aging complexity requires the ability to both increase and decrease it when appropriate. The K-link is the mechanism for increasing complexity in a RING file assembly. The journal link or J-link is the mechanism for decreasing complexity.

*How the journal linking facility relates to others.* One important example that highlights the relation between the J-link and others is the removal of a file from a RING file assembly. One would want to capture the information in that specific file relevant to the information in the others but may decide that the information can be adequately represented by citation from the file and commentary on it. The J-link permits, during reorganization, the information from one file to be copied into the journal file and the link to the source file to be broken. This functionality is also required in the case of K-links. The J-link facility is likewise able to go from the journal to a specific other file, extract the relevant file element, preserve a pointer to it, and delete the symbolic link from the specific other file. When subsequently, the RING file assembly is opened without the other specific file included in the RING, that file automatically disappears from the K-link (although a trace of it may remain in the K-link commentary of the journal) and the text extracted by the J-link appears as a citation to a remote (offline) file, appended to the K-link commentary in the journal.

## USEFULNESS OF THE RING FACILITY

### Datacase Studies Now Underway

***The psychology of the particular revisited.*** The reasons for deciding to retreat from the Three Years and Talking datacase to working with my earlier study are still valid. I have decided to complete the Psychology of the Particular datacase in the new RING environment. A further incentive occurred with the two books involving that study going out of print. Bringing materials of the case study corpus into machine-readable form is now going forward both by scanning of typed texts and by keying of central documents that are not scannable.

*The system environment.* The prototype implementation of POP will be in Macintosh Hypercard 2.1. The RING prototype runs on Apple SE-class machines (even earlier Apple Plus machines with enough memory to run System 7), but for real usefulness, systems with large or multiple screens are essential.

*The contents of the datacase.* The contents would, if presented in a figure like Figure 2.5, appear almost identical. The contents are the same. Every chapter that appears in one of the two books is, however, an individual file. The logic of the structure and its organization within the RING files assemblies is radically different from the earlier version of Figure 2.5 wherein the texts appeared with an organization similar to that of the book form. The collection of vignettes, which comprise a major resources within the corpus, have been retyped and can be loaded into the RING facility. Other corpus documents, such

the research proposal for The Intimate Study (appearing as Appendix A here), some related preliminary analytical work, and some important drafts of inter- pretations are planned for inclusion in the corpus. The documents are available. Bringing them online is labor intensive and time consuming.

The limited computing model of learning, Strategy Learner: Interactive Model (SLIM) has been recoded into hypertalk from the original Lisp. With associated papers reporting that research effort, that collection of programs will comprise the initial modeling component of the POP datacase. Other research proposals that indicate how to extend such models to other parts of the corpus are also being prepared for inclusion. Those models will be constructed as time, energy, and other factors permit.

*The method of file construction.* The file loaders of RING take ASCII files as input, parse the strings according to the encoded structuring indicators, and distribute the text characters into their appropriate fields. Graphics recreated from the original materials of The Intimate Study will be formatted for use in the files and merged into the POP text stacks as appropriate. These techniques remain unchanged from their first use with the initial version of POP in 1989 and the Hypercard *Society of Mind* in 1990. The indices of *Computer Experi- ence and Cognitive Development* and *Computing and Cognition* will be recre- ated by the author, myself, within the RING file assembly facility. The indices published with the book will be consulted for the guidance they can provide. The recreated indices will then be compiled and distributed throughout the indi- vidual files of the assembly. Where major index categories exist in the original texts that extend throughout the text in most chapters, those entries will be replicated using K-links created for the particular elements involved. Each file in the assembly will then be an instance of the RING shell with its variable content determined by the text and graphics loaded and by the specific indices and links constructed.[42] The assembly for the Psychology of the Particular will contain approximately 25 different files (not counting those that are temporary). ***Three years and talking.*** The case study that inspired the original CASE vision is only partially embodied in machine-readable form. To create that datacase and proceed with its analysis is the next project on my current agenda. This work is planned to begin in Spring 1995.

## Other Examples of Current Projects

In order to probe the extent to which these facilities might be useful in other areas of study and to provide examples of what that utility might be like in detail, samples of work have been produced using the RING file format. Here are three examples.

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[42] Because each file will embody the shell programs as well as the file content, it is relevant that the overhead per hypercard file prototype is approximately 50k bytes.
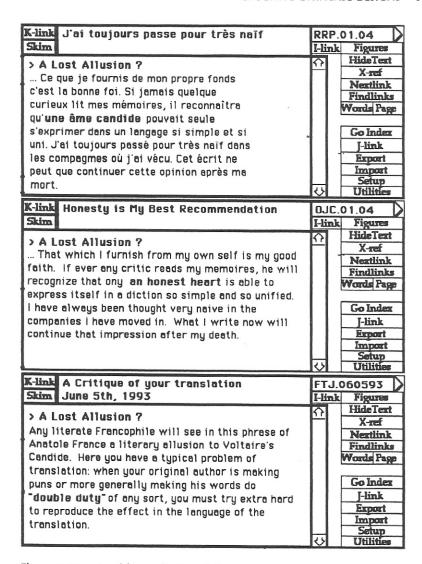
| K-link | J'ai toujours passe pour très naïf | RRP.01.04 |
|---|---|---|
| Skim | | I-link  Figures |

> A Lost Allusion ?

... Ce que je fournis de mon propre fonds c'est la bonne foi. Si jamais quelque curieux lit mes mémoires, il reconnaîtra qu'**une âme candide** pouvait seule s'exprimer dans un langage si simple et si uni. J'ai toujours passé pour très naïf dans les compagmes où j'ai vécu. Cet écrit ne peut que continuer cette opinion après ma mort.

*HideText · X-ref · Nextlink · Findlinks · Words Page · Go Index · J-link · Export · Import · Setup · Utilities*

| K-link | Honesty is My Best Recommendation | OJC.01.04 |
|---|---|---|
| Skim | | I-link  Figures |

> A Lost Allusion ?

... That which I furnish from my own self is my good faith. If ever any critic reads my memoires, he will recognize that ony **an honest heart** is able to express itself in a diction so simple and so unified. I have always been thought very naive in the companies I have moved in. What I write now will continue that impression after my death.

*HideText · X-ref · Nextlink · Findlinks · Words Page · Go Index · J-link · Export · Import · Setup · Utilities*

| K-link | A Critique of your translation | FTJ.060593 |
|---|---|---|
| Skim | June 5th, 1993 | I-link  Figures |

> A Lost Allusion ?

Any literate Francophile will see in this phrase of Anatole France a literary allusion to Voltaire's Candide. Here you have a typical problem of translation: when your original author is making puns or more generally making his words do "**double duty**" of any sort, you must try extra hard to reproduce the effect in the language of the translation.

*HideText · X-ref · Nextlink · Findlinks · Words Page · Go Index · J-link · Export · Import · Setup · Utilities*

**Figure 2.14.   A critique of a translation.**

***Translation critiques.*** Anatole France, a popular literary figure at the turn of the century and member of the Acadèmie Française, wrote some charming stories about a naïve young man, Jacques Tornebroche, and a worldly cleric, M. L'abbe Jerome Coignard. One such book is *Le Rotisserie de la Reine Pedauque,* from which I have included a sample of text from the introduction in the windows of Figure 2.14. Imagine yourself a French teacher who requires written translations of this text as an assignment. If the teacher has a machine-readable

copy of the original text and receives another file with a student's translation, he can return to the student his criticism embodied in knowledge links, the secondary terminals of which point to specific chunks of text (in the original French and the student's translation) compared and discussed in the teacher's commentary of the journal (see Figure 2.14).[43] The detailed criticism possible based on specific reference to translation of phrases and passages of the two texts in direct comparison could make easier and clearer the more sophisticated criticism that most professors would prefer to simple corrections and general evaluative comments.

*Literary analyses.* With the "new criticism" introduced by Ivor Richards in England and by Brooks and Warren in the United States at mid-century, the close reading of texts and comparison of variants became a primary mode for developing interpretations and evaluations. A second mode is the explication of text, wherein one takes a literary work of significant difficulty and teases apart its structure and specifies the relations of the parts to the whole and the impact of each on the meaning of the ensemble. Following are two examples of pieces that are suitable for such analyses and a sample of what RING file assemblies for supporting such an analysis might be like.

*Two texts by Clarke.* The different editions of Shakespeare's plays are commonly compared and analyzed. Use of variorum editions of poets' works is common as well, but it is much more rare to have the opportunity to compare and contrast published versions of "the same" novel. One such an opportunity occurs in the science fiction genre, due to accidents of history.

Clarke composed the novella *Against the Fall of Night* before World War II. Following the war, through which Clarke served, he had second thoughts about the work and decided to rewrite it. The extended work, a major novel in his distinguished corpus, is *The City and the Stars*. The comparison of the two novels could be remarkably fruitful because of the challenges the task implies— determining which changes were made for rhetorical effects and which were made because the author had encountered new ideas. The latter is especially an interesting question for this comparison because in the interval between publications, the modern digital computer was introduced and the structure of DNA was resolved. Both these discoveries impact the story in significant ways. Figure 2.15 represents a comparison of these versions of the novel with a comment on the author's technique created using a RING file assembly.

*Disentangling Nabokov's* Pale Fire. One of the comic masterpieces of this century is a satire of literary criticism, created by Vladimir Nabokov. The work, pretending to be an appreciative publication of a slain poet's final work, in its purposeful intricacy is itself a parody of the genre. How complex need file assemblies be to deal with such textual analysis? *Pale Fire*, as organized in the

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[43] Simple corrections and comments could, of course, always be directly entered into the text of the student's translation.

| K-link | Chapter 10: and children too | CAS 10.10 ▷ |
| Skim | | I-link    Figures |

**> The Price of Immortality**
The people of the village now watched with frank
curiosity as Alvin followed his guides; there was no
longer any pretense that they took him for granted.
Suddenly there were shrill, high-pitched shouts from
the trees on his right, and a **group of small, excited
creatures burst out of the woods** and crowded
around Alvin. He stopped in utter amazement, unable
to believe his eyes. Here was something his world had
lost so long ago that it lay in the realms of mythology.
This was the way life had once begun; these noisy,

Side buttons: HideText, X-ref, Nextlink, Findlinks, Words Page, Go Index, J-link, Export, Import, Setup, Utilities

| K-link | The Land of Lys: and children too | AFN 05.06 ▷ |
| Skim | | I-link    Figures |

**> The Price of Immortality**
The people of the village watched with frank curiosity
as Alvin followed his guides. **He was amazed to see
not a few children, who stared at him in grave
surprise.** No other single fact brought home to him so
vividly his remoteness from the world he knew.
Diaspar had paid, and paid in full, the price of
immortality.

Side buttons: HideText, X-ref, Nextlink, Findlinks, Words Page, Go Index, J-link, Export, Import, Setup, Utilities

| K-link | Comparison of two novels by A. Clarke | ▷ |
| Skim | September 7th, 1993 | I-link    Figures |

**> The Price of Immortality**
All the paragraphs of CAS have undergone rewriting
and expansion. The effect is one of providing a **more
profound insight** into the differences between the
two cultures. Subordinate elements of the changes are
removing any explicit criticism of Diaspar or the lives
or character of its citizens and an effort to establish
the superiority of Lys and its people as more richly
continuing the processes of life, whose vitality is
paid for in the currency of mortality,

Side buttons: HideText, X-ref, Nextlink, Findlinks, Words Page, Go Index, J-link, Export, Import, Setup, Utilities

Figure 2.15.    A comparison of two novels by Arthur Clarke.

RING file assembly format, provides a hint of an answer. Figure 2.16 represents the essential files for that analysis as six in number.

## General Categories of Applications

The preceding examples will help give some texture to the following suggestions I raise in conclusion. I see at least four major categories of computer-
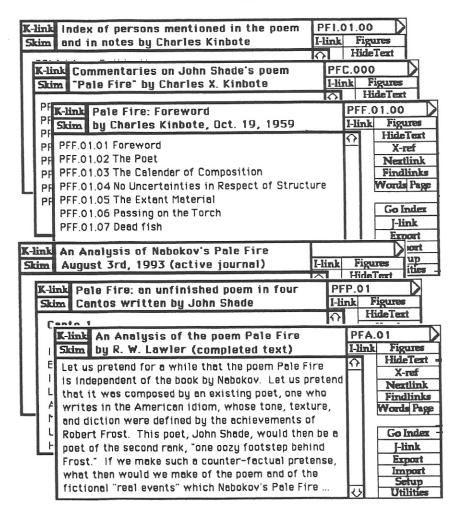
MARKED SET

| K-link | Index of persons mentioned in the poem | PFI.01.00 |
| Skim | and in notes by Charles Kinbote | I-link | Figures |
| | | HideText |

| K-link | Commentaries on John Shade's poem | PFC.000 |
| Skim | "Pale Fire" by Charles X. Kinbote | I-link | Figures |
| | | HideText |

| K-link | Pale Fire: Foreword | PFF.01.00 |
| Skim | by Charles Kinbote, Oct. 19, 1959 | I-link | Figures |
| | | HideText |
| | | X-ref |

PFF.01.01 Foreword — Nextlink
PFF.01.02 The Poet — Findlinks
PFF.01.03 The Calendar of Composition — Words Page
PFF.01.04 No Uncertainties in Respect of Structure
PFF.01.05 The Extant Material — Go Index
PFF.01.06 Passing on the Torch — J-link
PFF.01.07 Dead fish — Export

| K-link | An Analysis of Nabokov's Pale Fire | up |
| Skim | August 3rd, 1993 (active journal) | I-link | Figures | ities |
| | | HideText |

| K-link | Pale Fire: an unfinished poem in four | PFP.01 |
| Skim | Cantos written by John Shade | I-link | Figures |
| | | HideText |

| K-link | An Analysis of the poem Pale Fire | PFA.01 |
| Skim | by R. W. Lawler (completed text) | I-link | Figures |
| | | HideText |
| | | X-ref |

Let us pretend for a while that the poem Pale Fire
is independent of the book by Nabokov. Let us pretend — Nextlink
that it was composed by an existing poet, one who — Findlinks
writes in the American idiom, whose tone, texture, — Words Page
and diction were defined by the achievements of
Robert Frost. This poet, John Shade, would then be a — Go Index
poet of the second rank, "one oozy footstep behind — J-link
Frost." If we make such a counter-factual pretense, — Export
what then would we make of the poem and of the — Import
fictional "real events" which Nabokov's Pale Fire ... — Setup
Utilities

Figure 2.16.   Disentangling Nabokov's web of "Pale Fire."

based applications that can be significantly advanced with the suite of tools described here as the RING file assemblies.

*Articulating relationships among texts.* This is the primary application, but text processing is the single most flexible and widespread application of computing by individual knowledge workers. A smaller portion of knowledge workers are involved in text analysis than are users of personal computers, but that portion may at times includes most of those involved in education and many of those involved in all the fields of business and government. If these ideas prove useful, the audience of text analysts will not be a small one.

*Creating order for graphical databases.* As image archives become more accessible through increasing processor speed, increasing memory capacities, and the decline in the price of peripheral storage, the challenge of making sense of large collections of graphical data will become important. It is now a horizon issue with the increasing public availability of CD-ROM data stores and increasingly sophisticated software for manipulating images and animation. As archives of unorganized[44] images become publicly available, the challenge will become one of sorting elements of those images into usable collections and hierarchies. Keeping track of the contents and impressions made by those images will be a task in which knowledge links will prove useful.

*Making sense of "unrelated" files.* One element in the agenda of the Clinton–Gore Administration has been to open to the American public data that the government holds on file. One suggestion is that network access to these files will enable citizens to choose and act with more knowledge, and thus better guide the government. Whatever one thinks about the ideology of the agenda, the practical challenge is one to which RING files assemblies might make some contribution

*Sharing and comparing interpretations.* This is a fitting theme on which to conclude the discussion of these issues. We began with the need to share case study corpora in order to advance the credibility of the method. That need is still, for me, a primary motive. It is nonetheless clear that in other fields than psychology there may be some value in having tools for examining the available information, for constructing interpretations that cover that information, and for sharing that information with colleagues.

## ACKNOWLEDGMENTS

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[44] *Unorganized* as I use it here is meant to apply to any collection organized by categories different from those any particular individual might care about. In this sense, all organizations are unorganized to any person with a purpose not identical to that of the original archivist.

some of his students had undertaken similar studies. Mme. Sinclair has continued to argue for the general approach represented in my work among her students at Geneva and her fellow researchers in the Archives Piaget. Sheldon White (of Harvard) helped me over many years find the links between my own approach to understanding cognition and the efforts of earlier scholars who have defined the current traditions of psychology. Howard Gruber (of Rutgers, later of Geneva) through his work, through personal contact, and through his organization of a Case Analysis Study Group in the New York area helped shaped my perception of the breadth and power of the case study method. At a later time, the taff of the Murray Research Center welcomed me there as a visiting scholar, and I had the great pleasure to meet and interact with George Goethals before his recent retirement.

Over a period of many years, I have enjoyed also the interest in my case study work of colleagues in the Artificial Intelligence community. Seymour Papert and Marvin Minsky were early supporters and a continuing inspiration. William Frawley, Oliver Selfridge, Wallace Feurzeig, and Jospeh Psotka helped me to continue and to advance this line of research at critical times. My colleagues at Purdue University have been tolerant of the long time to publication in this sort of work and supportive of my using software prototypes with advanced students.

My gratitude to these professional colleagues is only exceeded by that I feel to my children as subjects and to my wife as a patient, unpaid coworker in this long and difficult line of research.

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