Academic Prototyping as a Method of Knowledge Production: The Case of the Dynamic Table of Contexts

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Abstract

Academic prototyping, like ethnography or bench studies, is a way of producing new knowledge about an idea. It can result in a kind of evidence that can be used to strengthen or weaken an argument. A prototype is an artifact, but it is not just an artifact; it may be a phase in product development, but it is not necessarily so. It is also, and perhaps more importantly, a phase in a critical process. In fact, it is perhaps better to speak of academic prototyping, rather than of academic prototypes. In this article, as an example, we discuss the Dynamic Table of Contexts, an academic prototyping project that has served for more than 10 years as a focus of ideas about what it means to remediate and improve on a venerable print tradition.

Keywords

Prototyping; Table of contents; Table of contexts; DToC; E-books; Book design

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Introduction

Academic prototyping is an attempt to reify an idea to a sufficient degree of fidelity that knowledge gained from the prototyping can be applied back to the idea. The necessary degree of fidelity will vary according to the kind of knowledge being pursued. As Alan Galey has succinctly put it: "why speculate when we can prototype?" (Galey & Ruecker 2009). The current process is as follows: people interested in working with experimental prototypes will propose some relevant research questions, often involving user study, then write and publish about the design ideas and the user tests, with the prototypes arising as a kind of side effect of the process. There have occasionally been efforts to address prototypes more directly, but what has tended to happen is that a brief discussion of the prototypes turns out to be insufficient for people attempting to assess their value as instances of new knowledge, and the length of the discussion increases over time until we are back to writing a paper for evaluation rather than having the prototype directly reviewed in some way.

We have previously suggested that the review of prototypes might leverage experience in reviewing other kinds of scholarly output (Galey, Ruecker, & the INKE Research Group, 2010), but so far, despite a growing interest, nothing of note has emerged. All of which is not to say that experimental prototypes are not of value in the pursuit of new knowledge, and in fact, it is possible to claim that a kind of intellectual trajectory can be recognized in looking at the changes made to prototypes over time. Our claim here is that this trajectory shows reasonably clearly that at least some academic prototypes have a relatively long lifespan as prototypes, with each successive cycle of design and development extending our understanding. As an example of the process, we will look at the conception and history of a relatively simple prototype system called the Dynamic Table of Contexts (DToC).

Research question: What are the possible new affordances of digital text?

The concept of the DToC arose as one answer to a much larger question: what are the possible new affordances of digital text? In general, these involve research areas such as text analysis and visualization. In more specific terms, we have distant reading, algorithmic criticism, text visualization, and interactive visualization (e.g., Ramsay, 2011). Our research projects in response to this question have included

- The Bi Sheng Electronic Book,
- Watching the Script (WtS),
- Simulated Environment for Theatre (SET),
- No One Remembers Acronyms (NORA),
- Metadata Offer New Knowledge (MONK),
- Implementing New Knowledge Environments (INKE),
- Paper Drill,
- CiteLens,
- Multitouch Variorum (MtV),
- The Text as a String of Words,
- Just in Time Research (JiTR),
- Repetition Loops,
- dialR,
- The Novel as Slot Machine,

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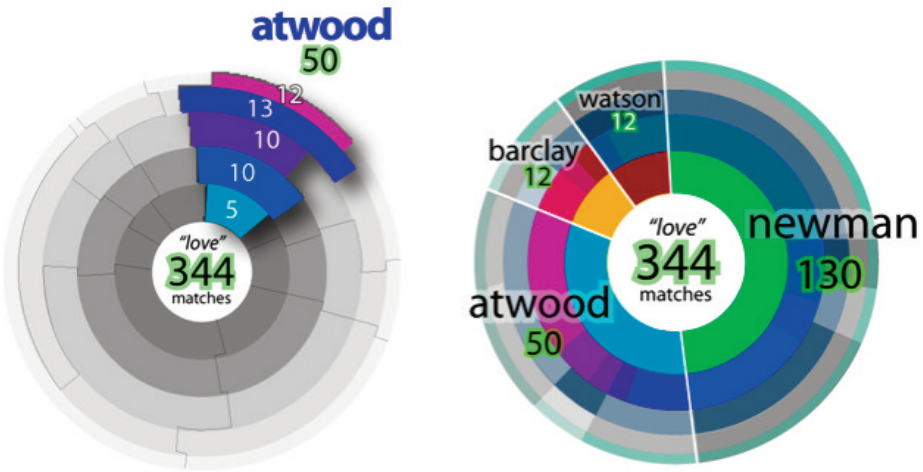
- Magic Circle,
- Mandala Browser,
- TextTiles,
- Bubblelines,
- Conversation as an Enterprise Asset and Resource (CLEAR), and
- The Reorganizable Textbook.

Each of these projects involved the design and evaluation of academic prototypes. The interactions between the prototypes and projects in this list have been complex, because these prototypes were not developed in order to test hypotheses. They are better understood as interpretive processes on a particular theme. As a result, these prototypes can help us generate knowledge in a range of subject areas that do not need to be predetermined.

To take one example, the magic circle (Figure 1) is a visualization that shows a breakdown of various contributions to some sort of whole, provided by a number of designated parts of that whole. It was originally sketched as a possible component of the MONK project, where it was going to serve as a way of showing how vocabulary use varied across different works, either by the same author or else across multiple authors. By extension, it could also be used to look at varying use of lemmatized vocabulary, stemmed vocabulary, or even parts of speech.

Figure 1: The original magic circle design, showing search results for the word love across multiple books by multiple authors.



However, the magic circle did not find its way into the final production of MONK, and was shelved for a couple of years. It next emerged in a collaborative project on wiki authorship, where the team was looking for some means of conveying the results of an algorithm that could give people credit for their contributions to wiki pages. Somewhat at odds with the typically anonymous approach to wiki authorship, the magic circle was an innovation intended to accommodate writing environments like industry and the classroom, where anonymous contribution is deprecated in favour of knowing who has been working on what (Arazy, Stroulia, Ruecker, Arias, Fiorentino, Ganev, & Yau, 2010).

Taking it one step further, the magic circle was included as an example of the kinds of output that could be anticipated from the interface design research team in the Implementing New Knowledge Environments (INKE) project. In this context, our intention was to apply it more broadly to questions of co-authorship, not just on wikis, but also across a number of media.

Finally, extending beyond INKE, the magic circle was adopted for production by the Canadian Writing and Research Collaboratory (CWRC), where it is intended for use in helping to manage and to provide appropriate credit for collaborative authorship across a range of projects. This one fairly small visual idea has therefore served as a component of three major projects, travelling across researchers, disciplines, and institutions. Like a useful theory or a new theoretical perspective, this process of adaptation of the magic circle extends readily into new areas; it is a tool of the mind.

A brief visual history of the Dynamic Table of Contexts

One of the virtues of digital humanities (DH) as a field is that we are at least as interested in the ideas behind the prototype as in the prototype itself. In practical terms, this means that we can discuss design concepts before we build them, allowing us to put extensive work into the design thinking rather than needing to push forward quickly into a software version. It is possible in DH to present and publish on ideas, sketches, interactive sketches, prototypes, and development systems, as well as user studies at practically every stage.

In the instance of some academic prototypes, it is possible not only to trace their interdisciplinary trajectories, but also to identify explicitly the kinds of research topics that they have informed. In the case of the DToC, we were interested in the design of the electronic book, and how people who want to read and study books might have their experience improved over what is possible with a print book. Our contention was not that digital books would replace print books – since we had previously carried out a study that suggested that they would not – at least for dedicated readers in this lifetime (Ruecker, 2002). Instead, we wanted to identify growth points, where what we would now call the skeuomorphic design, and what we then spoke of as the remediation of the print book into digital form, could be extended in ways that would be beneficial to the reader.

Our initial concept and conference paper (Ruecker, 2005) asked how the print table of contents (TOC) might serve as a rich-prospect browser. We identified which of the principles of rich-prospect browsing it met, and which it failed to meet, and then posited a digital system that would meet all of the criteria. The purpose of meeting these criteria was that the TOC could then become a more robust tool for researchers. Our example used the dynamic insertion by the reader into the TOC of characters, dialogue, and locations in *The History of Tom Jones, a Foundling*. At this stage, we were looking at some early sketches (Figure 2), but had not begun to think about the details of programming a working prototype. This was a low-fidelity version (a set of images in Illustrator) that was nonetheless useful in interrogating this augmentation of the conventional TOC, and communicating it to a scholarly audience.

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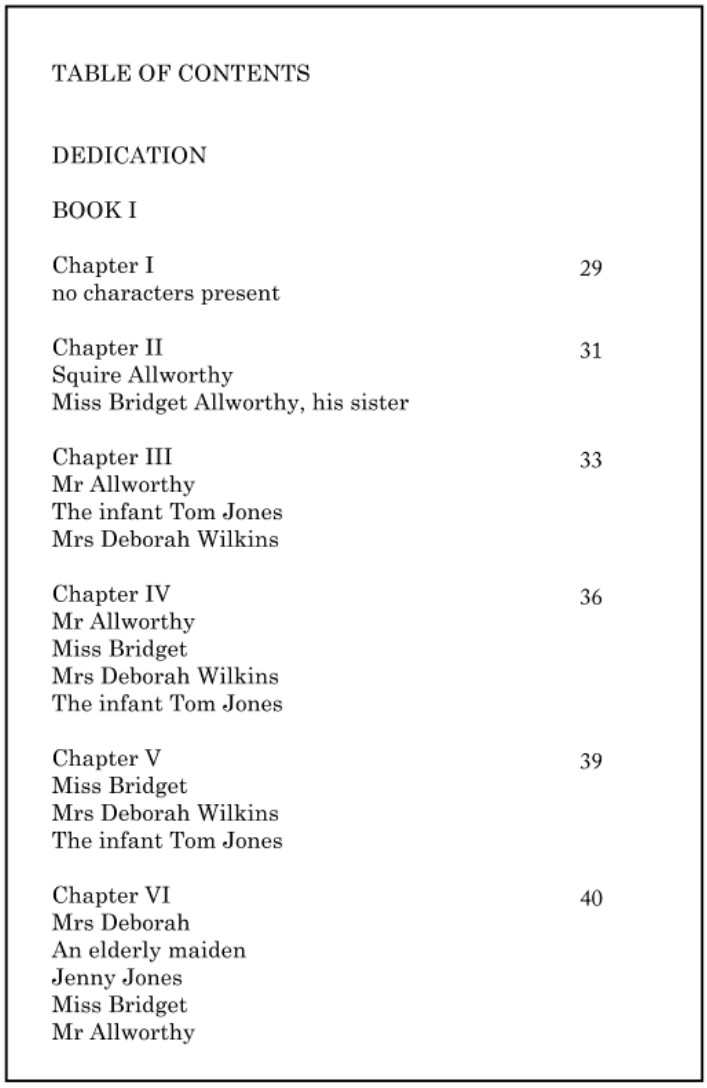
Figure 2: Characters in the first few chapters of Tom Jones: Where in the book do they appear? • What are they called? • What are they doing? • How are they characterized? • What is their ontological status? (cf. Willard McCarty on the Metamorphosis)



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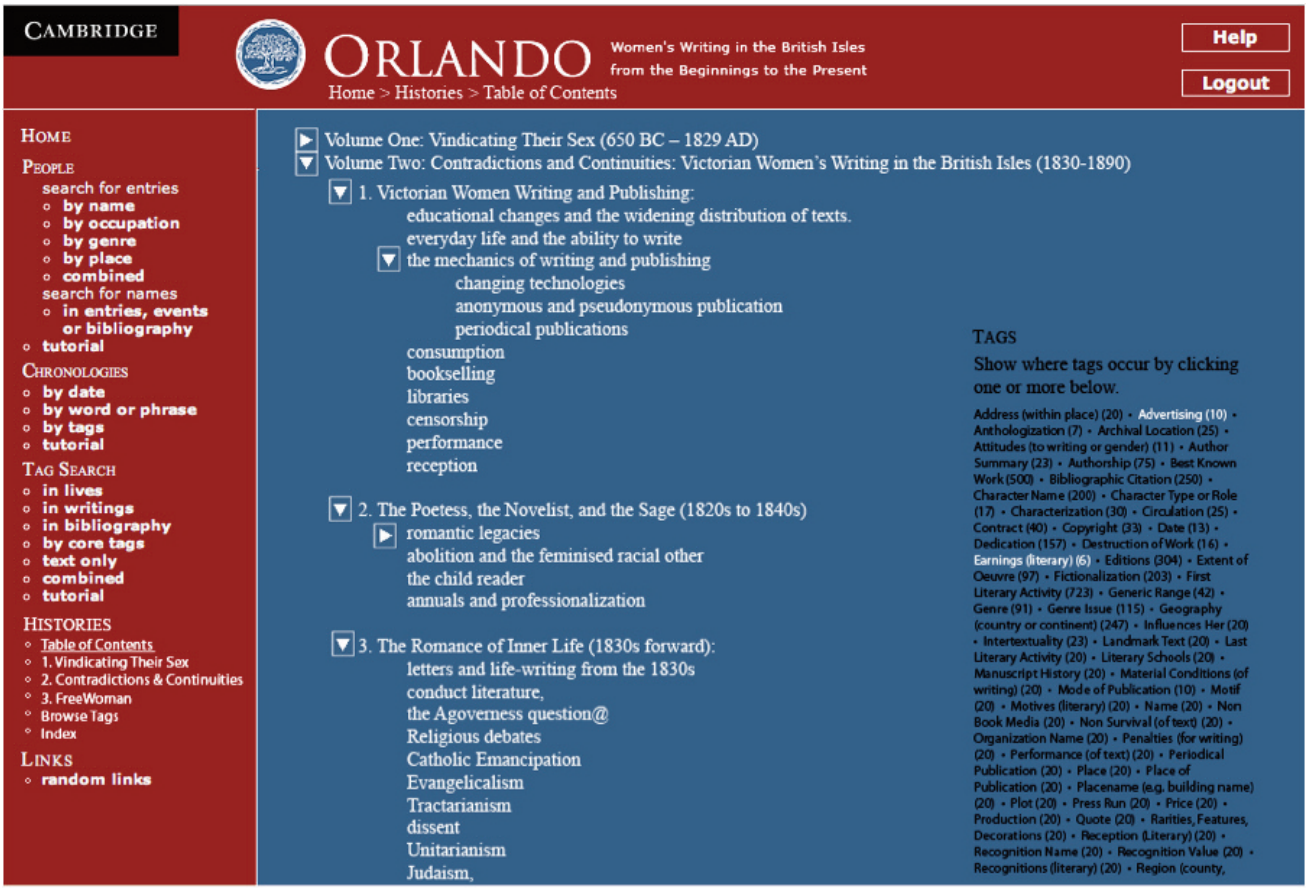
The next phase of the DToC took place in association with the Orlando Project, which is an online history of women writers in the British Isles, developed at the University of Alberta and the University of Guelph, and first published by Cambridge University Press in 2006. Our question in this case was whether an interactive TOC could be embedded somehow in the existing Orlando interface to accommodate more conventional period histories (Figure 3). In a sense, the Orlando project became a design client. We therefore decided to reproduce the design language in terms of colour, location, typeface, and content materials in order to focus the discussion on functional issues.

Since there were three proposed books, the combined tables of contents in the Orlando site would be quite complicated. We therefore added the possibility for the reader to collapse or expand selected sections of the TOC. It also became clear from the pattern

of use of Orlando that it would be useful to accommodate not only XML-encoded items but also free-text searches.

Figure 3: An interactive TOC for the Orlando Project, showing a collapsed Volume 1 and expanded Volume 2.



An additional complication in this case was that the TOC would be situated in the current interface. It would therefore become another option in the panel on the left (shown as the first selection under Histories). Other options related to the proposed volumes would include direct reading access to any of the three books, a display showing just their XML tags, or a conventional index. Note that in this version of the design, the tags, and index were assumed to be aggregated for all three volumes, rather than broken out by volume.

Placing the history volumes as an extra item in the navigation panel is one possible strategy, based in part on the principle that readers would want to have all the navigation items available at all times. However, this approach was also potentially confusing for readers, in that the existing four options in the navigation panel (People, Chronologies, Tag Search, and Links) provided access to the biographical material in the project, rather than to the more conventional historical volumes.

At this stage, we had done some preliminary thinking about how the mechanism of adding and subtracting material to the TOC would actually look and work. The reader

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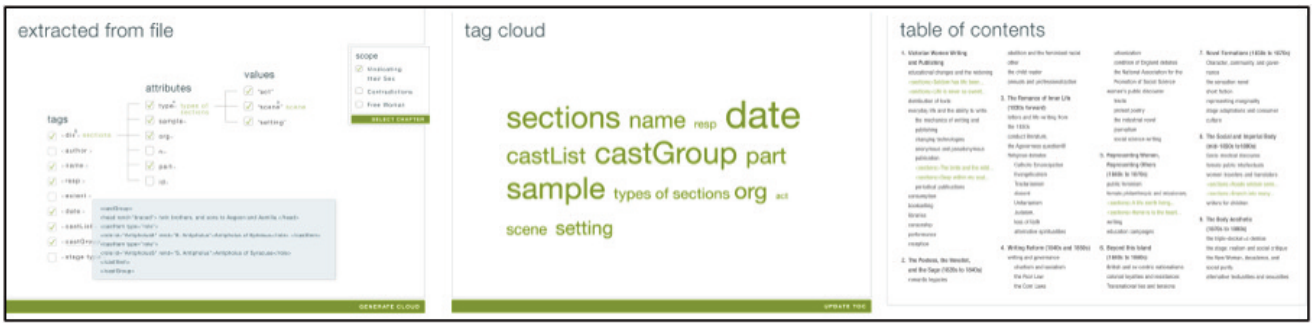
would be provided with a list of possible items to include, and could toggle them off and on. We recognized that we could use the XML encoding and leverage the human-readable versions of the tags that were already in place for the Tag Search option. We tried to condense the list as much as possible by using bullets as separators, since there could conceivably be on the order of 200 tags to consider. Since the contents would already be indexed, we were also able to show a count next to each tag, indicating how many instances would be inserted when the reader toggled that tag.

These designs combined existing Orlando material with the prospective material about the proposed volumes. In practice, the tagset for the volumes would most likely differ in some respects from the tagset previously used for the biographies. However, since the sketches were based on the existing Orlando tagset, and at this point that tagset had not been publicly released, we removed it from the published version of the design (Ruecker, Radzikowska, Brown, Nelson, Grundy, Clements, Balasz, Antoniuk, & Sinclair, 2009).

This iteration of the prototyping process helped us understand how a relatively simple original concept could be modified in order to accommodate pre-existing interface complexity. We had the existing Orlando interfaces and the results of user studies of them. Inserting the DToC between these two actors highlighted ways in which that interaction could be better mediated. The Orlando version of the DToC was at this point a high-fidelity sketch, with enough detail to communicate specific functions as they would occur in a real-world, rather than entirely speculative, context.

The next phase of the prototyping (Figure 4) was an attempt to theorize responses to the lessons learned from the work with Orlando. For example, we had learned that any significant XML-based text project is likely to have more tags than the reader can deal with easily. We also understood that knowing about the tags would not be enough to allow people to accurately select what would be inserted in the TOC: there were also the tag attributes and the values in those attributes. For example, if someone wanted to insert the names of people, but was only interested in specific people, the regularization of names in one of the attributes of the <name> element would be crucial.

Figure 4: Design sketches by Milena Radzikowska for a generic DToC. The process goes from choices made on either of the two panels to the left and results in a display on the right, which would then be used to access the text itself.



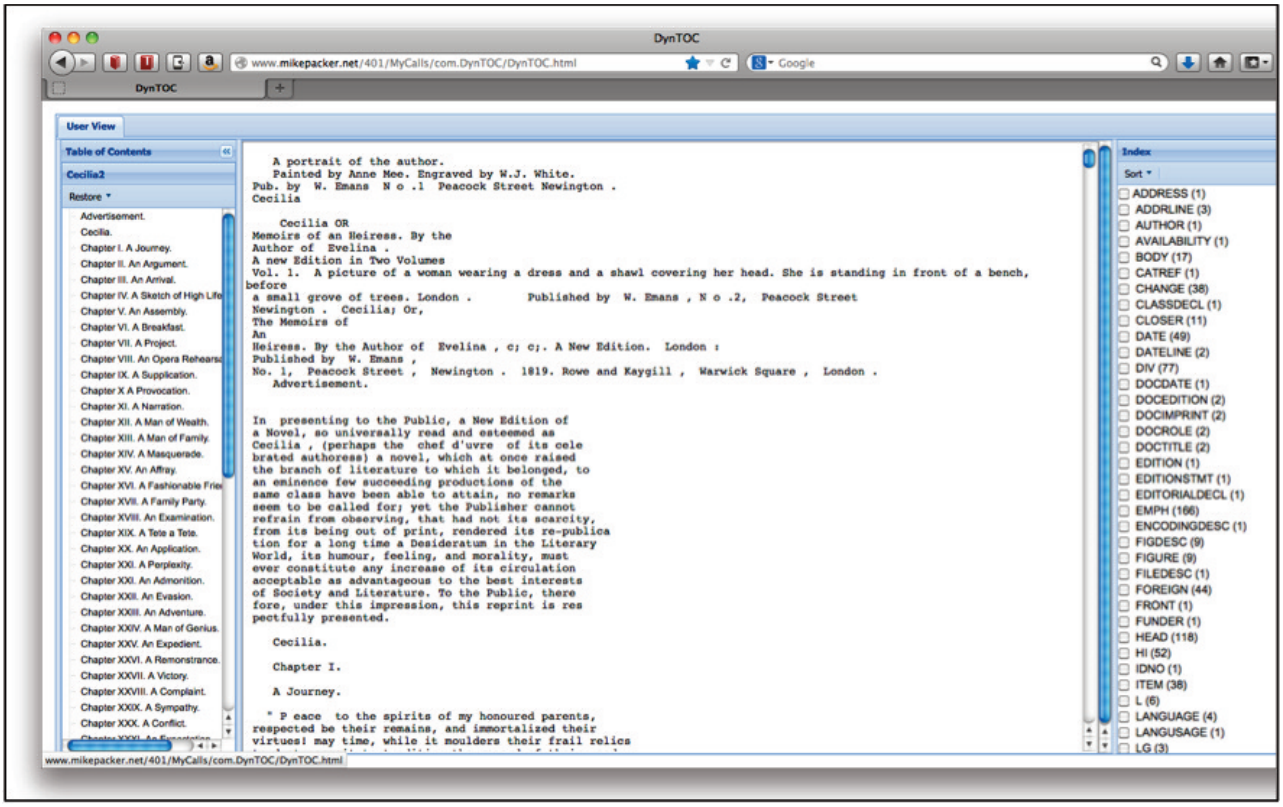
The generic design responded to this complexity by adopting a principle from rich-prospect browsing (Ruecker, Radzikowska, & Sinclair, 2011), which states that the data

should be accompanied by emergent tools. In this case, that suggests the complexity of the tags, attributes, and attribute values should be made available in both a simple and a complex form. Therefore, the reader has the opportunity to choose from two different interfaces in order to select the items to be inserted in the TOC. The list view appears on the left; in the centre is a tag cloud. Clicking on an item in either would insert the instances of that tag into the TOC on the right. Clicking on an item from the TOC would take the reader into the text.

A significant addition to the concept in this iteration is the inclusion on the left of more than just a list of tags. There is a Scope panel that allows the reader to choose which chapter to display. There is also a list of its attributes associated with each tag, and associated with each attribute, the values it contains. With this mechanism, the reader is provided with a finer grain of selections for which items to insert in the TOC. Since it is also quite complicated, choices made in this panel can be used to generate a much simpler tag cloud.

We subsequently had the opportunity to have the generic design built into a software version by a group of senior undergraduate computing science students[1] who chose this project for a team programming class (Figure 5).

Figure 5: First prototype programmed in GWT by senior students in computing science at the University of Alberta.



The prototype was useful in examining how the TOC interacted with the XML-encoding. At this point, it became clear that we would need a curator mode, where someone would manage the collection, choose which tags should be displayed to the

reader, and rename those tags to make them understandable by people who were not involved in the encoding project.

Our XML-encoded content for this prototype was Frances Burney's novel *Cecilia*, provided by the Brown University Women Writer's Project (WWP). Having real content is important because it will highlight specific logistical issues.

For instance, in conversations with Syd Bauman, a Text Encoding Initiative (TEI) specialist who has been with the WWP since 1990, it became clear that a useful feature to provide for the curator would be the ability to apply the same choices of tags and human-readable tagnames to any documents that shared a tagset.

Since *Cecilia* has more chapters than could appear in a list on a conventional screen at the time, inserting material of any length quickly reduced the number of chapters that were visible. We therefore inserted only a small amount of text, but added a popup that would appear on mouseover. The popup showed a reasonably large section of the text containing the tagged material.

To address the same issue of screen real estate, readers also had the option of removing chapters from the display; they could be added back with a restore switch at the top of the panel. Finally, readers could insert more than one tag at a time. A consequence of providing this affordance is that they would need to be able to keep track of which tag selected from the panel on the right had resulted in the contents being inserted on the left. Our solution was to preface the inserted text with the name of the tag.

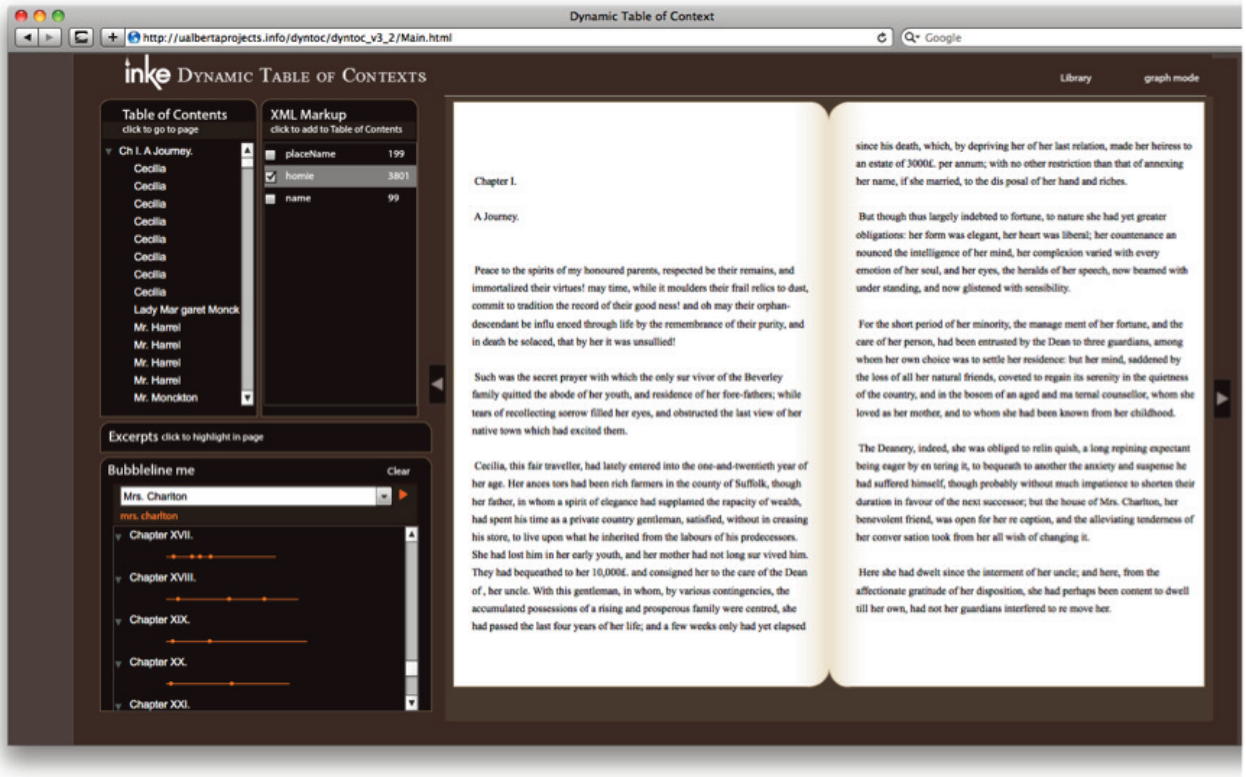
Although we now had a working prototype, after the class was over we had no ready means of modifying the interface in order to get it over the final hurdles so that it could be used for testing. In talking further with one of the student programmers (Mark Bieber), we became convinced that rewriting it from scratch would provide significant computational advantages.

Our opportunity to attempt this next iteration arose in connection with the INKE project, where our mandate was to look at improved interfaces for people working with electronic text. As opposed to the previous goal of creating a standalone reader with improved navigation, in this phase we were beginning to consider how the reader might interact with a new knowledge environment that included the DToC. The result was that we considered how the DToC could leverage a wide range of other existing tools from the digital humanities. Working again with *Cecilia*, we produced a second software prototype that incorporated facing pages in the reading panel, as well as additional text analysis and visualization tools. In particular, we added a search function, as well as a Bubblelines visualization (Figure 6) for comparing either tagging or search results across multiple chapters. It was also possible to swap out the reading panel for a search term frequency graph.

Having a more robust software version gave us an opportunity to run a user-experience study (Dobson, Heller, Ruecker, Radzikowska, Bieber, Brown, & the INKE Research Group 2012). Among other things, we learned that it would be useful to carry out user studies earlier in the process, preferably using sketches, so that we could more

quickly narrow our design target before programming. For instance, although our assumption was that facing pages would be a skeuomorphic feature of importance to readers, the user study suggested that it was more important to accommodate people with smaller screens. This was a finding that could have been elicited from a paper sketch, saving countless hours of programming time. However, we had not tried a study

Figure 6: Second software prototype programmed in Flash by Mark Bieber; design by Milena Radzikowska. Notice the Bubblelines feature bottom left.



with paper sketches because our previous attempts with digital humanities users had produced few results. That this situation seems to have changed is perhaps indicative of the growing experience of the community in dealing with visualizations.

Another important finding was that our participants were familiar with the idea that any encoding is a kind of interpretation, and they were interested in understanding more about the rationale behind the available tags that they were using to navigate the text. Making the tags visible had the side effect of making them into an object of study.

To further broaden the scope of what might be possible, we began to involve researchers who had been working in the history of book design, thinking about ways in which print experiments might be brought back into play within a digital environment (e.g., Nelson, Ruecker, Radzikowska, Sinclair, Brown, Bieber, & the INKE Research Group, 2011). The second software prototype was also polished enough that it could be used in conversation with potential INKE project partners to suggest the usefulness and practicality of the approach.

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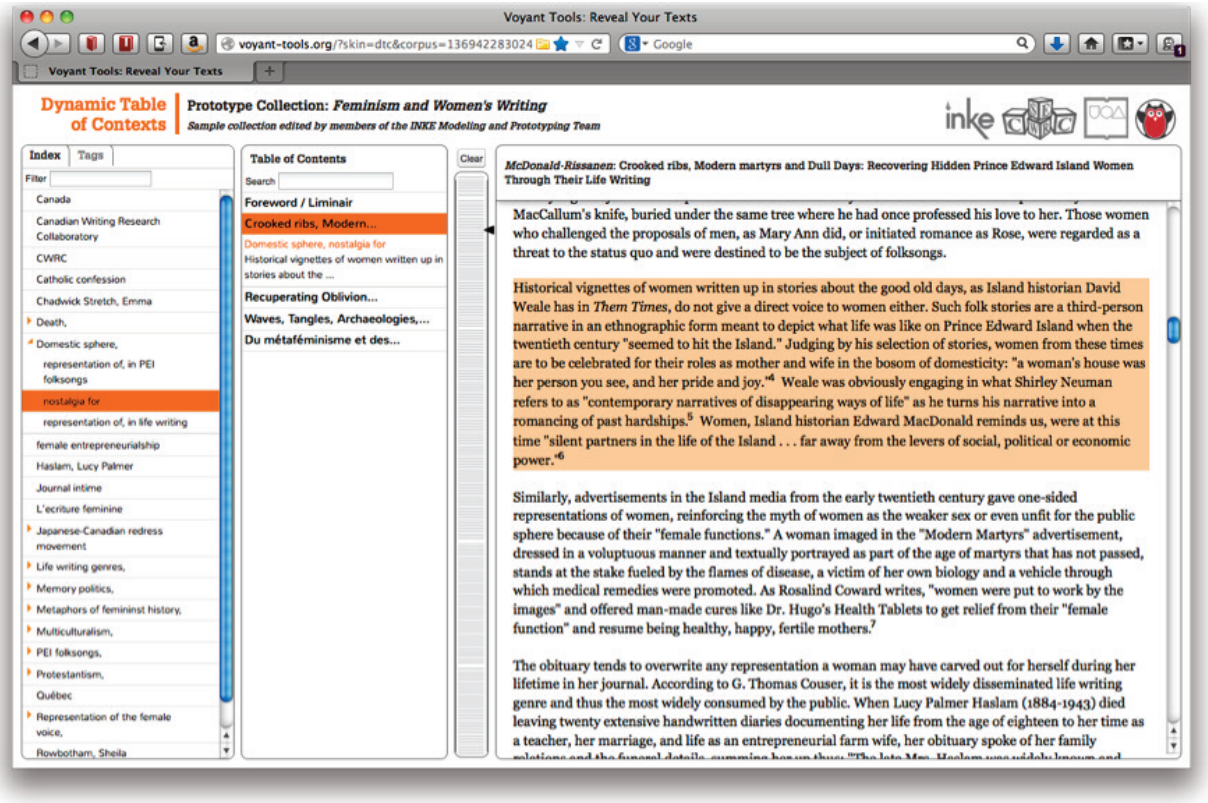
Building on the insights from Nelson et al. (2011) and the findings of the study by Dobson et al. (2012), we began a third software prototype (Figure 7), in conjunction with two partners: the Canadian Writing Research Collaboratory (CWRC) and the University of Alberta Press. This third software prototype was also built using the Voyant tools platform, meaning that it could potentially be robust enough to work as a development version for release to other researchers and projects. Close integration

Figure 7: Third prototype, programmed by Andrew MacDonald for CWRC in Voyant using HTML5; design by Jennifer Windsor.



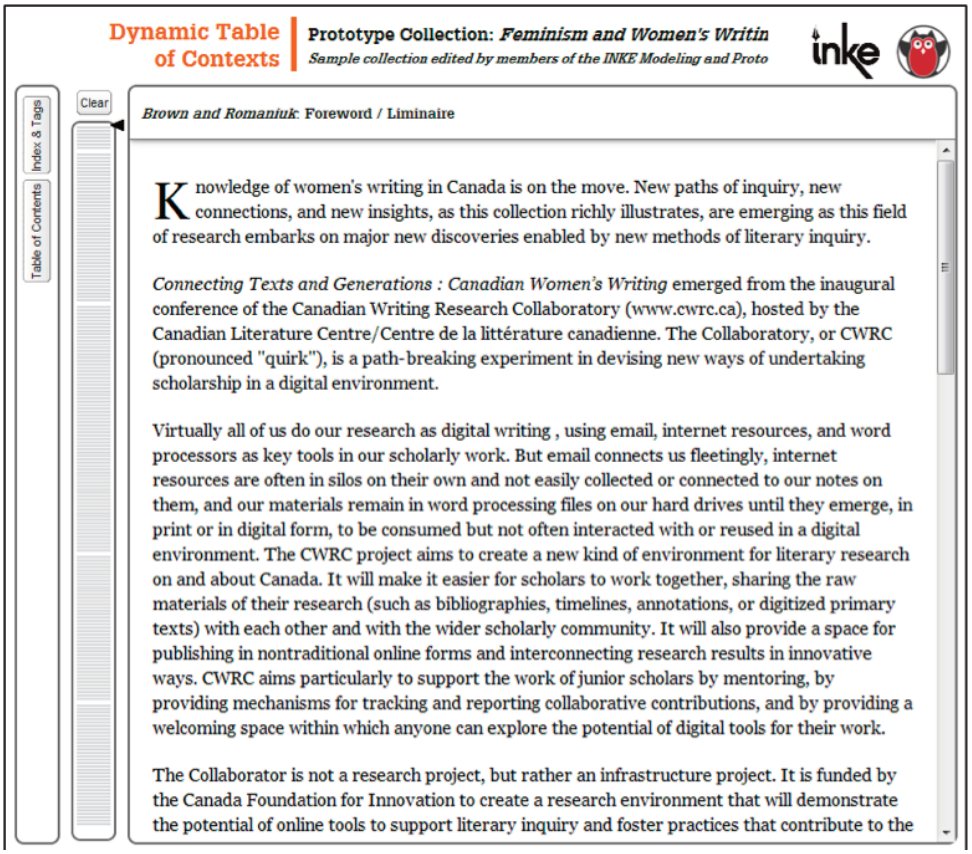
with Voyant also meant that we could conceivably find ways to leverage its many existing text analysis and visualization tools to work in conjunction with the DToC.

This version of the system takes more advantage of the affordances available with digital text. First is the index panel, which parallels the tag panel and serves a similar function with dissimilar contents (Brown, Nelson, Ruecker, Sinclair, Adelaar, Knechtel, Windsor, & the INKE Research Group, 2013). The traditional index is intended to help the reader locate specific information, which in many cases will only appear once or twice within a book. Semantic encoding, on the other hand, has tended to be applied to larger concepts that occur frequently enough to make including them in the tagset seem worthwhile. It would be normal, for example, to expect to see semantic tags for material such as people's names, major events, and geographical locations. In an index, however, what would typically appear are the actual names, events, and places. There is no easy mechanism for finding all of the names, events, or places at once in an index. Using an encoded file, however, will allow the reader to find all of them easily by searching for the presence of the appropriate tag. By accommodating both kinds of data, we essentially double the functionality of the prototype.

The second addition to this prototype is the document model, which appears as a thin column of lines between the navigation panels and the reading panel. This model provides a prospect view on the entire document (Homich, Ruecker, & Sinclair, 2005), allowing the reader to see at a glance where the currently selected tags, index items, or search terms occur, since they appear as coloured lines at approximately the right position. The lines are also interactive, so they can be used to jump to the next instance in the text. The advantage of this addition is that the overview visualization can show clusters of tags or terms where the discussion is most likely to be significant.

The document we were using for the third prototype is a frankentext that extended the number of metadata features that were available for us to use. It combines book chapters out of a recent edited collection with other book chapters that have not yet appeared in print but have already been subjected to encoding and indexing. One advantage of this content is that it also contained footnotes, reminding us to accommodate them in the reading panel with popup balloons. The balloons, in turn, required some careful thinking, since we wanted the contents to be available to cut and paste, while at the same time we wanted to avoid having them clutter up the reading panel. Our solution was to make them appear when the reader rolls the cursor over the footnote number in the text, but disappear when the cursor leaves the number – unless the user clicks on the number, at which point the footnote bubble becomes persistent until it is closed by clicking on a standard X in the top right corner.

Figure 8: Voyant DToC with panes collapsed for reading on an iPad.



Given the current prevalence of smaller reading devices such as the iPad and Kindle, the question also arose as to how difficult it might be to adjust the Voyant DToC so that it can function with the smaller screen real estate. Because this version had originally been designed with collapsible panes, it is possible to set the navigation panels to the side while reading (Figure 8), and then expand them when necessary. The result was that the system worked quite well on the iPad.

Future directions

The immediate future of the DToC will see further developments as a reading environment that supports other forms of visualization and text analysis. We would like it to easily access texts from a content management system. We are wondering if it would be useful for the reader to be able to dynamically reorganize the TOC panel, and whether editors would want to provide more than one form of TOC if the system made it possible. Then if multiple TOCs are available, should more than one be visible at a time? We have not even begun to consider what it might mean to accommodate other media, such as images or videos, but dealing with them seems like a logical next step. No doubt other possibilities will present themselves, as we ponder, build, and test our way into the future.

Conclusions

Given the exigencies of academic research funding, it is sometimes the case that a single version of a prototype is all that is possible. However, a prototype is not a product in the sense that the end of an iteration is the stopping point at which production takes over from development. Instead, academic prototyping is inherently a process with multiple iterations that expand and enrich the value of the core thinking that prototypes are intended to embody for the purposes of interrogation. The DToC is only one of many similar projects; as a case study, however, it suggests how many different ways this process can be enriched by including additional colleagues, other disciplines, and software tools, where knowledge is appearing in parallel. The object of study is a moving target because we are trying to find emergent affordances in a changing landscape of technologies and user needs, capacities, and expectations. That academic prototyping is an iterative process intended to produce knowledge rather than software should be reflected in the planning, management, and expectations of everyone involved.

Note

1. The students were Mark Bieber, Jamie Czerwinski, Xuefeng Ding, Matt Gooding, and Mike Packer. The instructor was Dr. Ken Wong.

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