LyX for academia

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1 What is LyX?

LyX is a cross-platform program which harnesses the resources of the TeX, XeTeX and LuaTeX typesetting engines and a wide variety of writing tools, including the LibreOffice dictionaries and thesauri, to enable writers, editors, copy-editors and typesetters to create superior documents for web and print media.

2 TeX, LaTeX and LyX

TeX[1], a typesetting engine written in Pascal by Donald Knuth, implements best typesetting practice as set out in the *The Chicago manual of style* (University of Chicago Press, 1982). Among the limitations of TeX arising from its creation before the growth of the Internet is that it does not support Unicode and offers only a limited range of typefaces. The XeTeX and LuaTeX typesetting engines seek to address these weaknesses and support for them was added in LyX 2.

LaTeX began as a markup language to help DEC employees to use TeX but has spawned a large number of packages to serve the diverse needs of writers, all of which are available from CTAN. No one needs them all; so selections of the most useful are distributed, notably as *MacTeX* for Apple computers, *TexLive* for Linux and *MiKTeX* for Windows, to which users can add whatever else they need from CTAN.

LyX was created by Matthias Ettrich in 1995 as a graphical user interface for the LaTeX macros. Originally, it simply hid the complexity of the most common features of LaTeX so that the user could produce beautiful documents without knowing anything about LaTeX. But it has gradually evolved into a flexible writing tool that can handle an increasing range of LaTeX features while enabling those who understand LaTeX to tweak the output in a variety of ways.

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[*]The author would welcome notification of any errors or possible misunderstandings.

[†]First presented in the Magrath Room of The Queen's College, Oxford at 11 am on Monday, 4 May 2015.

[1]The name TeX is a representation of the Greek letters T, E and X which start the word from which we get 'technical;' so it is pronounced 'tech' as in 'technical' rather than 'teks.'

3 Why use LyX?

Most of the things that you can do in a word-processor, such as styling and colouring text, adding images and tables, adding headers, footers, margin notes, footnotes and endnotes, defining bullet styles, find and replace, spell-checking or change management can be done in LyX. Some require the use of LaTeX commands within the LyX interface, for example, rotating text or defining numbering styles.

The advantages of using LyX over a word-processor, which are covered in the next two sections, fall into two main groups: those which derive from using LaTeX, XeTeX or LuaTeX and those which relate to the LyX interface.

4 Reasons derived from LaTeX, etc.

4.1 Parts, chapters and sections

LaTeX offers a hierarchy of parts, chapters (in books) and sections, with normally at least three levels of sectioning, in which numbering is handled consistently and automatically. Parts, chapters and sections can automatically be included in the Table of Contents of a book or the Bookmarks of a PDF. No word-processor offers this; at best you will get options to create Master and Child documents (also available in LaTeX) or Sections.

Within LyX the outliner allows you to move any part, chapter or section anywhere within the document or to promote or demote it in the hierarchy while the document settings allow you to specify the depth of the Table of Contents, for example, just chapters or chapters, sections and subsections.

4.2 Front matter, main matter and back matter

A book always consists of:

- *front matter*, anything before the start of chapter 1,
- *main matter*, the chapters of the book, and
- *back matter*, the appendices, bibliography, indexes and so on.

Elements in the front matter of English books are unnumbered and the pages always have Roman numerals; elements in the back matter, other than appendices, are also unnumbered. The pages in the main and back matter always have Arabic numerals. This is handled in LaTeX by marking the start of the front matter and main matter (and the back matter if it contains anything other than appendices, bibliographies, glossaries or indexes which are automatically considered back matter). This is independent of any decisions the author makes about the parts, chapters or sections of the main matter.

No word-processor offers this feature.

LyX does not handle this natively and does not display it correctly but it is trivial to add the LaTeX commands which produce correctly formatted output.

4.3 Automatic handling of appendices

LaTeX allows you to mark the start of the appendices and any chapters or sections that follow are numbered differently from the chapters in the main matter.

This is fully supported in LyX.

4.4 Floats for images and tables

It is normal to print larger images or tables on a page of their own or at the top of a page. LaTeX offers floats to do this; an image or table together with a caption can be placed in a float near the text to which it refers and cross-referenced in the text. LaTeX then selects the best page on which to place the float; if the text changes, LaTeX will recalculate the best page on which to place the float.

Small tables, for example,

Bradford GNU/LUG	WYLUG
Last Wednesday	Second Monday

and images, such as (the Notes icon), can be placed inline and TeX will automatically format the paragraph to accommodate them. They can also be placed between paragraphs but, if they are not in a float, they cannot be cross-referenced. The exception is a long table which cannot be placed in a float, because it is intended to cross page boundaries, but can be given a caption which can be cross-referenced.

No other software offers this level of flexibility.

These features are fully supported in LyX; in addition, LyX will accept images in almost any format because it uses the ImageMagick program to create a `.png` image to display on screen and an `.eps` image to send to the TeX engine. It also supports the LaTeX features that allow you to resize or rotate images or rotate tables.

4.5 Bibliographies, indexes and glossaries

LaTeX can handle multiple bibliographies, multiple indexes and glossaries. While a simple bibliography can be entered directly into a LaTeX document in much the same way as in a word-processed document, anyone who is likely to re-use a reference is better off storing it in a BibTeX database and accessing it through BibTeX or BibLaTeX.

Both programs can generate a wide range of bibliographic styles; this means that, once you have entered a reference in the database, you can re-use it with any bibliographic style you choose, simply by specifying that style for the bibliography.[2]

The BibTeX database format requires you to specify the nature of the item you are cataloguing; this ensures that, when using English, journal and book titles are printed with italics but chapter and article titles are not and a Master's Thesis and a doctoral thesis are correctly typeset. It also means that, if you write for a foreign language journal, you can choose an

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[2]There is an almost complete catalogue of European and North American BibTeX styles at http://johnrhudson.me.uk/computing/BibTeX_styles_catalogue_for_LyX.pdf

appropriate bibliographic style and your bibliography will appear in a language appropriate style with words like 'Edited by' and 'Edition' translated for you.[3]

BIBTEX also supports the inclusion of hyperlinks in citations; as long as hyperlink support is enabled in a document, these will be active in any document which accesses the citation, as demonstrated on page 22.

Multiple bibliographies can be at the end of each chapter or section and/or at the end of a document.

There is no need to keep track of your citations, index entries or glossary definitions. These are automatically updated in the bibliographies, indexes and glossary whenever there is a change in the document, whether by addition or deletion. This means that bibliographies, indexes and glossaries are always consistent with what is in the text of the document.

While word-processors offer facilities to manage bibliographies and indexes, they do not offer dynamic handling, flexible handling of multiple bibliographies within a single document or the range of bibliographic styles that BIBTEX does.

The separation of multiple bibliographies within a document requires the insertion of LaTeX commands but, otherwise, these features are fully supported in LyX; there is an introduction to BIBTEX in appendix C.

4.6 Mathematics

Early in the life of LaTeX the American Mathematical Society developed a range of packages for typesetting mathematics which are the gold standard in maths typesetting. These enable mathematical expressions to be typeset inline or in their own paragraphs, numbered and cross-referenced. For example, if I enter $\sum_{i=1}^{n}$ in-line, the sub- and superscripts appear after the $\sum$ whereas the same expression in its own paragraph

$$\sum_{i=1}^{n}$$

shows the sub- and superscripts in the correct positions (as also happens with the product $\prod$ and co-product $\coprod$).

LyX implements virtually all these natively and has an unrivalled maths manual explaining how to typeset maths correctly. Unlike all other maths editors, there is no need invoke a different interface; maths editing is carried on within the same interface as text editing. LyX also has an advanced search feature which enables find and replace of mathematical expressions. There is an introduction to the maths features in appendix B.

4.7 Document classes and paragraph styles

LaTeX enforces the use of document classes and paragraph styles. Unlike a word-processor which lays out a page line by line, LaTeX lays out the document page by page according to the

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[3]However, names of editions, e.g. 'Third,' may not be depending on the style chosen.

chosen document class which in turn determines which paragraph styles will be available. For example, a letter or a script for a film has a very different layout and needs different paragraph styles from a book or report.

If you choose a foreign language document class or set a different language for the document, it will be typeset according to the conventions of that language; for example, the addition of spaces before certain punctuation in French happens without any action on the part of the author.

As with word-processor templates, you can create your own document classes and edit paragraph styles but they cannot be dispensed with in LaTeX as they can in a word-processor because they are essential to the process of laying out the whole document.

LyX supports the most commonly used document styles and new document styles can be added; it supports limited editing of paragraph styles, for example, the width of an indentation.

4.8 Page layout

The TeX engine also differs from all word-processors in offering more extended and sophisticated algorithms for handling key aspects of the layout of a document, including determining page boundaries by examining the entire content of a chapter or section. It will sometimes permit a widow or orphan because removing it would make the layout of other pages less satisfactory.

4.8.1 White space handling

Unlike a word-processor, the TeX engine lays out a page by sharing horizontal space across each paragraph and vertical space between each paragraph so that the white space between the words in a paragraph is roughly the same and the bottom lines match on facing pages. It automatically adds a wider space at the end of a sentence and allows you to specify a thin space, for example, between a sequence of initials.

LyX fully supports these features.

4.8.2 Headers, footers and two sided format

LaTeX automatically generates headers and footers, including page numbers, according to the style specified; if a two-sided document is specified, page numbers are automatically placed on the outside of the page.

It always starts a chapter on a fresh page and, if a two-sided document is specified, on a right hand fresh page, inserting additional pages as necessary.

LyX supports most of these features natively, the only exception being styles which permit non-standard headers or footers; these have to be specified using LaTeX commands.

4.8.3 Footnotes or endnotes

As in this document, LaTeX automatically distinguishes between footnotes relating to a document title, which are indicated using an asterisk or dagger if there is more than one, and footnotes within the main text which are numbered. Footnotes may be collected as endnotes at the end of each chapter or section or at the end of the document.

LyX supports the footnote features natively; the placing of endnotes has to be specified using LaTeX commands.

4.8.4 Multiple columns

Multiple columns may start and finish anywhere on a page and LaTeX will apply the same formatting principles to them as to a whole page; so, for example, the bottom lines of columns will match.

LyX supports simple multiple columns starting and finishing anywhere on the page natively but for more complex layouts LaTeX commands have to be used.

4.9 Dynamic cross-referencing

By labelling a heading, caption or footnote, you can cross-reference it anywhere else in the document; there is no need to know what chapter it is in or what page it is on — LaTeX will add that. Additionally, if the cross-reference is to the previous or following page or to a facing page in a two-sided document, it will use 'on the previous page,' etc. as appropriate rather than using the page number.

Some word-processors offer static cross-referencing with manual updating; only LaTeX offers dynamic, and intelligent, cross-referencing.

These features are fully supported in LyX.

5 Reasons based on the LyX interface

5.1 The LyX interface

Figure 1 shows the start of this document using the classic icon set and the triple pane interface with two documents opened in tabs. To the left of the text area is the outliner showing the Table of Contents; selecting this button allows you to change the list to images, tables, footnotes, references, etc. Towards the top left hand corner, the Author button shows that the cursor is in a paragraph whose style is Author; selecting this button allows you to change the paragraph style being used. The name of the author is in a hyperlink box which, like those in the paragraph below, becomes a blue clickable link in a PDF.

Below the text area is the LaTeX source code for the paragraph containing the name of the author and the two footnotes. The footnote text is in the footnote markers, which can be opened for further editing, but will appear at the foot of the page in any output. This makes
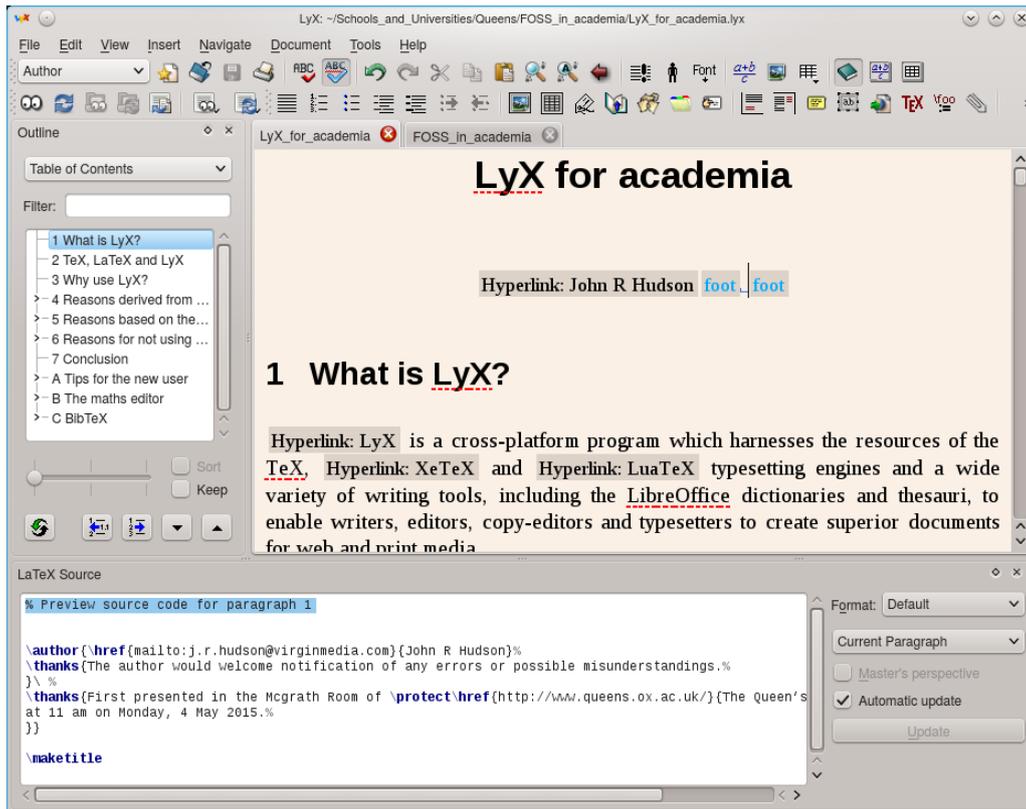
Figure 1: The LyX interface

it easier to keep track of any changes in what a footnote refers to and less likely that you will forget to edit the footnote when the text to which it refers is changed.

The red underlining of 'TeX' and 'LibreOffice' shows that I have not added these words to my personal dictionary.

For most work, I close the outliner and source code panes and, unless I am using a split screen to edit different parts of the same document, use a relatively small window because it causes less eyestrain. But you can choose whatever size interface you are comfortable with and customise many aspects of the interface with Tools ▷ Preferences.

5.2 Context sensitive menus

The LyX interface makes extensive use of context sensitive menus, that is, options which are not relevant to what you are doing will not appear or are greyed out, while the Navigate menu will grow and adapt to every change you make, giving a direct link to every part, chapter, section, float, image, footnote, citation or cross-reference that you have entered.

If you wish to access several of the above, you may find that opening the outliner, which does not close when you have made your selection, is preferable to using the Navigate menu.

5.3 Tabbed documents, split views and insets

Multiple documents are opened in separate tabs and split views can be opened to edit two documents simultaneously or to edit different parts of the same document. For example, you can have a translation side by side with the original or check different parts of the same document to make sure that you are not unnecessarily repeating yourself.

This does not slow L𝑌X down; I have worked on a 300,000 word document alongside other documents without any reduction in scroll speed, in part because insets such as floats and footnotes can be closed so that there is no need to render them as you move through the document.

The only things that will slow the scroll speed down are keeping the source code pane open and very long long tables (which, because they cannot be in a float, cannot be closed).

5.4 Advanced search

As well as an excellent Find and replace, L𝑌X has an Advanced Find and replace feature which allows you to find and replace formatted material, in particular mathematical expressions.

5.5 Autosave and emergency save

L𝑌X has the most unobtrusive autosave I have ever come across and an emergency save feature which will often save everything successfully as the computer crashes. So there is no need to bother about saving a L𝑌X document until you have finished working on it.

5.6 Version control

L𝑌X supports RCS, CVS, SVN and GIT version control as long as you have your chosen version control software installed on your computer.

6 Reasons for not using L𝑌X

6.1 For certain scripts

L𝑌X does not yet support all the scripts supported in LaTeX, notably Indian scripts and polytonic Greek, the latter being scheduled for inclusion in late 2015. It does, however, support the Latin Modern fonts which contain glyphs for all known Roman script accents and diacritics.

6.2 For lithographic printing

PDFs produced by LaTeX will produce the highest quality output using digital printers but the hyperlinks contained in a LaTeX document may cause problems during lithographic printing.

6.3 For highly coloured documents using bleeds

LaTeX is not intended for producing highly coloured documents where the position of each image is crucial and colour goes to the edge of the page; for this Scribus or commercial desktop publishing software should be used.

6.4 Single use cases

Because of the learning curve involved in becoming familiar with all the features of LyX, using LyX for a single document other than one containing significant amounts of mathematics may not be worthwhile. The advantages of LyX, particularly the ability to re-use references in a BibTeX database in future documents without ever having to re-enter or re-format them, accrue with regular use over time.

This applies as much to a single author as to a team authoring a text using LyX unless the team already has members familiar with LyX who can support those who not familiar with it. That said, David Spencer successfully used LyX to create the image rich research report on the Stanbury Hill Project, the excavation of a rock art site on Bingley Moor in Yorkshire.

6.5 Import from a wide range of word-processors or spreadsheets

If a document relies on importing pre-formatted material from a wide range of different word-processors or spreadsheets, then the time taken to reformat this material after importing it into LyX as text files may make using LyX more time-consuming. For example, while graphics are always linked in LyX and can therefore be edited and refined many times before publication without having to be re-imported, tables are never linked and must be re-imported every time a change is made in the source table. Thus collaborating on a document containing many tables, particularly if they are being refined during the course of the writing, may be better effected using a word-processor.

On the other hand, when preparing an edited collection, the different authors will almost always have used different facilities in their chosen word-processor and trying to bring consistency to documents created on different word-processors can take longer than importing them all as text files and letting LyX bring consistency to the document.

6.6 To be 'different at all costs'[4]

LyX enforces typographical standards on the author which are built into the LaTeX packages; if you don't want to be bound by these standards, you need to use a word-processor.

7 Conclusion

LyX crosses the boundaries between traditional word-processors such as Microsoft Word, OpenOffice and LibreOffice and desktop publishing software such as Adode InDesign and Quark Express.

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[4]'Different at all costs' is a (polite) translation of the Swiss German phrase '*Ums Verrecken anders.*'

It offers typesetting quality unavailable in traditional word-processors, maths typesetting quality unavailable in any other software and document handling features not available in word-processors or frame-based desktop publishing programs. It also comes with more authoring tools than any word-processor or desktop publishing software.

For academic use, the features offered by BibTeX alone make it worth exploring while its maths handling should make it the program of choice for anyone needing to write significant amounts of mathematics.

For publishing edited collections LyX offers consistency across individual contributions and the freedom to place bibliographies, footnotes and endnotes to suit the particular needs of the edited collection.

Whether these features make LyX the software of choice will partly depend on the range of features an author or group of authors need. But no academic should ignore the possibility of using LyX to save time while enhancing the quality of their work.

A Tips for the new user

A.1 Document classes

The default document class when you open a new document in LyX is 'article' but nowadays it is worth going immediately to Document ▷ Settings and changing the Document class to 'article (KOMA-Script)' and, if you don't want the current date to appear in every document, select Suppress default date on front page. If you wish to use system fonts, go to Fonts and enable Use non-TeX fonts; then select the appropriate Roman, Sanserif and Typewriter fonts; if you prefer the LaTeX fonts, change the Roman, Sanserif and Typewriter fonts to Latin Modern. Also, if you are including references, change the Bibliography to Natbib; if you intend to distribute documents in PDF format, go to PDF properties, tick Use hyperref support and fill in the details. You can then save these changes as your default document class (unless you intend to use a different class more frequently).

A.2 Font size and margins

Font sizes in LaTeX are determined by the font size used for the body text. All other font sizes in a particular document class are set relative to this font size. Often margins, top and bottom, inner and outer, are set relative to the font size, reflecting best typesetting practice in the language which the document class supports. This may vary from country to country, in some cases because languages with accents may benefit from slightly taller line heights.

However, the KOMA Script document classes offer a choice of two different traditional typesetting conventions for determining page margins. For more details, see the KOMA Script documentation.

A.3 Character sets

The default character set for LaTeX is Latin-1 but LaTeX allows different input and output encodings which was helpful in the days before Unicode. LyX supports UTF-8 as an input

encoding and Scott Pakin maintains a comprehensive list of the symbols available in LaTeX and the packages needed to support them at CTAN. You may find you need to consult this to use an obscure mathematical or phonetic symbol or an accent.

XeTeX and LuaTeX offer full Unicode support.

A.4 Text enhancements

Most of the text enhancements you need will happen automatically as you select a paragraph style; the full range of enhancements is available through Edit ▷ Text style ▷ Customized but only *Emphasis* and Small caps have their own icons as these are the only two which typesetters traditionally use within the text of a document.

A.5 Getting the right —, ' and space

Typesetters, and therefore TeX, distinguish between what most people think of as a dash or hyphen; so one of the few quirks of the LyX interface which a new user needs to know is the difference between a *hyphen*, an *en dash*, an *em dash* and a *minus sign*. The first three are made with one, two or three '-' characters and the fourth by using math mode.

Name	Unicode	Output	Made with	Used for
hyphen	U+2010	-	'-'	Word and line breaks
en dash	U+2013	–	'--'	From A–Z; pages 3–15
em dash	U+2014	—	'---'	Dash — there it goes again!
minus sign	U+2212	−	Ctl-m '-'	$x^2 - y^2 = z^2$

Because TeX was originally developed for 7-bit ASCII systems, it uses the backquote (`) for the opening quotation mark and the apostrophe (') for the closing quotation mark. LyX will generally respect quotation marks in UTF-8 but, if you import text from word-processors that use different encodings, you may have to replace them to get the correct character to appear.

Less obviously, LaTeX distinguishes between a full stop after an abbreviation and a full stop at the end of a sentence and puts more space at the end of a sentence. However, this algorithm is not perfect as LaTeX may think a full stop after a lower case character is at the end of a sentence and one after an upper case character is after an abbreviation. So 'It is I. No it is he' and 'Prof. Jones' may be wrongly typeset. To adjust this insert an end of sentence full stop (Ctl-full stop or Insert ▷ Special character ▷ End of sentence) after 'I' and an inter-word space after 'Prof.' (Ctl-Alt-space or Insert ▷ Formatting ▷ Inter-word space). This produces 'It is I. No it is he' and 'Prof. Jones.' In my experience, this is less frequently a problem than not using the correct dash.

A.6 File names and folder paths

Because graphics are always accessed via a link which must satisfy traditional Unix conventions, avoid spaces and most non-alphanumeric characters other than _ and - in file names and folder paths as these will often halt TeX without throwing up a meaningful error message.

A.7 Export formats

Different users will champion different ways of generating Word documents from a L_YX document but, as long it does not use many footnotes which will have to be added in to the resulting Word file, Export ▷ HTML and then copy and paste the entire file into a Word document works reasonably well. This preserves the text formatting, particularly of bibliographies, but may require some manual adjustments to the Word file — not enough to outweigh the time saved in achieving the consistent output that L^AT_EX is famous for.

B The maths editor

L_YX has an inline maths editor which has evolved to cope with the huge number of mathematical symbols needed — most alphabets don't have more than 40 characters and so editing text is relatively simple by comparison.

You can use the L_YX maths editor in three ways: with a small number of keyboard combinations, with the basic maths toolbar and with the advanced maths toolbar.

B.1 Very basic maths

You can enter mathematics in-line with Ctl-m or in display mode, that is, in a separate paragraph, with Ctl-M (Ctl-shift-m). But you can also use math mode to set out text in certain contexts; for example, you might want to say that:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

Here I began with Ctl-M to obtain display mode and then entered Ctl-m (which toggles to allow you to enter text as text within maths mode) to enter 'Speed.' This text was nested in math mode; so I had to move the cursor out of the nested text back into math mode to enter the equals sign and then the fraction ($\frac{a}{b}$ in the basic maths toolbar). The fraction appeared with two empty containers. I put the cursor in each of these and entered Ctl-m each time in order to add the text above and below the line. I then moved the cursor out of all the containers and pressed Enter in order to start the next paragraph. Had I not entered Ctl-m in math mode in order to use text mode nested within math mode, I would have got *Speed* because T_EX would have assumed I was entering a mathematical expression.

The point of using math mode in a situation like this is that the result is perfectly typeset in a way which, if not impossible, is more difficult to achieve in a word-processor. However, most people will want to use math mode for more formal mathematics.

Apart from Ctl-m or Ctl-M to initiate math mode, ^ adds superscripts like powers and _ adds subscripts. So you can enter things like $x^2 - y^2 = z^2$ without ever using the toolbar. Note that the output has spaces in the expression which are generated by L^AT_EX; only in a limited number of situations is it necessary to add extra spaces when entering expressions in math mode.

Whenever you use these keyboard combinations, you are creating a nested container in which to place one or more expressions. When a container is empty, it has a blue border; when you fill it, the border disappears and is often replaced by red markers at each corner. These markers can be a little indistinct on the screen but they are useful when, for example, you place a container within another container. For example, to enter an expression like $x^{\frac{1}{2}}$, you follow x with a superscript container and then the two fraction containers. Having added the 1 and 2 to the fraction containers, you move out of the fraction containers first, then out of the superscript container and finally out of the math mode container. As you move the cursor, you will normally see it cross the boundaries of the containers as marked by the red corners.

You can move out of a container by using Esc or the arrow keys or the space bar if you are at the end of the expression in the container. Using the space bar elsewhere can produce unexpected results; so I generally avoid this method though LaTeX users who are used to ending an expression with a space will find it natural.

B.2 The basic toolbar

Whenever you enter math mode, one or both maths toolbars appear; if both appear, the π icon on the right allows you to toggle just the basic toolbar or both of them. The first three icons toggle in-line and display mode and allow you to enter subscripts and superscripts; the square root icon has a single container and the root icon has two. Next comes the simple fraction icon. The following examples from a mathematical textbook (Courant and Robbins, 1996) illustrate how LaTeX can sympathetically typeset deeply nested expressions using the simple root and fraction functions:

$$2^m \sqrt{2 - \sqrt{2 + \sqrt{2 + ... + \sqrt{2}}}}$$

$\frac{840}{611}$ can be expressed as:

$$1 + \frac{229}{611} = 1 + \frac{1}{\frac{611}{229}} = 1 + \frac{1}{2 + \frac{153}{229}} = 1 + \frac{1}{2 + \frac{1}{\frac{229}{153}}} = 1 + \frac{1}{2 + \frac{1}{1 + \frac{76}{153}}} = 1 + \frac{1}{2 + \frac{1}{1 + \frac{1}{\frac{153}{76}}}} = 1 + \frac{1}{2 + \frac{1}{1 + \frac{1}{2 + \frac{1}{76}}}}$$

The next four icons offer you the three commonest delimiters and access to the full range of available delimiters including omitting one of a pair (as I did after $\coprod$ on page 4, having used an ordinary '(' to open the parenthesis). Though most keyboards offer you '(', '[' and '{,' these are not scalable; so you can get odd effects if you include them in an expression such as $\frac{2(p+q)}{r}$. If you use the equivalent math mode delimiters in, for example, two slightly different expressions, $\frac{2(p+q)}{r}$ and $\frac{2(p^2+q^2)}{r^2}$, the delimiters are scaled to match the expression. This applies when using the next two icons, to insert a matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ inside delimiters or to create an array $\begin{cases} a & b \\ c & d \end{cases}$.

The next four icons allow you to add or delete rows or columns to and from matrices and arrays, in the course of which the delimiters will change size:

$$\begin{bmatrix} a & b \\ c & d \\ e & f \end{bmatrix}$$

Matrices and arrays have the number of containers needed to match the number of rows and columns you have specified.[5] Note that the delimiters create a container in which to hold an expression, matrix or array and so are best entered before the expression though in some cases you can also highlight an expression and then select a pair of delimiters. This also means that, if you try to delete a delimiter, you will delete its contents; so cut the contents, delete (not cut) the delimiter and paste the contents in the math mode container to get rid of an unwanted delimiter.

The last icon toggles between the basic toolbar and both.

B.3 The advanced toolbar

The advanced toolbar offers a wider range of alternatives such as two smaller styles than in-line mode, for example: $x^2-y^2=z^2$, several different types of fraction, such as km/h, and access to a wide range of mathematical symbols. Some of these, like the fractions, create additional containers.

Before and after the icons for the alternative styles and alternative fractions are the icons for alternative spaces and fonts; though you can leave the spacing and fonts for most maths up to LaTeX, for some expressions some intervention may be required. The example given in the LyX help is that, when entering integrals, LyX accepts $\int A(x)dx$, and inserts the correct space between $\int$ and A. However, there should be a small space between (x) and dx and the d in dx is an operator which should be set upright. So place the cursor after the (x) and add a thin space via the spaces icon; make the d upright by highlighting it and either using the keyboard shortcut Alt+C R or selecting the fonts icon and Roman. This gives: $\int A(x)\,\mathrm{d}x$. You can make vectors upright bold, as in **v**, by highlighting them and using Alt+C R and Alt+C B or by selecting the fonts icon and Roman and then Bold. (You don't have to repeat this every time you want to enter a vector — you can copy and paste it once you have made the changes; for a different vector, just change the character).

Changing fonts in LyX math mode is different from changing them in text mode.[6] In text mode, the changed font adds an attribute to the text which the user can turn off at any point; in math mode it creates a container. In both math mode and text mode, you can carry on adding characters in the same font if you want but in math mode, when you have finished, you don't switch off the attribute, you move the cursor to get out of the container.

Typesetting certain maths functions requires the alternation between upright and italic characters and TeX cannot tell whether a sequence of alphabetic characters like tan is supposed to be $t \times a \times n$ or 'tan' where it means 'tangent.' So in an expression like 'the polar form of the complex number $z = a + bi = \langle r, \theta \rangle = r\left(\cos\theta + i\sin\theta\right)$,' 'cos' and 'sin' are both inserted from the list of functions that appear when you select $\genfrac{}{}{0pt}{}{\exp}{\tan}$ and not typed in as separate letters (in Figure 2 the advanced toolbar is above the basic toolbar and the function list obscures $\genfrac{}{}{0pt}{}{\exp}{\tan}$). This ensures that they are typeset upright unlike all the other characters in the expression.

---

[5]I had to put something in the containers in order to illustrate the matrices and array in the output though the containers were visible on the input screen.

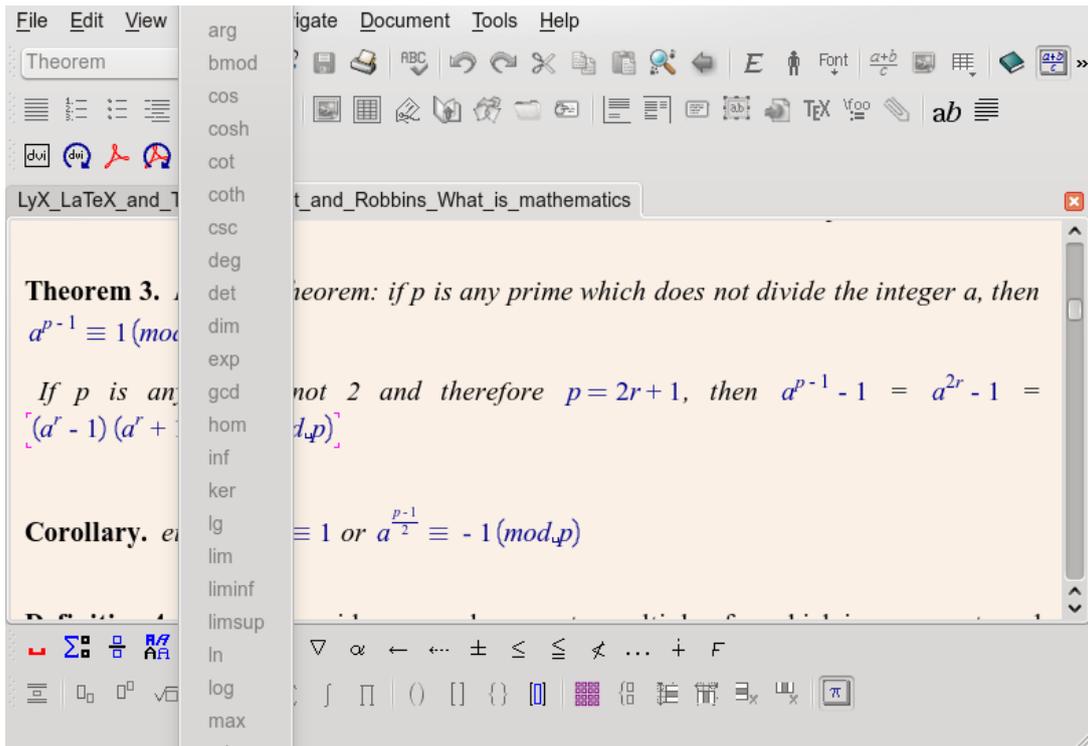[6]But it is essentially the same in LaTeX.

Figure 2: Advanced maths — inserting functions

Among the functions supported in this way are

- 'det' as in 'where $\underline{A} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, $\det \underline{A} = \det\left(\underline{A}^T\right) = ad - bc$,'

- 'log' and 'ln' as in '$\ln\left(\sin^{-u} x\right) = -u\ln\left(\sin x\right)$' and

- 'lim' as in

$$\int_S f\left(x, y\right)\,\mathrm{d}A = \lim_{N \to \infty} \sum_{i=1}^{N} f\left(x_i, y_i\right)\,\delta A_i \text{ where } \delta A_i \to 0 \text{ for each } i \text{ and } N \to \infty$$

$\underline{A}$ in the 'det' example illustrates the next icon, for adding decorations to one or more characters, for example, to indicate vectors. The decoration creates a second container into which you can place one or more characters or symbols, for example, $\overrightarrow{PQ}$, but in order to get out of the decoration container, you have to make two cursor movements or use Esc.

The remaining icons in the advanced toolbar provide access to the wide range of mathematical symbols one might need including big operators, such as $\sum$, a range of miscellaneous operators, such as ∇ and $\mathbb{R}$, the Greek characters, such as λ, a multiplicity of arrows, such as $\leftrightarrows$, smaller operators, such as $\cap$, and relationships, such as $\neq$. (Though it is possible to cancel characters in LaTeX, this does not always produce a typographically attractive result. So glyphs for a number of cancelled characters like $\neq$ have been created to produce a more pleasing result).

Apart from the dots icon, the remaining icons provide, for the most part, alternatives developed by the AMS for those who prefer these to the standard symbols. If you are using a lot of

symbols associated with a particular icon, you can add a toolbar for these symbols with View ▷ Tool<u>b</u>ars ▷ Other toolbars.

B.4 The AMS document classes and more

If you are producing a mathematical document, ensure that the AMS and `esint` packages are enabled in <u>D</u>ocument ▷ <u>S</u>ettings ▷ Math options; you can add paragraph style modules with <u>D</u>ocument ▷ <u>S</u>ettings ▷ Modules to a general document style or use the AMS document classes which incorporate paragraph styles such as Theorem, Corollary, Lemma, Proposition and Conjecture, all of which have numbered and unnumbered (asterisked) versions. Figure 2 illustrates three of these styles in use (as well as the tabs when more than one document is loaded). You can also insert numbers after mathematical expressions in display mode and cross-reference them within the document.

If you intend to use any of the features of the advanced toolbar or the AMS document classes, it is worth reading the LyX maths help — even seasoned LaTeX users will gain from it.

C BibTeX

You can insert references into a LyX or LaTeX document by using the Bibliography paragraph style. That may be enough for you if you only insert a handful of references a year into relatively short documents. But, if you frequently use references, particularly within long documents, the benefits of using BibTeX appear to increase exponentially the more you use it. Though you can use the Bibliography paragraph style and BibTeX in the same document with the addition of some LaTeX macros, it is better to choose one or the other for each document you create.

BibTeX was written by Orem Patashnik (1988) to work directly with TeX and, like pretty well everything to do with TeX, it has acquired many extensions and even some different versions to deal with problems not originally envisaged in the 1980s. Philipp Lehman has more recently developed BibLaTeX. LyX does not support BibLaTeX natively but the LyX Wiki describes how you can use it within LyX. The BibLaTeX documentation is available from CTAN.

BibTeX has two main elements: a bibliographic database and a bibliographic style. BibLaTeX replaces the BibTeX bibliographic styles with LaTeX macros but retains the bibliographic database.

C.1 The BibTeX database

The structure of a BibTeX database, which is possibly unique in allowing records with different structures to co-exist within the same table, is

```
@RECORDTYPE{identifier,fieldname1=contents,fieldname2=contents, ... }
```

The first part determines whether the record refers to a book, article, chapter in a book, thesis, etc. The identifier acts both as the index key for BibTeX and as a human readable identifier for the user to identify a record in a file; so it needs to be created with care.

Figure 3: A BIBTEX database

There are about twenty potential record types, some of them duplicates, each of which has a small number of mandatory fields and normally one or more optional fields. You can also create your own fields if you want to store additional data about particular references.

Alphanumeric fields are enclosed in double inverted commas but square brackets can be used if it is necessary to use double inverted comments within a field. Numeric fields like volume can be changed to alphanumeric fields by enclosing the contents in double inverted commas if, for example, volumes are expressed as Roman and not Arabic numerals. The best summary of the available record types and fields is in *Tame the BeaST* by Nicholas Markey (2009) available from CTAN.

Figure 3 shows an extract from a BIBTEX file with syntax highlighting; record type is blue, the identifier green, the field names blue, the alphanumeric fields red and the numeric fields black.

Many reference styles abbreviate personal names to initials and make titles lower case. So in the second record, \relax is added to 'Revd' to ensure that it is not abbreviated to 'R.' and both it and 'Mad Quakers' are placed in braces to ensure that they are excluded from normal processing. The note field is not subject to any processing; so I have had to add the \textit macro to ensure that the title is printed in italics; this is handled automatically in the book title and journal fields. In the first record I had to precede '&' in 'Routledge & Kegan Paul' with \ and enclose them in braces to ensure that they are not processed as a TEX command (see section C.2.3).

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C.2 Tips for entering data

C.2.1 Authors and editors

Book references may have an author field, an editor field or both. For a `@BOOK` record, use either the author or the editor field (not both); for an `@INCOLLECTION` record, that is, a reference to a chapter in a book, there will be the author(s) of the chapter and the editor(s) of the book.

You must use 'and' between the names of multiple authors/editors in the author and editor fields, however unnatural this may look, because BibTeX uses 'and' as the delimiter. Where appropriate, 'et al.' will be used in the citation (Figure 5) and the names will appear in the reference with commas between all but the last two, as on page 22. If you want to force 'et al.' in a reference, perhaps because you are citing a research paper to which lots of researchers have contributed, use 'and others' in the BibTeX record.

C.2.2 First von Last

BibTeX expects names to consist of two or three parts; if the author is an organisation, you need to put the whole name in braces to prevent BibTeX from breaking it up. Otherwise, BibTeX looks for the most sensible way of breaking up a name into first names, a 'von' part (for which you may need to use `\relax`) and a last name. You can help by entering names as 'lastname, first names' but you don't need to; BibTeX will try to make sense of whatever is there. If you get unexpected results, Markey (2009) gives an excellent account of the ways to handle different types of name.

C.2.3 Common non-alphabetical characters

Because LaTeX uses certain non-alphabetical characters as part of its syntax, they need to be distinguished in BibTeX files.

Character	expressed in BibTeX	Character	expressed in BibTeX
#	`{\#}`	{	`{\{}`
$	`{\$}`	}	`{\}}`
%	`{\%}`	~	`{\~{}}`
^	`{\^{}}`	/	`{\//}`
&	`{\&}`	\	`{$\setminus $}`
_	`{\_}`		

C.2.4 Accents

Because BibTeX was created long before Unicode became a viable option, it expects macros for accented characters. The main Western European accents are expressed as follows:

Character	expressed in BibTeX	Character	expressed in BibTeX
e acute	`{\'e}`	o circumflex	`{\^o}`
e grave	`` {\`e} ``	n tilde	`{\~n}`
c cedilla	`{\c{c}}`	u umlaut	`{\"u}`

For the rest download Scott Pakin's list of symbols from CTAN.

C.2.5 Hyperlinks and URLs in BibTEX files

You can insert hyperlinks and URLs in BIBTEX files by enabling hyperref support in Document ▷ Settings ▷ PDF Properties and using the LATEX macros `\href` and `\url` which should be enclosed in braces within the relevant field. This allows you to create a link to a document on the web while displaying only the title of the document or including an author's email address as a link from their name, for example,

```
{\href {http://www....}{<title of document>}}
{\href {mailto:<email address>}{<author>}}
```

Alternatively, the URL macro will display the URL as part of the reference:

```
{\url {<URL>}}
```

C.2.6 Empty fields

For the most part, an optional empty field will cause no problems. But some bibliographic styles will stop reading a record once they encounter an empty optional field. So it is generally prudent to delete empty optional fields which come before your last filled optional field. Note also that, where you have a choice of volume *or* number, you must not include both fields even if one of them is empty.

C.3 Adding the BibTEX database file

To add a BIBTEX database file to your LYX document, use Insert ▷ Lists/TOC ▷ BibTEX Bibliography in an empty standard paragraph where you want the references to appear in the document. Selecting Add will offer you a number of example files; so select Browse in the pop-up window and, if your BIBTEX file is in the same folder as your LYX document, it will be there to be selected. Once you have selected it with Open, it will appear in the Databases window.

Figure 4 shows the interface as it appears[7] when selecting a database (though, as you can see from the Databases window, after I had in fact made the selection); the top window lists the example databases and the Browse option opens the file selection dialogue that enables you to select your database; in the second window it is just possible to see on the left that the `chicago` style has been selected (though the scroll bar to select it is hidden); on the right is the Browse option which allows you to use a style of your own.

If you don't know which to use and prefer numerical citations, choose `plainnat`; if you prefer author-year, choose `chicago`;[8] then OK the dialogue. Both need Natbib enabled as described in the next section.

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[7]The dimming of the windows behind the top one in Figure 4 is a 'feature' of KDE4 which has been toned down in more recent releases.

[8]`chicago` is the standard Harvard style; the name Harvard comes from an English visitor to Harvard seeing the newly described Chicago style in use over a century ago and misnaming it the Harvard style on his return to England.
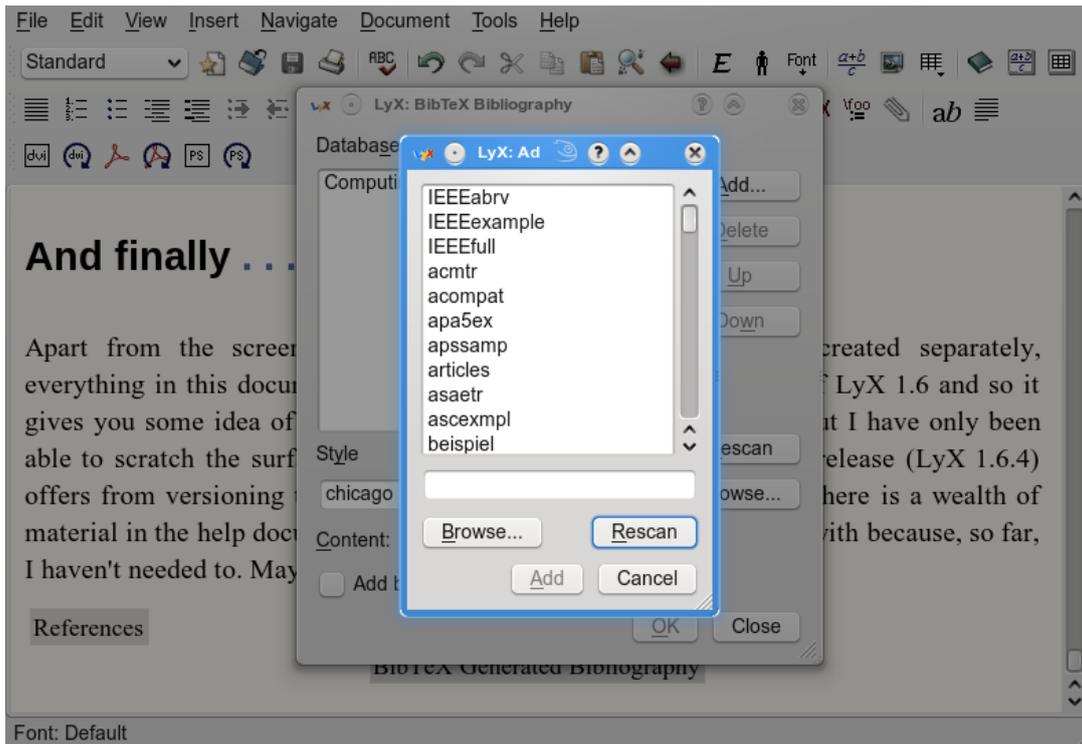
Figure 4: Inserting a BIBTEX database

C.4 BibTEX styles

As with most things to do with TEX and LATEX, BIBTEX quickly acquired extensions, particularly Natbib, created by Patrick Daly (2010), and later Jurabib which allow you to vary the citation between, for example, '(Daly, 2010),' 'Daly (2010)' or just '(2010),' to add comments like 'for example' before or page numbers after a citation or, in the case of Jurabib, to use '*ibidem.*'

A number of Natbib styles, like `plainnat`, duplicate an original bibliographic style in the references but allow the author to choose between leaving Numerical enabled or enabling Author-year. Others, like `chicago`, benefit from Author-year being enabled via Documents ▷ Settings ▷ Bibliography ▷ Natbib ▷ Author-year so that you can use all the different citation styles that are associated with author-year referencing. The most recent summary of Natbib is available from CTAN while the BibTeX styles catalogue for LyX summarises the main European and North American bibliographic styles supported by LYX.

C.5 Inserting citations

Once you have inserted the link to the BIBTEX database, you can begin to insert citations. Figure 5 shows the dialogue you see after selecting Insert ▷ Citation or the icon that looks like a bunch of papers.
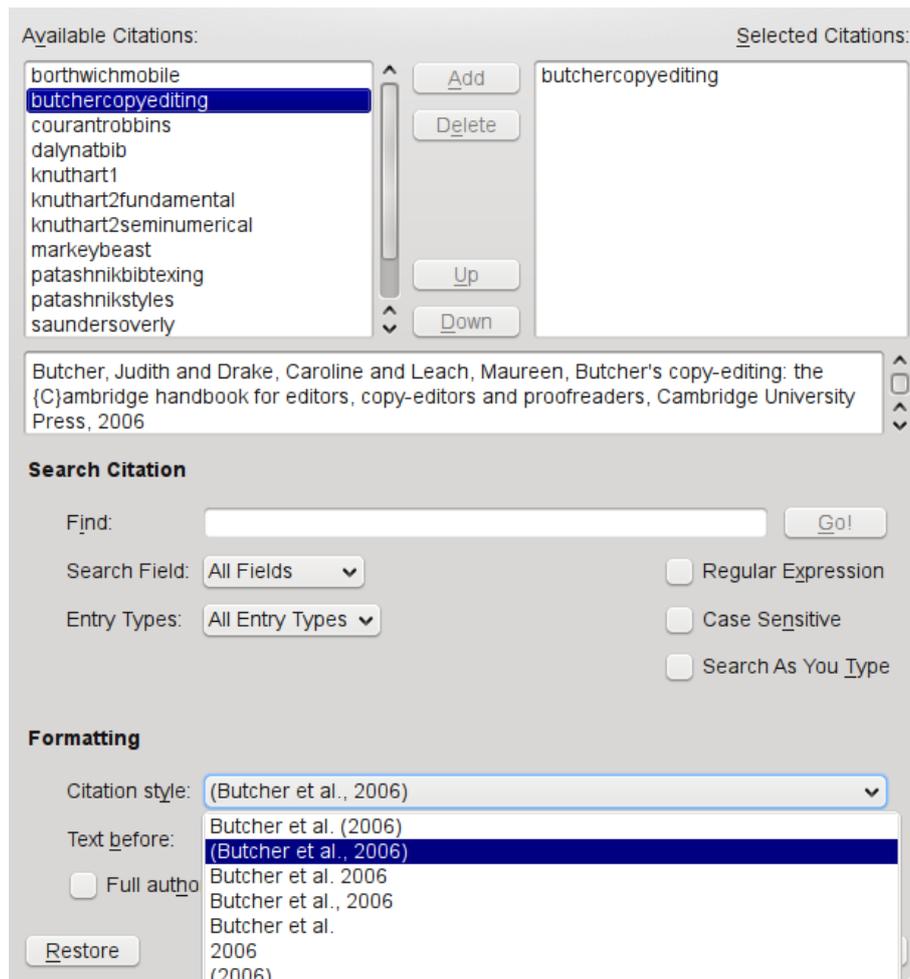
Figure 5: Inserting a citation

The upper left window lists the identifiers from the BIBTEX database; if you have a very large BIBTEX database (700 entries is the maximum recommended size) or you forget the identifier, you can search on any term in the BIBTEX entry.

butchercopyediting is still highlighted because I have just selected Add and it has appeared in the upper right window. You can create multiple citations at the same point in a document by selecting and adding further citations to the upper right window and there are options to move citations up and down in that window in order to change the order of their citation.

Below these windows, the contents of the highlighted BIBTEX record appear as a CSV record showing 'and' being used as a delimiter and the braces I added to force BIBTEX to capitalise the 'C' in 'Cambridge.'

This display is helpful if you have two similar identifiers and have forgotten which reference you want to cite. It also helps if you have entered a foreign character not recognised by BIBTEX, as they often shows up in this window allowing you to alter them before trying to use the reference and throwing up an error message.

The lower part of the dialogue contains the Natbib extensions which allow you to specify, among other things, how the citation will appear in the text. You can see that Natbib is using 'et al.' in the citation because there are more than two authors and that I have chosen the option to have the entire citation in parentheses with a comma before the year. Below are the Text before and Text after dialogue boxes (the latter hidden) and two further options for handling references.

If you have not enabled Natbib or Jurabib in Documents ▷ Settings ▷ Bibliography, the lower part of this dialogue will be inaccessible — a useful reminder if you have rushed to insert the link to the database but forgotten to enable one of them.

C.6 The power of BibTEX

You really begin to appreciate the power of BIBTEX when you are dealing with multiple complex references; apart from the fact that, once you have the correct reference in your database, you know that it will be correct in every document you produce, where you cite multiple references by the same author in one year, Natbib will add the 'a', 'b', 'c' to the year in the citation and the references and ensure that they are always correctly cited in your document. It even knows that you use '2006a,b' in an author-year citation when you cite two references from the same author in the same year at the same place.

If your publisher wants a different style, there are only a few extreme changes of style, like `plain` to `chicago`, where you need to do anything more than opening the dialogue in Figure 4 and changing the style. BIBTEX will handle everything else. BIBLATEX promises even more power and flexibility while using the same database structure.

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