ASTEX : AN INTEGRATED AND CUSTOMIZABLE MULTIWINDOW ENVIRONMENT FOR SCIENTIFIC RESEARCH

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AsTEX: an integrated and customizable multiwindow environment for scientific research

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Abstract. AsTEX is a program that runs on a PC under the control of Framework 3, and transforms it into an integrated and customizable multiwindow environment for scientific research, as comfortable to use as the one of a workstation. It has been devised as a help to create scientific books and, more generally, as a help for everyday scientific work. It includes a hypertext-like file manager which allows to classify and archive all the files related to the current document by means of a hierarchy of explicit titles, and to retrieve any of them very easily, whatever its physical location. It allows also to display the structure of a LaTeX document of any length, and to modify and restructure it in a completely interactive manner. It offers an interface with a local or distant Fortran compiler, which allows to perform numerical computations from a LaTeX document. It has also an interface with the computer algebra program Maple, to perform formal computations interactively from a text, a worksheet or a database, when the PC is connected to a Unix station through a LAN or through a modem.

A set of PCs equipped with AsTEX and connected by a LAN to a workstation can provide a low-cost alternative to a network of workstations, for laboratories and educational institutions already equipped with PCs, and that cannot afford or do not want to equip each researcher or student with a workstation.

Résumé. AsTEX *est un programme qui tourne sur PC sous contrôle de Framework 3. Il transforme celui-ci en un environnement multi-fenêtre intégré et personnalisable pour la recherche scientifique, qui est aussi confortable d'utilisation que celui d'une station de travail. Il a été conçu comme une aide à la création de livres scientifiques et, plus généralement comme une aide pour le travail scientifique de tous les jours. Il comprend un gestionnaire de fichiers de type hypertexte, qui permet de classer et d'archiver, par un ensemble hiérarchique de titres explicites, tous les fichiers qui se rapportent au document courant, et d'accéder très facilement à n'importe lequel d'entre eux, quel que soit son emplacement physique. Il permet aussi de visualiser interactivement la structure d'un document* LaTeX *de longueur quelconque et de le modifier et restructurer très facilement de façon entièrement interactive. Il dispose d'une interface avec un compilateur Fortran local ou distant, qui permet de faire des* *calcul numériques à partir d'un document LaTeX. Il possède également une interface avec le langage de calcul formel Maple, pour faire du calcul formel interactivement à partir d'un texte, d'une feuille de calcul ou d'une base de données, lorsque le PC est relié à une station Unix par un réseau local ou par modem.*

Un ensemble de PC dotés d'A^{S}TeX et connectés en réseau local avec une station de travail, peut constituer une alternative très économique à un réseau de stations, pour les laboratoires ou les établissements d'éducation scientifiques (universités et grandes écoles), qui sont déjà équipés de PC et qui ne peuvent pas ou ne veulent pas équiper chaque chercheur ou chaque étudiant avec une station de travail.

Key words: PC, workstation, scientific book, structure of a document, multiwindow environment, customizable environment, file manager, numerical computation, computer algebra, Framework 3, LaTeX, Fortran, Maple, LAN, local area network, low-cost alternative to workstations network.

1. Introduction

Our aim in designing A^{S}TeX was to facilitate the creation of a scientific book, from its conception to its printing, on low-cost PCs. This means not only typing a scientific text, but also structuring it, making numerical and formal computations from it and, more generally, performing the author's everyday work in a customized and comfortable environment.

Most programs on PCs have been devised for business management. They are well adapted to tasks such as accounting, secretarial work and management of databases (clients, supplies...), but they are ill-adapted to scientific tasks. Since we did not want to write everything from scratch, which would have been too long, we have adopted the approach of the good cook: "Try to make the best possible at the lowest cost, with what is available today".

1.1. A^{S}TeX's ingredients: LaTeX, Fortran, Maple and Framework 3

To cook A^{S}TeX we have used, as ingredients, TeX and LaTeX, Fortran compilers, the computer algebra program Maple and Framework 3. TeX and LaTeX bring their expertise for formatting mathematical texts. Maple and Fortran compilers bring their power to make formal and numerical scientific computations. Framework 3 brings its skill for managing windows, telecommunications and, more generally, for treating and structuring informations of various types.

We have then added a few carefully chosen condiments: a hypertext-like file manager, a transcoder of Framework structure to LaTeX structure, interfaces with Fortran compilers and Maple program, and various utilities. These condiments are a fifty-page long program written in Fred, the programming language of Framework 3, a few abbreviations and other utilities, plus about fourty batch programs. It comes with a detailed user guide (in French) of about a hundred pages.

The choice of TEX and LaTeX needs no explanation at this conference, especially as the new implementation emTeX by E. Mattes provides a complete set of professional quality public-domain programs and drivers. The choice of Fortran is compulsory for scientific numerical computations. Maple [Char89] is a very powerful program for interactive formal and numerical computations, that allows outputs in LaTeX[1]. Finally, Framework 3 is an integrated software that has many interesting possibilities, complementary to those of the preceding programs, as will be explained in the next paragraphs.

These programs are widespread and less expensive than other equivalent solutions: Framework 3 is sold 400$ in France, for educational institutions. A solution based on Windows 3, Word, Excel and Superbase, for example, would cost about four times more. The program Maple is sold 600$ in France for educational institutions, while Mathematica and Macsyma cost about five times more.

1.2. Which multiwindow environment to use for research ?

Framework 3 has several very interesting possibilities, among which a **hierarchical multiwindowing system** with the possibility to customize titles of subwindows, and an object-oriented language to manipulate windows (see appendix A for a detailed description).

A^{S}TEX exploits these possibilities and transforms Framework 3 into an integrated and customizable environment for scientific research. It is more powerful than Windows 3 for the text-oriented tasks that make the largest part of ordinary scientific work, such as writing computer programs, typing scientific documents and electronic mail. It is also more democratic than Windows 3, because it functions even on entry-level PCs (using it on powerful

[1] To use Maple with A^{S}TEX, the PC must be connected to a Unix server by a LAN (local area network), or at least by a modem to a machine that runs Maple, since computer algebra programs need lots of memory.

ones does no harm, of course!). You can complete at home an urgent report on your old PC/XT, or you can organize training sessions for students on low-cost 80286 machines, to learn programming in Fortran in a multiwindow environment. On the contrary, Windows 3 requires powerful machines based on 80386 or 80486 processors to function properly, and needs lots of memory (at least 4Mo) to be really useful. It cannot function on PCs based on 8088 processors, and it is almost useless for those based on 80286.

Of course, both environments are not incompatible: if you have a PC powerful enough, you can run A^S^TEX from Windows 3 as an external application, and use Windows 3 capabilities to manage extended memory and graphic programs.

1.3. Which word-processing companion for TEX and LATEX?

The "local" word-processing possibilities of Word and Wordperfect are much more developed than those of Framework 3. For example, they allow various mathematical symbols, characters with different sizes, proportional fonts, indexing and inclusion of figures anywhere in the text. However, as soon as we decide to use LATEX, the advantages of Word and Wordperfect disappear because LATEX allows all this and much more.

On the contrary, the "global" word-processing possibilities of Word and Wordperfect for displaying the structure of the document are much less developed than those of Framework 3. The last version 5.1 of Wordperfect, for example, can only produce the table of contents through batch processing of the document, as is done with LATEX. Word is a little more powerful, but the process to hide parts of text is very laborious, as compared to the elegance of Framework's method.

As a consequence, the combination Framework 3 + LATEX is more powerful than the combinations Word + LATEX or Wordperfect + LATEX. The skills of Framework 3 are complementary to those of LATEX, they are not useless repetitions.

A^S^TEX enhances the possibilities of this combination by transforming the word-processing module of Framework 3 into a preprocessor of LATEX structure, and by allowing to manage easily documents of arbitrary length. This is developed in more detail in section 3.

1.4. Possibilities of Framework 3

In addition to its hierarchical multiwindowing system and programming language, Framework 3 has many other interesting possibilities. It has a database manager dBase3-compatible, a spreadsheet with dynamic data exchange between worksheets, graphics associated to worksheets, telecommunications with cut and paste functions to and from other windows, files exchange with Kermit protocol, macros and abbreviations, mailing, a dictionary of synonyms and a spelling checker. A^{S}T$_E$X exploits several of these possibilities (see paragraphs 3.4 and 4.2).

Furthermore, Framework 3 is an **integrated** software: all commands are identical in all modules. For example, the copy function is F8 in the word-processor module to copy text, in the spreadsheet module to copy cells, in the database module to copy fields, in the telecommunications window to copy text and in the multiwindow system to copy windows.

1.5. Shortcomings of Framework 3

Framework 3 has also severe drawbacks. As most wide-spread programs on PC, it is designed for standard office and commercial work, and it has no advanced mathematical capabilities. The only "scientific" capabilities of the word-processing module are indices and exponents. There are no greek letters, no mathematical symbols, no possibility to include graphs in formulas. There is no possibility to include external drawings, nor graphs with text flowing around. The spreadsheet module has no built-in possibility to make numerical scientific computations. A^{S}T$_E$X eliminates these drawbacks by coupling Framework 3 to LaTeX, Fortran and Maple.

Moreover, documents are limited to about fifty pages. Beyond this limit, Framework is constantly swapping between pages of extended memory, and it becomes prohibitively slow. Files accessed from a document are limited to about a dozen. Beyond this, the window becomes too crowded with icons and subwindows. A^{S}T$_E$X eliminates these drawbacks by adding a hypertext-like file manager.

Another severe drawback of Framework 3 in France, is the very bad reputation of the importer, among PC users. Unfortunately, A^{S}T$_E$X cannot eliminate this one...

2. The file manager of A^{S}T$_E$X

Writing a scientific book from scratch is not only the matter of typing it with a scientific word-processor. When you create a document that will at the end have several hundreds of pages, and that will make reference to hundreds of files (chapters of the book, numerical results, computer programs, input and output data, electronic illustrations, electronic mail...), it is very important to be able to navigate easily, in a **logical** way, in the document and in the files that are related to it, during the whole process of its creation. You need a file manager that allows to classify and archive your files in a **structured** way, so that you can retrieve them easily, with a few keystrokes. This is equally valid if you do not plan to write a book, but just want to collate *your everyday's results in a coherent document.*

2.1. The file manager of Framework 3

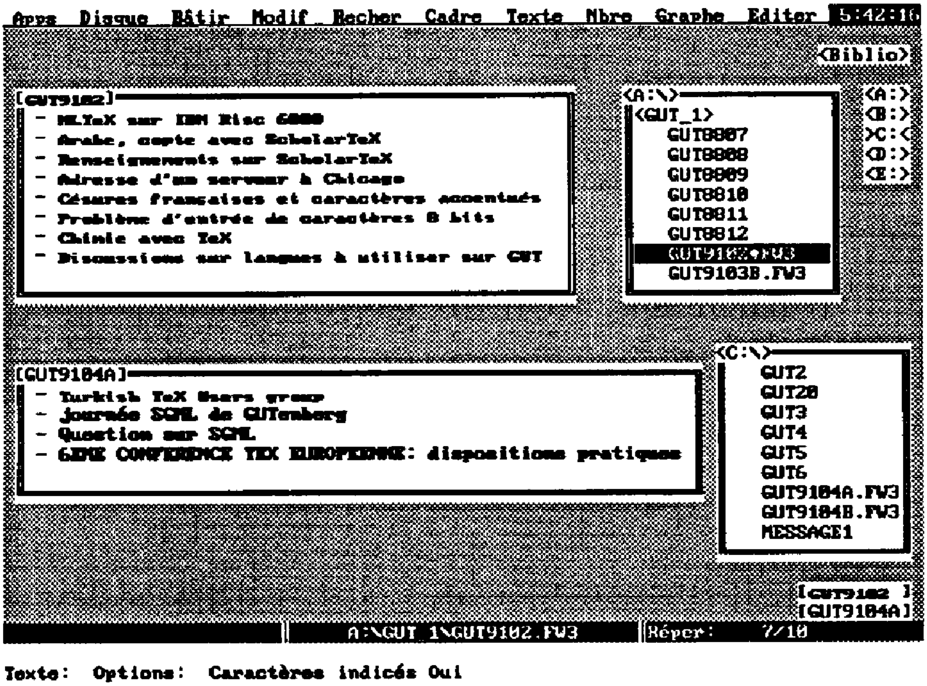
With the file manager of Framework 3 (as with the file manager of Windows 3), you access to files from their **physical location** on disk: you first select the disk, then the directory, then the file. You have to scroll among the whole set of directories and files, although most of them are not pertinent to your document. Moreover, names of directories and files are limited to eight characters. They are not very explicit in general, and it may be very difficult to retrieve files that were created or received several months ago.

Let us illustrate this with the e-mail that is received by subscribers of the GUTenberg association (see Fig. 1): to consult the mail of april, we have to remember that it is stored in the directory `c:\courrier`. Then we have to scroll in this directory until we find the file **gut9104a.fw3**. Then we must remember that the mail of march is stored on a network disk in the directory `e:\courrier\gut` and the mail of february on a floppy disk labeled **gut_1**.

2.2. Description of the file manager of A^{S}T$_E$X

With the file manager of A^{S}T$_E$X you access to a file from its **logical location** in the document, not from its physical location on disk.

For example, to retrieve the e-mail of the GUTenberg association from february to april, we just point on the titles "Février", "Mars" and "Avril" in the document (see Fig. 2). Files that are logically related can be accessed


Apps Disque Bâtir Modif Recher Cadre Texte Nbre Graphe Editer 5:42:16
<Biblio>
<A:>
<B:>
>C:<
<D:>
<E:>

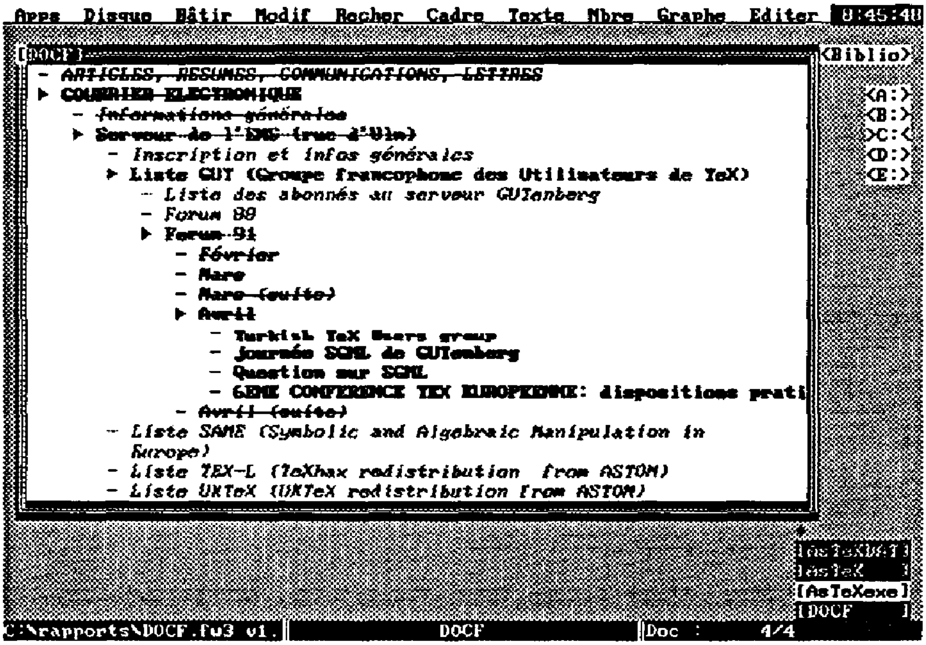
```
[GUT9102]
 - MLTeX sur IBM Risc 6000
 - Arabe, copte avec ScholarTeX
 - Renseignements sur ScholarTeX
 - Adresse d'un serveur à Chicago
 - Césures françaises et caractères accentués
 - Problème d'entrée de caractères 8 bits
 - Chinie avec TeX
 - Discussions sur langues à utiliser sur GUT

<A:\>
<GUT_1>
   GUT8807
   GUT8808
   GUT8809
   GUT8810
   GUT8811
   GUT8812
   GUT9102.FW3
   GUT9103B.FW3

[GUT9104A]
 - Turkish TeX Users group
 - journée SGML de GUTenberg
 - Question sur SGML
 - 6EME CONFERENCE TEX EUROPEENNE: dispositions pratiques

<C:\>
   GUT2
   GUT20
   GUT3
   GUT4
   GUT5
   GUT6
   GUT9104A.FW3
   GUT9104B.FW3
   MESSAGE1

[GUT9102 ]
[GUT9104A]
A:\GUT_1\GUT9102.FW3    Réper:    7/10
Texte:  Options:  Caractères indicés Oui
```

Figure 1. Retrieving files with the file manager of Framework 3

from the same place in the document, whatever their physical locations on disks. We see that the four titles that appeared in the window GUT9104A of Fig. 1, appear in Fig. 2 under the title "Avril".

As another example, let us assume that the window "COURRIER ELECTRONIQUE" of Fig. 2 is empty, and we want to consult the e-mail announcement of the 6^th European TEX Conference. We can access to it with a few keystrokes, by loading successively the windows "COURRIER ELECTRONIQUE", "Serveur de l'ENS (rue d'Ulm) ", "Liste GUT (Groupe francophone des utilisateurs de TeX)", "Forum 91", "Avril". At last, we click on the title "6EME CONFERENCE TEX EUROPEENNE..." to read the text.

This sequence of keystrokes will be **always the same**, today as also in one year, even if we decide in the meantime to archive the corresponding files on floppy disks. The only exception is if we want to **improve** the logical path to access it, but this means that future accesses will be even easier. With the file manager of Framework 3, the path access is changed most often for reasons that have nothing to do with the logic of your document: the directory is too crowded, your hard disk is full, etc...



```
Apps  Disque  Bâtir  Modif  Recher  Cadre  Texte  Nbre  Graphe  Editer  08:45:48
[DOCF]                                                               <Biblio>
 - ~~ARTICLES, RESUMES, COMMUNICATIONS, LETTRES~~
 ▶ ~~COURRIER ELECTRONIQUE~~                                             <A:>
    - ~~Informations générales~~                                         <B:>
    ▶ ~~Serveur de l'ENS (rue d'Ulm)~~                                   >C:<
       - Inscription et infos générales                                 <D:>
       ▶ Liste GUT (Groupe francophone des Utilisateurs de TeX)         <E:>
          - Liste des abonnés au serveur GUTenberg
          - Forum 89
          ▶ ~~Forum 91~~
             - ~~Février~~
             - ~~Mars~~
             - ~~Mars (suite)~~
             ▶ ~~Avril~~
                - Turkish TeX Users group
                - Journée SGML de GUTenberg
                - Question sur SGML
                - 6EME CONFERENCE TEX EUROPEENNE: dispositions prati
             - ~~Avril (suite)~~
       - Liste SAME (Symbolic and Algebraic Manipulation in
         Europe)
       - Liste TEX-L (TeXhax redistribution  from ASTON)
       - Liste UKTeX (UKTeX redistribution from ASTON)
                                                                   [AsTeXDAT]
                                                                   [AsTeX    ]
                                                                   [AsTeXexe]
                                                                   [DOCF     ]
C:\rapports\DOCF.fw3 v1.|           DOCF           |Doc :        4/4
```

Figure 2. Classifying and archiving electronic mail with A

Linked windows

To go further in our description, let us give a few technical definitions.

A Framework 3 document is a tree of windows. $\mathrm{A^ST_EX}$ allows any window of the tree to be *linked* to a file. The contents of the linked window can be *unloaded* into the file, and the linked window is emptied. Conversely, the contents of the file can be loaded from disk into the linked window.

For example, in Fig. 2, the windows “Février” and “Avril” are linked to the files `a:\gut_1\gut9102.fw3` and `c:\courrier\gut9104a.fw3` that contain the mail for these months, and the second file is loaded into its linked window.

A given file can be referenced from several documents (i.e. linked to several documents), and it can be accessed with different titles from different documents. This reminds links under Unix (although it is not identical): a file can be accessed with distinct names by different users.

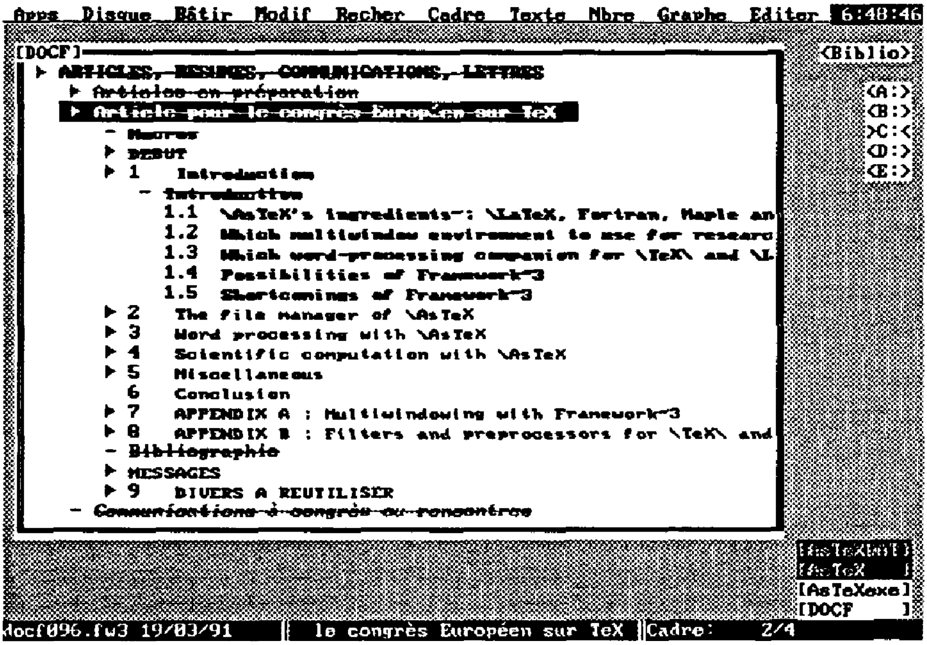
The notion of link allows to use titles of windows as an index set on the database of linked files. Searches are efficient because they are done on the index set, not on the database. Alternatively, the file manager of A^{S}T$_E$X can be considered as a text-oriented hypertext program, where the buttons are the titles of the windows and linked windows are reference buttons. A document is then a hypertext application.

The important point to remember is that **each document carries its own hierachy of related files.**

Relative and absolute links

The name of a link can be relative or absolute. If it is relative, the file inherits the attribute "directory" of the document.

For example, the links of the windows "Février" and "Avril" are absolute (see preceding paragraph). The link of the window "Forum 91", in Fig.2 is `docf067.fw3`. It is relative, and the contents of its window is saved in the file `c:\rapports\docf067.fw3` because the main document is saved in the directory `c:\rapports`.


Apps Disque Bâtir Modif Recher Cadre Texte Nbre Graphe Editor 6:48:46
<Biblio>
<A:>
<B:>
>C:<
<D:>
<E:>
[AsTeXinit]
[AsTeX]
[AsTeXexe]
[DOCF]

```
[DOCF]
 ▶ ARTICLES, RESUMES, COMMUNICATIONS, LETTRES
   ▶ Articles en préparation
   ▶ Article pour le congrès Européen sur TeX
      - Macros
      ▶ DEBUT
      ▶ 1   Introduction
         - Introduction
           1.1  \AsTeX's ingredients~: \LaTeX, Fortran, Maple an
           1.2  Which multiwindow environment to use for researc
           1.3  Which word-processing companion for \TeX\ and \L
           1.4  Possibilities of Framework~3
           1.5  Shortcomings of Framework~3
      ▶ 2   The file manager of \AsTeX
      ▶ 3   Word processing with \AsTeX
      ▶ 4   Scientific computation with \AsTeX
      ▶ 5   Miscellaneous
        6   Conclusion
      ▶ 7   APPENDIX A : Multiwindowing with Framework~3
      ▶ 8   APPENDIX B : Filters and preprocessors for \TeX\ and
      - Bibliographie
      ▶ MESSAGES
      ▶ 9   DIVERS A REUTILISER
   - Communications à congrès ou rencontres
docf096.fw3 19/03/91  ||  le congrès Européen sur TeX ||Cadre:    2/4
```

Figure 3. Displaying names of links

The name of a link of a window is displayed in the lower left corner of the screen, when the window is selected. For example, in Fig. 3, the window

"Article pour le congrès Européen sur TeX" has been selected, and we can see the name of its link, `docf096.fw3`.

Absolute links allow to gather together in the document files that are physically distant.

Relative links allow to save in one directory, files that would normally need a system of subdirectories to be structured. Their hierarchical organization is saved **logically** in the document, not **physically** on disk. This simplifies considerably the backup of files. Moreover, a physical organization of files may be well adapted to one document but ill-adapted to another one.

2.3. Other advantages of the file manager of A$^{\mathrm{S}}$TEX

Each file can be accessed from the hierarchy by means of an **explicit title**. If we want to find the electronic address of a subscriber to the GUTenberg server, we have just to point to the title "Liste des abonnés au serveur GUTenberg" and use the searching string function of Framework. It would be much more difficult to find the address if we had first to remember that the list is stored in the file **gut00001.fw3** in the directory `c:\courrier`.

Only the files **pertinent to the document** are displayed and accessible from it. The files that are unrelated are not displayed. This speeds up the scrolling through titles and avoids to crowd windows with useless informations.

Transfering text between chapters saved in distinct files, is much faster than with the file manager of Framework 3.

Modifying the structure of a set of related files is very easy because files are reorganized logically in the document, they are not reorganized physically on disk.

One has **several levels of backup** for linked files. For example, the file "Article pour le congrès Européen sur TeX" (see Fig. 3) can be backed up in the file "ARTICLES, RESUMES, COMMUNICATIONS, LETTRES" and in the current document. When the file is in its definitive form, backups are automatically destroyed by unloading the linked windows upwards in the hierarchy.

Local images of the interesting directories of ftp servers can be constructed in real time. This speeds up next connections.

2.4. Modifying linked files

Very often, data stored in external files have to be inserted in the current document. This can be done sometimes with the cut and paste function. But, in many cases, the file can change with time: results of experiments can be corrected or extended during the time you write your book, computer programs can be improved, electronic illustrations can be modified. TEX and LATEX provide the commands `\input`, `\include` and `\special` to include files in the document, but the inclusion is made only at compilation time.

ASTEX complements this mechanism by allowing to display and modify external files from the document. A file is linked to the document by pointing first to the place in the document where you want to insert it, and then pointing to the file from the file manager of Framework 3. The title of the linked window is initialized to the name of the file but you can modify it to make it more explicit.

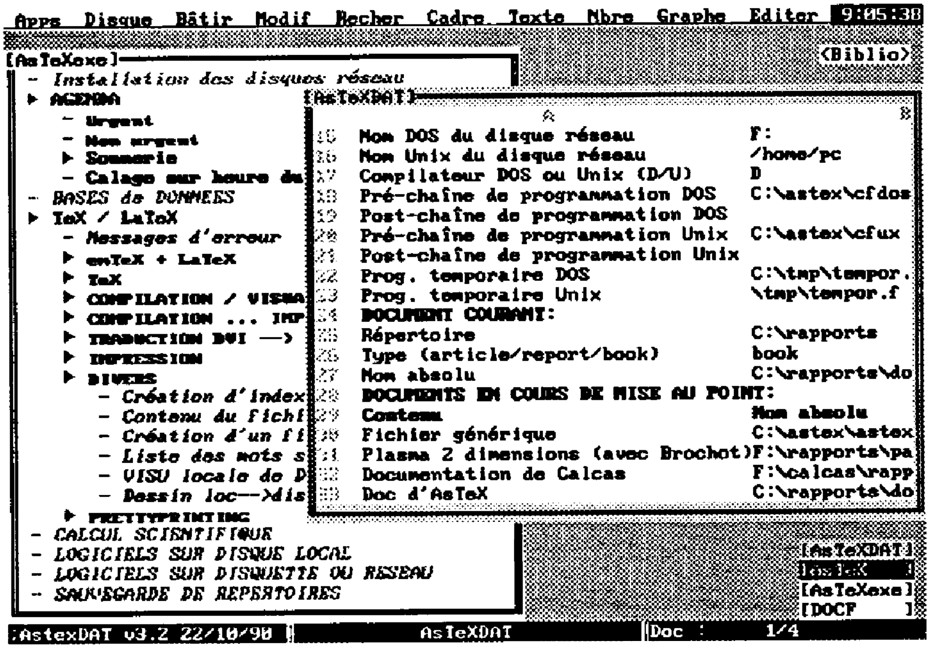
This is very convenient for managing computer programs, classifying and archiving in a structured way numerical results, electronic mail, etc... Archiving is made by loading the file into the linked window, removing the link of the window and destroying the external file.

2.5. The special windows AsTeXDAT and AsTeXexe

Each time ASTEX is run, it loads three windows (see Fig. 4). The first one, AsTeXDAT, contains all informations that are specific to the current user, in particular the names of his **personal documents** and current values of environment-dependent parameters (names of the temporary files, directories, network disk and Fortran compiler he uses, mode of creation of LATEX files and outputs).

This allows several users to work from different PCs on a network, without any interference, although downloading ASTEX and Framework 3 from a network disk. This allows them also to put a common document into form together. Each one uses his own copy of the document with his own configuration, while sharing common linked files. It is very easy to collaborate with colleagues, to correct the thesis of a student while he is typing it, etc...

The second window contains the current document. The same document is always loaded, until the name of the current document is changed in the data window AsTeXDAT.



```
[AsTeXexe]
 - Installation des disques réseau
 ▶ AGENDA
    - Urgent
    - Non urgent
    ▶ Sonnerie
    - Calage sur heure du
 - BASES de DONNEES
 ▶ TeX / LaTeX
    - Messages d'erreur
    ▶ emTeX + LaTeX
    ▶ TeX
    ▶ COMPILATION / VISUA
    ▶ COMPILATION ... IMP
    ▶ TRADUCTION DVI —>
    ▶ IMPRESSION
    ▶ DIVERS
       - Création d'index
       - Contenu du Fichi
       - Création d'un fi
       - Liste des mots s
       - VISU locale de D
       - Dessin loc—>dis
    ▶ PRETTYPRINTING
 - CALCUL SCIENTIFIQUE
 - LOGICIELS SUR DISQUE LOCAL
 - LOGICIELS SUR DISQUETTE OU RESEAU
 - SAUVEGARDE DE REPERTOIRES
```

```
[AsTeXDAT]
15  Nom DOS du disque réseau                     F:
16  Nom Unix du disque réseau                    /home/pc
17  Compilateur DOS ou Unix (D/U)                D
18  Pré-chaîne de programmation DOS              C:\astex\cfdos
19  Post-chaîne de programmation DOS
20  Pré-chaîne de programmation Unix             C:\astex\cfux
21  Post-chaîne de programmation Unix
22  Prog. temporaire DOS                         C:\tmp\tempor.
23  Prog. temporaire Unix                        \tmp\tempor.f
24  DOCUMENT COURANT:
25  Répertoire                                   C:\rapports
26  Type (article/report/book)                   book
27  Nom absolu                                   C:\rapports\do
28  DOCUMENTS EN COURS DE MISE AU POINT:
29  Contenu                                      Nom absolu
30  Fichier générique                            C:\astex\astex
31  Plasma 2 dimensions (avec Brochot)F:\rapports\pa
32  Documentation de Calcas                      F:\calcas\rapp
33  Doc d'AsTeX                                  C:\rapports\do
```

Figure 4. The special windows AsTeXDAT and AsTeXexe

The third window, AsTeXexe, automatizes access to general internal or external resources, independently of the current document. **Internal ressources** are for example agenda, alarm, frequently used databases (scientific articles, books, names and addresses of colleagues...) tuning of the PC clock to the one of the network server. **External ressources** are in general batch programs, to run external PC programs in a personalized environment or to send Unix requests to the server. They are accessible from the window AsTeXexe exactly as any item in a hierarchical system of menu. They are activated by pointing to an explicit title instead of typing the name of a program. For example, to execute the program `makeindex`, we point to the title "Création d'index" through the path "TeX/LaTeX", "DIVERS" (see Fig. 4). All the titles are customizable: they can be straightforwardly adapted to foreign languages. It is possible to modify the action of any item of the menu by loading the batch program in the window of the item for modification.

3. Word processing with ASTEX

When you write a long document, you have to modify its structure very often. LaTeX commands such as type styles, figure environment and mathematical symbols remain unchanged. We will call them **local** formatting commands. On the contrary, sectioning commands must usually be modified. For example, if a long section is transformed into a chapter, its subsections become sections, etc.... This may force to modify manually many LaTeX sectioning commands. These will be called **global** formatting commands.

With ASTEX, you have not to modify the sectioning commands because you never write any of them. They are automatically generated each time you want to preview or print the document or any part of it.

Any modification in the structure of the document is displayed interactively by Framework: when a section is transformed into a chapter, subsections are automatically transformed into sections, etc... ASTEX transforms Framework 3 into a preprocessor of LaTeX **structure**.

3.1. Transcoding local formatting commands

Many word-processors are able to display a certain number of local formatting commands. There are a lot of filters that transcode files from a given word-processor to TeX and LaTeX (cf. appendix B). Although the final result with LaTeX is not the same as what was displayed, the text is more readable without LaTeX commands.

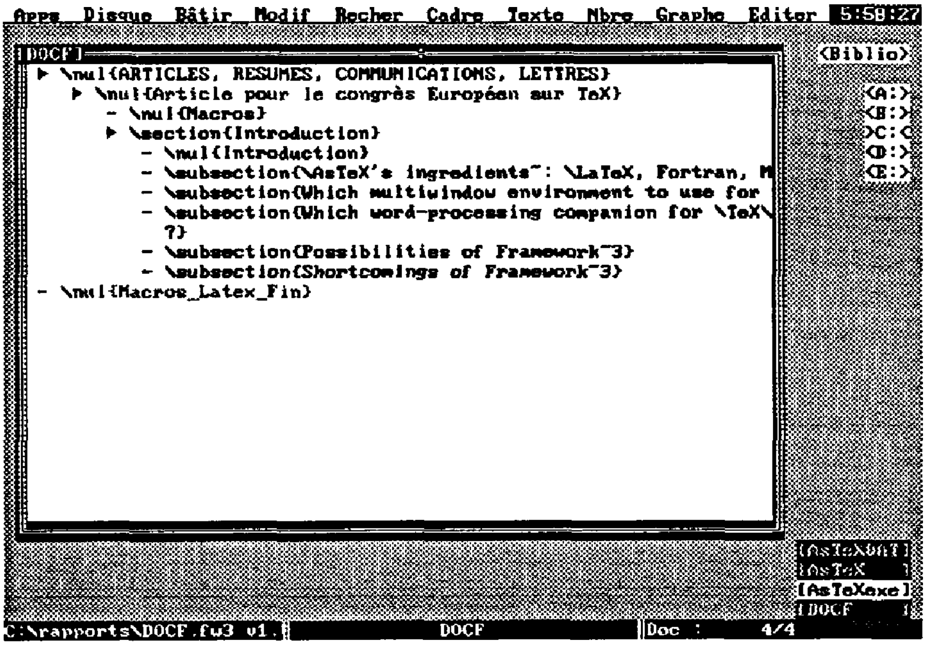
ASTEX allows such a transcoding for the attributes of characters of Framework 3 (italic, bold, underlined, overstrike, indices and exponents). However, this possibility has been added only to automatize the migration of files from Framework format to LaTeX format and as an introduction to LaTeX commands, for Framework 3 users that are new to TeX. The transcoding is made interactively on the screen, and it ought to be done once and for all.

Many other "local" properties of the text could be transcoded without too much effort (tabs, hard returns, hard page breaks, footnotes, headers and footers...). However, the general philosophy of ASTEX is to display interactively only **global formatting** of text, and to use LaTeX commands for **local formatting**. These are considered as encapsulated in small blocks of informations that are stored into linked files. ASTEX deals with the organization of these blocks through organization of linked windows on screen, and it allows the author to forget completely about local formatting commands. He is just reminded the contents of the blocks through their titles, and he can concentrate on the important part of his work, that is on the logical connection of the various components of his document and on the scientific computations that are related to it.

The blocks that contain LaTeX local formatting commands can be typed directly in LaTeX (eventually with the aid of Maple for formulas, see section 4), or created with a preprocessor of LaTeX that has mathematical capabilities (see Appendix B).

3.2. Exporting a LaTeX document

Let us consider the document of Figure 3, which corresponds to the present article. When AsTeX is asked to export a LaTeX document from it, it generates the document of Fig. 5. We see that AsTeX does not export blindly the whole document: a lot of windows have been eliminated.



```
▶ \nul{ARTICLES, RESUMES, COMMUNICATIONS, LETTRES}
   ▶ \nul{Article pour le congrès Européen sur TeX}
      - \nul{Macros}
      ▶ \section{Introduction}
         - \nul{Introduction}
         - \subsection{\AsTeX's ingredients~: \LaTeX, Fortran, M
         - \subsection{Which multiwindow environment to use for
         - \subsection{Which word-processing companion for \TeX\
           ?}
         - \subsection{Possibilities of Framework~3}
         - \subsection{Shortcomings of Framework~3}
- \nul{Macros_Latex_Fin}
```

Figure 5. Document with LaTeX sectioning commands, generated by AsTeX from the document of Fig. 3.

When the document is displayed as in Fig. 3, it is configured for debugging the first section of the window "Article pour le congrès Européen sur TeX". To export and debug the whole article, we would have simply to select windows numbered 2 to 8 in Fig. 3.

To illustrate further the great flexibility of A^{S}TEX in creating LaTeX documents, let us just indicate that the document "DOCF" of Fig. 3 manages several hundreds of files[2] and that, in the above example, we have exported only a small part of the file `c:\rapports\docf096.fw3`.

3.3. Displaying attributes of windows

A^{S}TEX is able to export only selected parts, with or without titles, with or without numbering of sections. The output can be a complete LaTeX document, or a file to be included with the `\input` command. The way the export is done depends on the attributes of the windows of the document. Framework 3 attaches three attributes to a window: it can be opened or closed, its title can appear or not, and it can be numbered or not. By default, the attributes of a window are inherited from the ones of its containing window. A^{S}TEX adds a fourth attribute to a window – linked or unlinked – and it displays these attributes according to the following rules:

The title of a window is displayed with small characters if it is unlinked, with italic characters if it is void, with bold face characters if it is opened, with overstriked characters if its title must not appear. For example, we see on Fig. 3 that only the first three windows and the last one are linked.

We will not give here a precise description of the exporting mechanism, because this would be too lengthy [Lavaud91a]. We just note, on the example of Fig. 3, that the windows of the first section are opened, while the windows of the other sections are closed. The section "The file manager of A^{S}TEX" for example does not exist any more in Fig. 5. This arises from the rule: only opened windows are exported.

3.4. Worksheets in LaTeX

Tables issued from worksheets can be included in a LaTeX document. They are updated automatically when a value is modified or added. For example, the following worksheet:

```
\begin{tabular}{|l|l|l|l|}
```

[2] In particular, the electronic mail of Fig.2 is accessible from the same document "DOCF". The window "ARTICLES, RESUMES, COMMUNICATIONS, LETTRES" appears in both figures (unloaded in Fig.2, loaded in Fig. 3).

```
\hline
INGREDIENTS         & PRICE    & NUMBER        &  COST       \\
\hline
Chicken             &       42 &             2 &          84 \\
Potatoes (kg)       &     3,50 &             5 &       17,50 \\
\hline
TOTAL COST          &          &               & {\bf 101,50}\\
\hline
\end{tabular}
```

gives:

INGREDIENTS	PRICE	NUMBER	COST
Chicken	42	2	84
Potatoes (kg)	3,50	5	17,50
TOTAL COST			**101,50**

If we change the number of chickens from 2 to 3, the entire array is automatically updated:

INGREDIENTS	PRICE	NUMBER	COST
Chicken	42	3	126
Potatoes (kg)	3,50	5	17,50
TOTAL COST			**143,50**

Any cell can be formatted individually. For example, the formula used to compute the total cost and print it in bold face is:

```
"{\bf " &@decimal(@sum(G6:G7)) &"}
```

3.5. Abbreviations

We have implemented a few abbreviations to generate various environments. For example, the sequence

```
\begin{equation} \label{ }
\end{equation}
```

is generated automatically by typing `\be`, and the cursor points inside the braces of the `\label{}` instruction.

3.6. Mailing in LaTeX

It is possible to do mailing in LaTeX. You write the model letter in LaTeX and you couple it to a database with the standard mailing option of Framework 3. This can be used for announcing conferences in a personnalized way: all types of accented letters, non-latin alphabets, etc...can be used, and no special equipment to edit adresses on stick-on labels is needed, if you use envelopes with a transparent window.

By combining mailing with worksheets, databases and the possibilities of LaTeX to use non-alphabetic fonts, it is possible to do automatically various exotic things entirely in LaTeX, for example printing in sanskrit the notes of all students of an Indian university, with averages over disciplines... Here, only imagination is a limit !

3.7. Prettyprinting of Fortran programs

Prettyprinting Fortran programs is very easy with the method of Naudin and Quitté [Naudin90], because Fortran uses none of the special characters used by TeX. A program can be prettyprinted from the document, even in the course of debugging. For example, with the following program:

```
C Programme ESSAI.FOR
C
      DO 10, I=1,20
        DO 15, J=1,2
          P=I**J
          WRITE(*,*) I,J,P
15      CONTINUE
10    CONTINUE
      END
```

we obtain:

C Programme ESSAI.FOR
C

```
      do 10, I=1,20
        do 15, J=1,2
          P=I**J
          write(*,*) I,J,P
15       continue
10     continue
      end
```

This is not possible so easily with Maple programs, because some Maple commands use special characters of TEX.

4. Scientific computation with ASTEX

Numerical and formal computations are very useful in everyday research, because they guide theoretical investigations through preliminary numerical studies, replace real experiments through numerical simulations, and are able to give exact solutions to a large class of analytical problems through computer algebra languages.

ASTEX allows to run Fortran and Maple programs from a document. When the problem cannot be treated on the PC, it is submitted to a distant machine, transparently if the PC is connected to it by a LAN, through cut and paste between telecommunications and text windows, if it is connected by a modem.

4.1. Numerical computations in Fortran

Most scientific computations are made in Fortran, because there are large libraries (NAG, IMSL, Harwell, CPC, Modulef...) on mainframes and workstations that allow to solve almost all usual numerical problems in mathematics, physics and chemistry. The best solution is to put into shape Fortran programs locally, and to submit to mainframes only a definitive version. This is much more economical and efficient than working on the mainframe from a terminal.

With ASTEX, Fortran programs can be debugged on a PC as easily as on a workstation. The main program, subroutines, data files and executables are linked bijectively to windows, and are accessible from the document through explicit titles by means of the file manager. Fortran modules can be edited, compiled to check syntax and run from the document, simply by pointing to their title. Error messages are loaded in a special window to facilitate debugging. Subroutines can be put in a subtree of windows that reflects exactly their position in the tree of the program. This facilitates structured programming. Input data and results can be browsed or edited and executable files run from the document.

The Fortran compiler used can be local, or can reside on a Unix machine if the PC is linked to a LAN. The user has only to indicate in his configuration window AsTeXDAT which compiler he wants to use. The compilation is made transparently on the machine that has been selected.

4.2. Formal computations with Maple

Maple is an interactive mathematical program. It allows to make preliminary numerical studies, or to perform exactly and in a blink of an eye analytical computations that would be very long to do by hand. If the PC is connected through a LAN to a server that runs Maple, A^{S}T$_E$X allows to make computations directly from a text, a worksheet or a database. The result is inserted automatically in the text, after the selected formula. If the PC is connected through a modem, the result must be inserted manually by means of cut and paste[3] between the telecommunications window and the current window of the document.

Let us assume we have typed the following Maple formula in a text:

```
Int(1/(a^2+x^2),x) = int(1/(a^2+x^2),x)
```

After having selected the formula, the computation is run in one of the three modes: Full screen, LaTeX or linear. If we ask for the full screen mode, the following result is inserted after the formula:

```
%               /
%               |     1          arctan(x/a)
%               |  --------- dx = ------------
%               |   2   2              a
%               /   a  + x
```

If we ask for a LaTeX output, we obtain:

[3] This is exactly the procedure used on the workstation itself, when we run Maple in one window and type the text in another one.

```
{{\int  { {( { { a^{2}}+ { x^{2}}} )}^{-1}} d x} =
{ \frac{{ \arctan ( { \frac{x}{a}})}}{a}}}
```

which gives:

$$\int (a^2 + x^2)^{-1} dx = \frac{\arctan(\frac{x}{a})}{a}$$

Including in the document both the full screen and the LaTeX outputs provides a simple way to **display LaTeX formulas** on screen, in an easily readable form. This can be an alternative to preprocessors of formulas.

If we ask for the linear mode, we obtain:

```
Int(1/(a**2+x**2),x) = 1/a*arctan(x/a)
```

This mode is adapted to the execution of a sequence of computations from a text. Indeed, it is possible to select a result in this mode and include it in a new formula. The computation can be run from a cell of a worksheet or a field of a database. This adds scientific computation possibilities to the spreadsheet module of Framework 3 and allows to create databases of results or formulas.

It must be noted that Mathematica provides an interesting notebook front end between computer algebra and text, on Macintosh and NeXT. This has been extended recently to Unix systems [Dill91]. Framemaker proposes a comparable solution (more sophisticated for the PAO module, less sophisticated for computations). All these solutions are very expensive and need powerful machines. On PCs, Mathcad is supposed to provide a similar environment. However, it is also very expensive (from 800$ to 1600$ in France) and is much less powerful than the solution we propose, since it has neither the power of Maple for computations not the one of LaTeX for formatting text.

5. Conclusion

AsTeX is a **low-cost** solution to perform your current scientific work in as good conditions as on a workstation, with your existing hardware. You can use a unique keyboard adapted to your national language (in France, with accented vowels) and unique editing commands whatever the machine used (if you are connected to a distant machine by a modem or a LAN).

You can profit by a **color screen**, without any investment if your PC is already equipped, or for a few hundreds of dollars if it is not. Equipping a workstation with an entry-level color screen would cost ten times more.

ASTEX preserves also your investment in **PC software**, and offers, even on a standalone PC, functionalities that are not available as standard tools on workstations (in particular a hypertext file manager).

When the PC is connected by a LAN to a workstation, ASTEX transforms it into a machine as powerful as the workstation, for most scientific tasks. A network of PCs equipped with ASTEX and connected to one workstation[4] provides a very economical alternative to a network of workstations and X-window terminals, at a cost **five to ten times lower** [Lavaud91b]. This could be useful for laboratories or universities that cannot or do not want to equip all their researchers or students with workstations.

Of course, ASTEX can only delay the necessary migration to Unix systems, but it can help waiting until prices become low enough. This migration can be done **very progressively**, because Framework 3 files can be exported with all their structure as LaTEX documents, and imported on workstations into scientific word-processors such as The Publisher. It is possible to replace only a few networked PCs every year, by the newest models of workstations, instead of replacing today all PCs by workstations, whose power will appear ridiculous in a few years, as compared to the most recent ones.

A. Multiwindowing with Framework 3

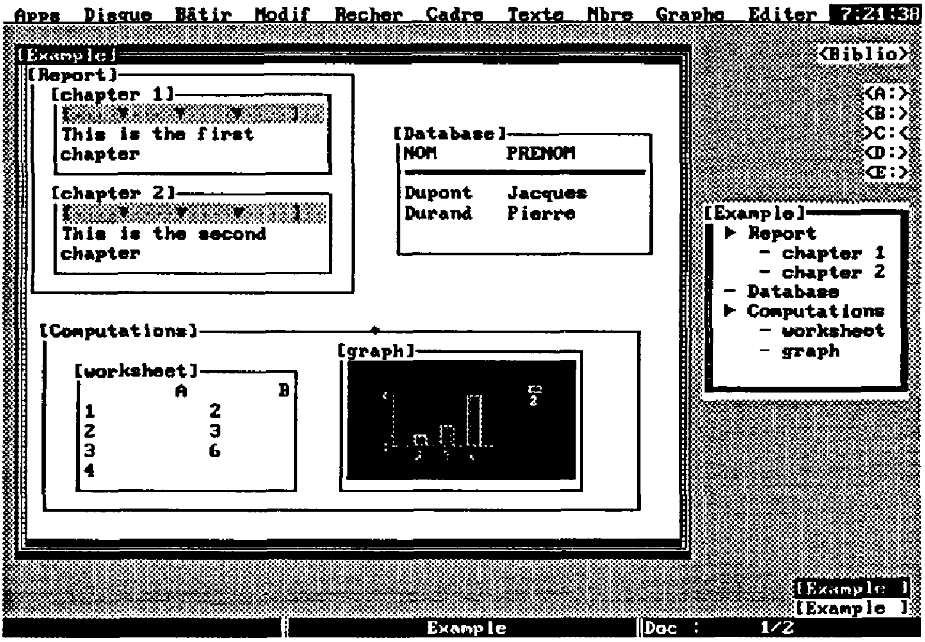
We describe here the properties of Framework 3 that are useful in constructing the multiwindow environment of ASTEX. For more informations on the general possibilities of Framework 3, see for example [Chene90].

A.1. Hierarchical windowing

With modern operating systems, files can be organized hierarchically. They are grouped inside directories, and each directory can contain files or subdirectories. The files are leaves of the tree.

[4] A unique workstation can be used as a server for several tens of PCs, because most transactions are done (or can be done) locally on the PCs. The network is solicited only when network disks or workstation programs are used.

With Framework 3, windows can be organized hierarchically in a similar way. Each window can contain other windows (then it is the analog of a directory), or contain either text, or a spreadsheet, or a database, or a graphic, or a telecommunications session (then it is the analog of a file, and it is a leaf of the tree). This is illustrated in Figure 6.



This is the first chapter

This is the second chapter

NOM	PRENOM
Dupont	Jacques
Durand	Pierre

	A	B
1	2	
2	3	
3	6	
4		

Figure 6. Example of a hierarchical set of windows, with Framework 3.

With Windows 3, and also with other windowing systems such as sunview on Sun workstations, windows can only be placed side by side, as ancient operating systems did with files. Although many applications can also open subwindows (for example emacs, Word, etc...) these can only be placed side by side (i.e. they cannot contain other subwindows) and they must be of the same type (they must all contain text, or they must all contain spreadsheets...).

A.2. Customizable titles of subwindows

With Windows 3, windows have the title of the application together with the name of the file. For example, if we open several files with Write, they all have the same title ("Write file1", "Write file2", etc...).

With Framework 3, the titles of the subwindows are customizable. For example, one can give the titles "Preparing your manuscript" and "Mailing the material" to two windows of text. When they are closed, their icons keep the same name, so that one can select the correct one without any problem.

A.3. Navigating through the document

With a single keystroke, you can toggle between a portion of text and the table of contents of the document. It is very easy to navigate from one part of the document to another, and it is much faster than scrolling in the whole text, or searching for strings.

B. Filters and preprocessors for TEX and LATEX

There are several public-domain and commercial filters from PC word processors to TEX and LATEX. A very complete list has been given in [Siebenmann89]. We cite here just a few of them to update this list.

B.1. Public domain or shareware software

The following filters can be obtained by ftp from ymir.claremont.edu (ftp 134.173.4.23), directory tex.ibm_pc.front_ends:

Pcwtex From PC-Write v2.2 to TEX, by J.W. Breen, Monash University, Australia. File pcwtex.zip.

Pcwritex From PC-Write v2.71 to TEX, by Peter Flynn, University College, Cork, Ireland. File pcwritex.arc.

Wsltex From Wordstar to LATEX. It translates superscripts, subscripts, underline, hard line breaks, hard page breaks. File wsltex.

Wp2latex From Wordperfect to LATEX. by Ron Helwig, Eindhoven University of Technology. Directory wp2latex.

There is also a translator from Word (see communication at this conference), but its type of distribution is not yet known.

B.2. Commercial software

There are several commercial software on PC that can be used as preprocessors of TeX. Some can be used also as preprocessors of LaTeX.

Publishing Companion Filter from Wordperfect to TeX or LaTeX. Sold in the U.S. by K-Talk Communications, about 200$.

MathEdit Equation editor driven by menu. Sold in the U.S. by K-Talk Communications, about 130$.

MathDesign Equation editor driven by menu. Sold in France by Apsylog, about 400$ for the French version. It requires Windows 3.

Mathor Word processor integrating an interactive equation editor. Sold in France by Novedit, about 1000$. It can export in TeX and LaTeX.

It must be noted that using a scientific word processor as a preprocessor of TeX needs great care in typing the equations. For example, a secretary who does not know mathematics will type f(x) instead of $f(x)$. This can lead to correct display on screen, but to unusable results when transcoded, if some pieces of a formula have been typed in text mode and others in math mode.

References

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