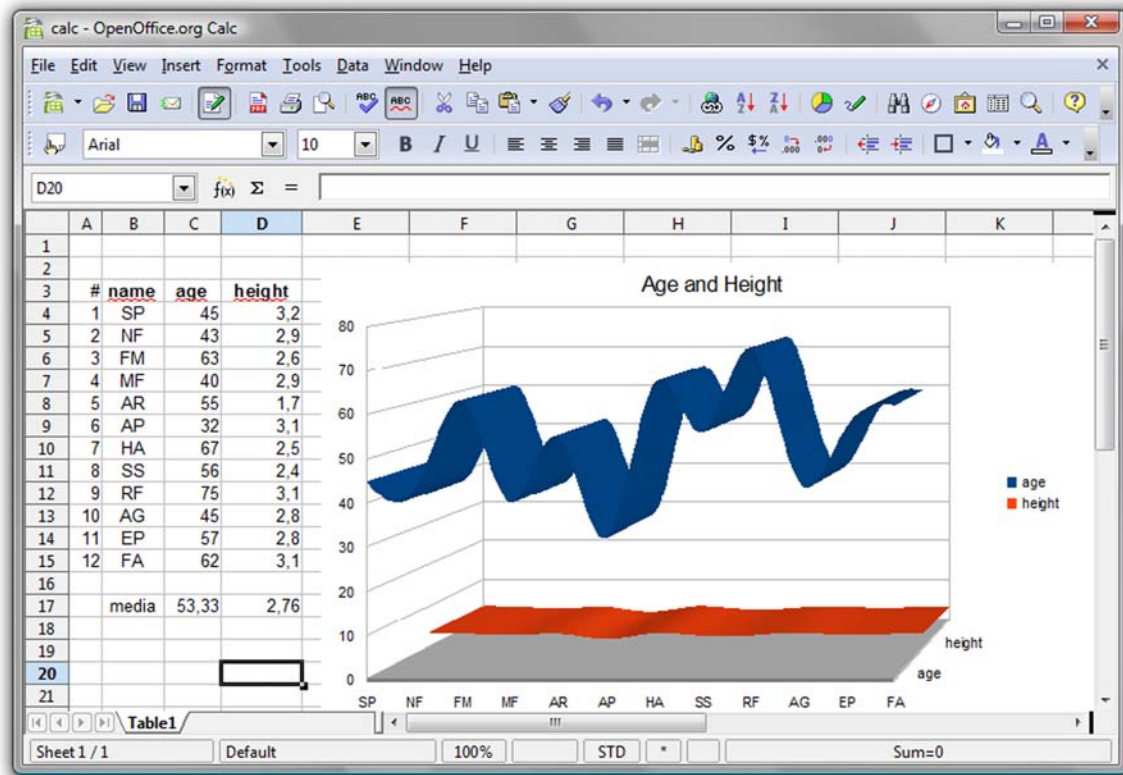


Fig 4. The OpenOffice.org Calc GUI and the work area look like the common commercial counterpart one: toolbars on top, formulas above the work area, and sheet labels just below it. We created a nice looking chart with a few clicks starting from the data collected.

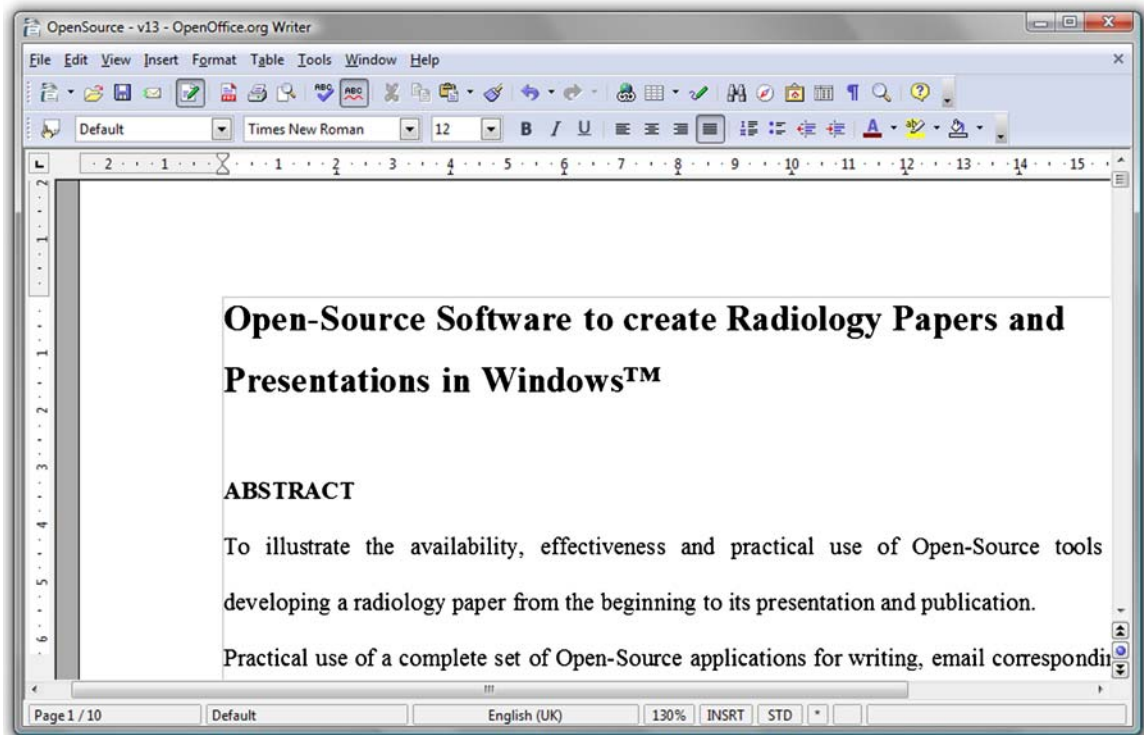


Fig 5. The OpenOffice.org Writer GUI is comparable to other well-known word processors. Menus, buttons, and behaviors are intuitive and user friendly.

and to export the paper in PDF format, to be further forwarded to other collaborators.

#### Preparation of the Iconography

We used Paint.net to prepare the iconography for the slide show and for the publication. The images retrieved and extracted from the original DICOM archives with ImageJ were then edited with Paint.net. Paint.net is a simple and efficient image editor program which takes the editing, compared to Microsoft Paint, to a higher level; however it is not suitable for some particularly sophisticated operations (Fig. 7).

In our opinion, Paint.net is the current best alternative to perform simple editing of radiological images, thanks to the easy use of tools such as the regulation of brightness, saturation, and contrast, or the possibility to cut or resize images with a few clicks, requiring no need for any particular skill. More complete Open-Source alternatives to Paint.net exist, for example The Gimp; hence these applications sometimes may result overly complicated if compared to the actual need for image manipulation.<sup>6</sup>

The operations we used to obtain an iconography of good quality were cutting, adjustment of brightness and contrast, resizing, positioning of arrows, and saving in different formats. In all of these tasks Paint.net was excellent, i.e. much better than the other well-known commercial counterparts.

#### Slide Show

We chose OpenOffice.org Impress to create a slide show; its aspect and its functionalities are very similar to the commercial counterparts (Fig. 8). OpenOffice.org Impress can work with different file formats (both in reading and saving), and it introduces some interesting properties, such as the possibility to export its documents in Flash format, which is now a standard at international congresses thanks to its wide compatibility.<sup>7</sup>

OpenOffice.org Impress helped us write the text and choose the layout; we used it to decide slide timing and transitions, to change color combinations and background, to export the final version of the working PDF format for printing and in Flash format for distribution.

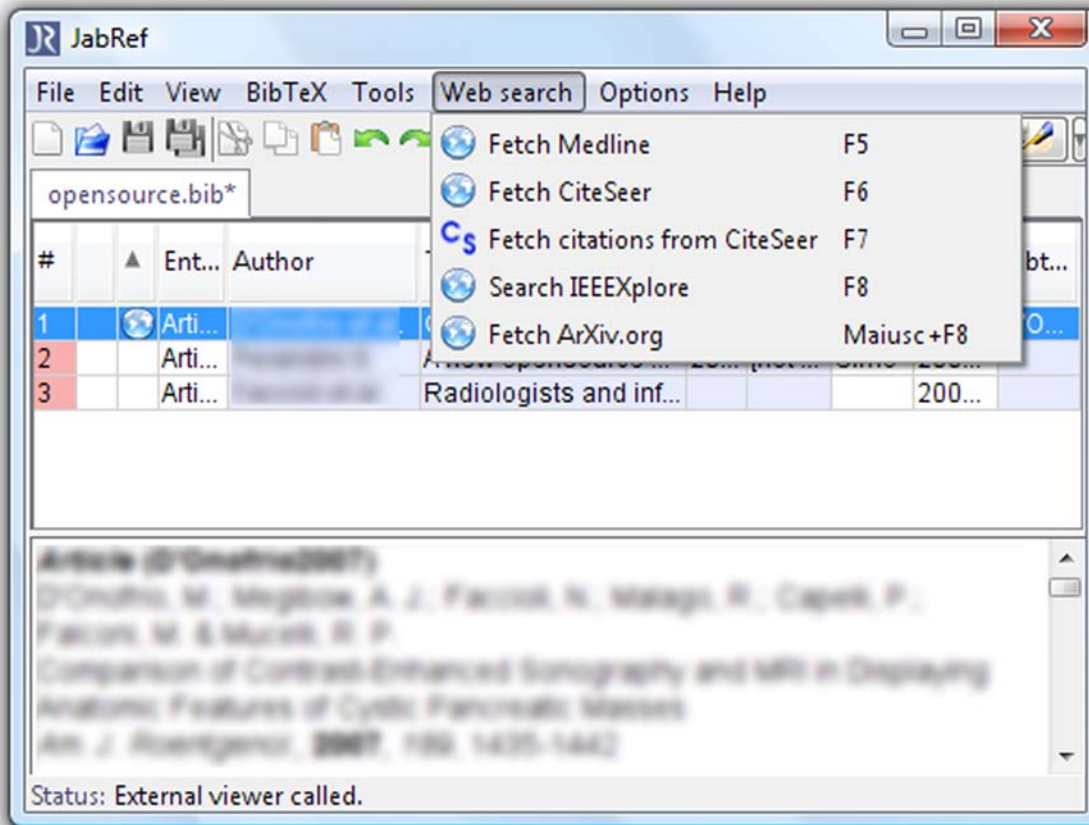


Fig 6. JabRef: GUI and an example library. It is possible to fetch different engines from the very program itself.

#### DISCUSSION: REASONS FOR A CHOICE

The reasons why we suggest to take into consideration the possibility to move to these Open-Source solutions are several. Firstly, Open-Source applications are not less complete than the on-sale counterparts.<sup>2</sup> The standard functions of the commercial programs are entirely included; the advanced ones are incorporated, compatibly with the intent not to integrate proprietary software. Some new functions bundled into the latest commercial software, if they are found innovative enough, can be developed on selected open source software too, and often in a reasonable period of time.

In second place, migrating to these applications is quite easy thanks to the support offered by a wide community of users who shares suggestions on on-line forums.

The working ambient is comforting because different applications have very analogous interfaces: the structure of the menus, the name of the

commands and even the icons are similar. Consequently, the passage from one solution to another is easier and the customer does not feel confused by using both the alternatives at the same time.

It is important to remember that the commercial suites are compatible with the Open-Source ones and vice versa.

Regarding the technical support for free software, or at least the most spread ones (Mozilla Thunderbird, Mozilla Firefox, OpenOffice, etc.), there is a matchless presence of helping groups, forums, websites, and mailing lists. Sometimes it is possible to speak about problems or difficulties and to obtain custom changes directly from the developers of the software itself.

In third place, these applications are very easy to get: they are available online and legally downloadable, free of charge, from specific websites using a broadband connection (Open-Source application can range from a few to several hundreds of megabytes).

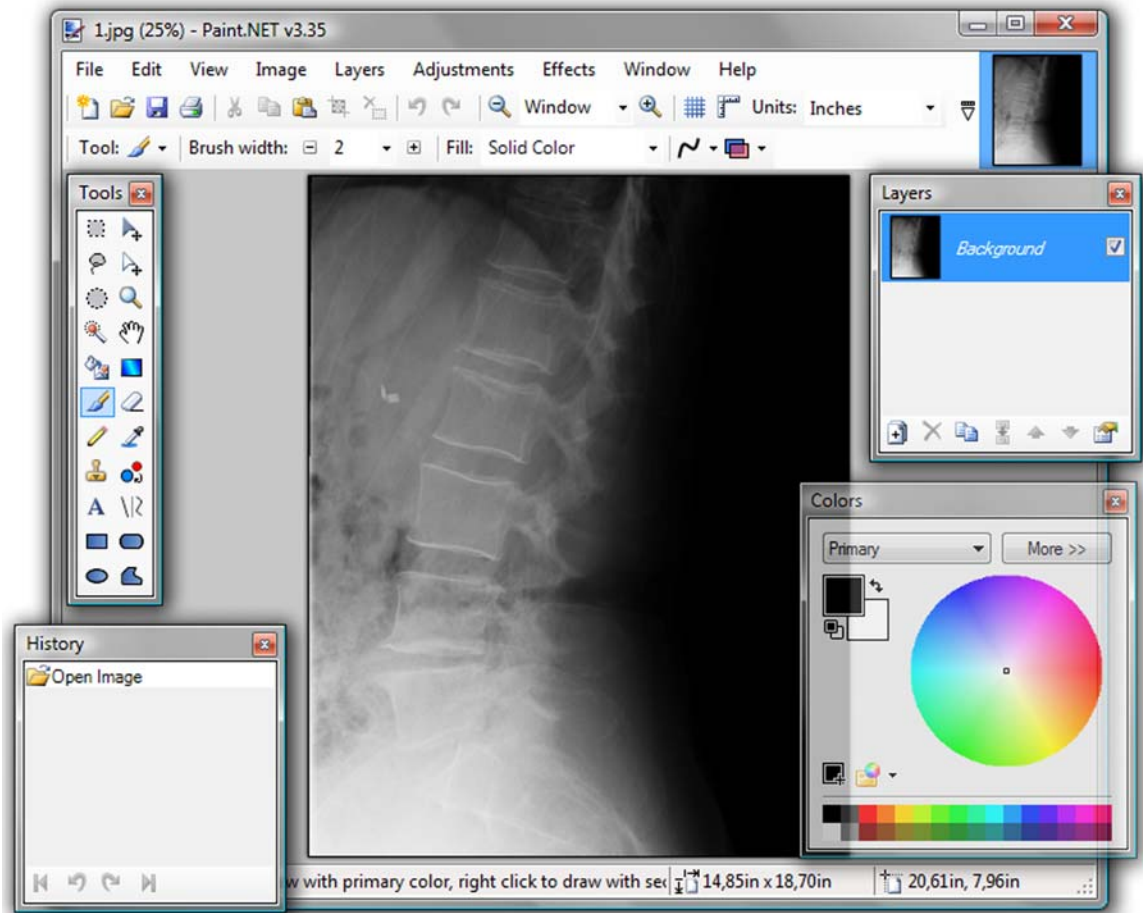


Fig 7. Paint.net: GUI and an overview of the toolbars. The handy floating toolbar on the left allows to select different actions both with the mouse and with keyboard shortcuts.

Moreover, Open-Source software is not influenced by commercial logics; it improves implementations even better while the developers manage to create interesting functions, such as the possibility to run data and programs on an USB pen-drive (OpenOffice Portable, USB version of OpenOffice). This kind of programs does not even need installation, so the portability of the system is even wider.

Updates are constant and always free: by this mean the software is kept up-to-date, the imperfections are fixed and they help maintain a high security profile.

Most of these applications can be customized by third-party plug-ins in order to bring the working experience to the top. It is possible to change settings, to make some common operations automatic and to program the suite to work differently.

In the end we cannot ignore the significant economic saving for a single user or a company that uses of these free alternatives. In fact, licenses of common commercial software can be very expensive, especially if we consider that most of the scheduled updates and plug-ins are not included.

On the other hand, we think that the main limit of such an approach is that setting up an ambient as described above could be a little demanding for a beginner,<sup>8</sup> as it requires browsing among numerous websites, downloading the fittest files for the system and dealing with installers. We believe, however, that these operations could be addressed by a skilled technician in an Institution, while single users still need peculiar abilities.

Eventually, using the Open-Source programs was not harder, more laborious, or less efficient,



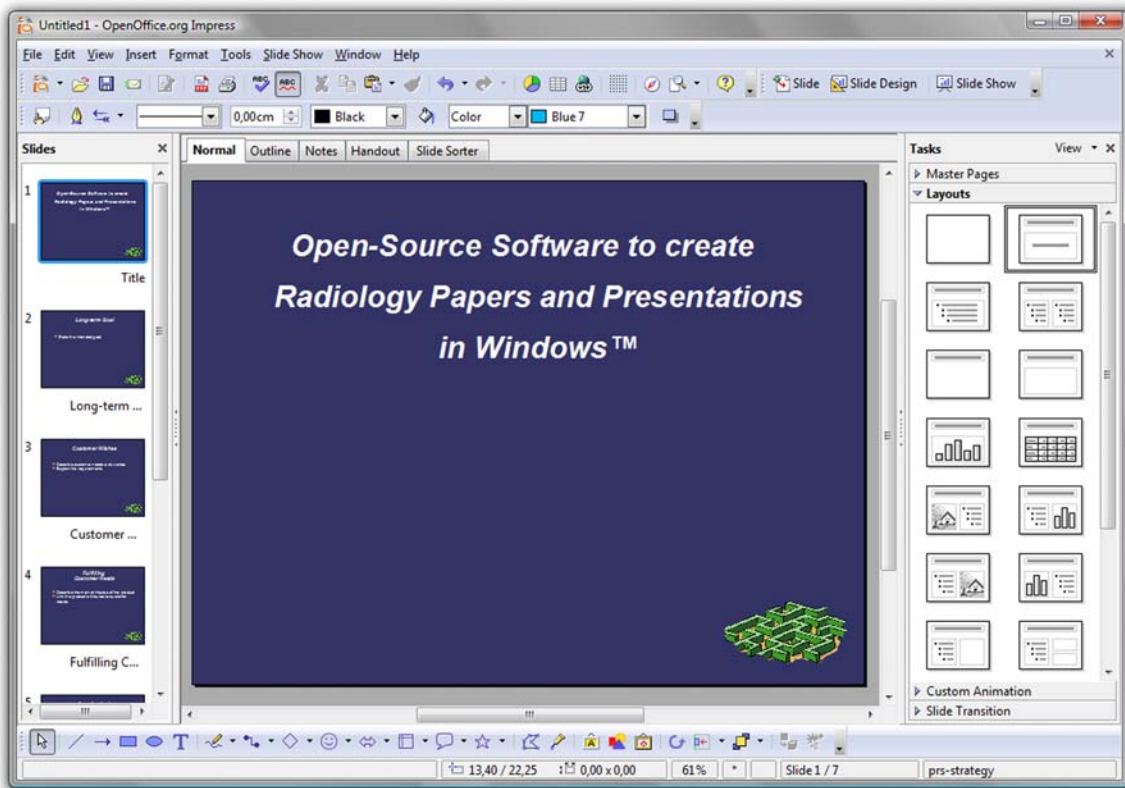


Fig 8. OpenOffice.org Impress: the GUI is very similar to the commercial counterparts. This presentation has been created in a few click starting from a premade template.

since these applications satisfy all the needs that developing a scientific paper requires. The selection of applications we made is arbitrary and based on our personal experience, but it is meant to be a starting point and a clear example on how it is possible to build up a customized suite of free computer programs to fit any particular purpose.

## CONCLUSIONS

The Open-Source applications we tested are a freely available alternative to commercial suites; they are all completely compatible and as much efficient as the commercial counterparts.

Constant automatic updates allow to have a stable, resource plenty, and continually improving working environment. The trustworthiness, the total compatibility with commercial tools already present in the system, and the ease of use, make

these applications an attractive option for the single radiologist and the Institution.

## REFERENCES

1. National Electrical Manufacturers Association. Digital Imaging and Communication in medicine (DICOM) Web site. Available at: <http://medical.nema.org>. Accessed on May 14, 2008
2. Erickson BJ, Langer S, Nagy P: The role of Open-Source software in innovation and standardization in Radiology. *J Am Coll Radiol* 2:927–931, 2005
3. Open-Source. Article in Wikipedia. Available at: [http://en.wikipedia.org/wiki/Open\\_source](http://en.wikipedia.org/wiki/Open_source). Accessed on May 14, 2008
4. Escott EJ, Rubinstein D: Free DICOM image viewing and processing software for your desktop computer. What's available and what it can do for you. *Radiographics* 23:1341, 2003
5. Nagy P: Open-Source in imaging informatics. *J Digit Imaging* 21:1–10, 2007
6. Scarsbrook AF: Open-Source software for radiologists: a primer. *Clin Radiol* 62:120–130, 2007
7. Yam CS: Using macromedia flash for electronic presentations: a new alternative. *AJR* 187:209–217, 2006
8. Gatta R, Abeni F, Buglione M, et al: Open-source, low-cost, high-reliability solutions for digital imaging systems: Example of a "dicom router". *Radiol Med* 112:1252–1259, 2007