Electronic Engineering Notebooks: A Study in Structuring Design Meeting Notes

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ABSTRACT

The electronic engineering notebook (EEN) is a pen-based computer tool designed to capture engineering notes and to assist in structuring them. Structuring of design meeting notes was studied using three different notebook interfaces. The system is described briefly, along with the initial results obtained. The discussion focuses on issues in structuring design information and on user strategies in information retrieval.

Keywords

Personal electronic notebook, note-taking, structuring notes, semantic indexing, design meeting.

INTRODUCTION

In spite of its importance, engineering design information is often difficult to retrieve. This is especially true of information recorded in paper engineering notebooks that do not support the structuring needed to facilitate access to notes. This study examined how electronic notebooks can assist engineers in capturing and retrieving structured notes from design meetings.

Although a number of researchers have studied electronic notebook use in the context of personal [2,6] and design [3] note-taking, empirical studies on keyword terminology usage and on retrieval strategies are generally lacking.

Terminology used in electronic notebooks should be appropriate for the task, in order to facilitate subsequent retrieval. In an earlier study, researchers manually indexed documents from a design project with domain model terms and demonstrated resulting improvement in information retrieval [1]. In the study reported below, the task domain model was used by engineers to index their own notes in an EEN. The goal was to assess the fitness of terminology as a means of indexing design meeting notes.

Given the structured nature of design activities, and of design meetings in particular [5], we were interested in finding out what effect different notebook interfaces (e.g. structured or a free-form) have on the task and on the retrieval strategies people use to accomplish the task.

ELECTRONIC ENGINEERING NOTEBOOK

We designed and implemented an electronic notebook for engineers with three variants of user interface. The first was a free-form interface that did not impose any constraints on user input (see Figure 1). It allowed for attaching labels to handwritten objects. Terminology used for labels, based on our design ontologies [4], allows for description of concepts in the design process (requirement, rationale, issue), the product structure (part, parameter), and project management items (action, meeting). Each concept was further characterized by attributes and by relations to other concepts. Users could attach attribute labels to objects and link objects to represent their relationships. The second interface was similar, but with user defined terms for labels. The third interface was forms-based, using the same domain terminology as in the first. Each of the main concepts had a corresponding form with attributes and relations represented as fields. In each interface variant, notes were organized into pages that could be named by users. EEN was implemented in Java, running on a computer with pen input.

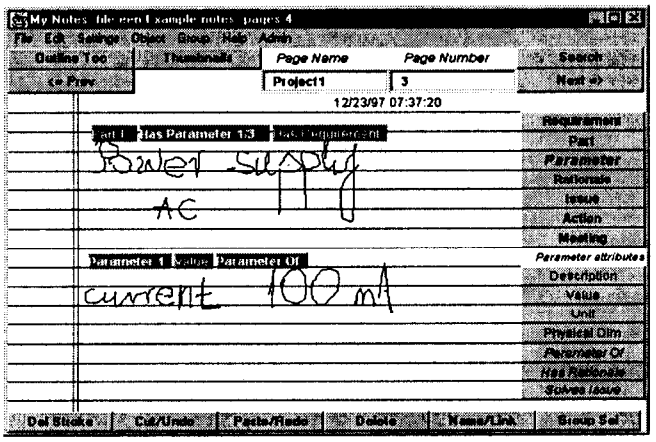

Figure 1: Free-form EEN interface.

DESIGN MEETING NOTE-TAKING STUDY

We conducted a design meeting note-taking study with 20 subjects (undergraduate and graduate students in the Dept. of Mechanical and Industrial Engineering). The study consisted of two one hour sessions for each subject (with the second session being held several days after the first). The study had three conditions, each defined by one of the variants of the EEN interface. We run seven subjects in the first and the third, and six in the second, conditions.

In the first session, after 15 minutes of training on the usage of domain terminology, on the task, and on the interface itself, subjects performed a note-taking task while watching a videotape from a short (10 min.) design meeting. Subjects were allowed to pause and rewind the tape.

After note-taking, subjects in the free-form conditions organized their notes by attaching labels, while subjects in the form condition went through their notes and counted the types of forms (i.e. main concepts). In the second session subjects performed information retrieval from their notes. We observed their information finding strategies. The contents of all created notes were analyzed with respect to usage of structuring elements.

Results and Discussion

We focus our discussion on issues in structuring design information. Our observation of subjects confirmed an expectation that taking notes and categorizing them at the same time is difficult. All subjects in the form condition had problems with selecting forms and appropriate fields within the forms. They wrote notes on unrelated forms that just happened to be open, often using "wrong" fields. Some subjects put many notes into one field on a form, others put notes related to the same topic on several forms.

In the free-form conditions we observed that it was easier for subjects to structure notes by attaching labels after note-taking. However, applying categorizations after note-taking was also problematic. Three out of seven subjects in the first free-form condition experienced difficulty in differentiating the meaning of labels.

In the two conditions with domain-based terminology, five out of fourteen subjects dealt with difficulties in categorization by adopting one category as a "miscellaneous" container. Others used gross categorization in which they applied one label to a group of notes, thus avoiding detailed categorization.

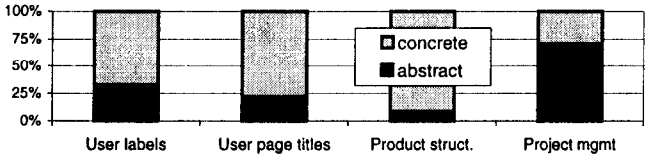

Figure 2. Usage of abstract vs. concrete terminology

User defined terminology tended to be concrete, while our domain-based labels were abstract (see Figure 2). The proportions of abstract and concrete terms differed across terminology types. User terms describing product structure were very specific, while terms describing project management were more general. The preference for concrete terminology was confirmed by observations of information finding strategies and during interviews with subjects.

In the information retrieval session categorizations were reapplied. Subjects had difficulty in recalling the categories used in their initial classification of content. A couple of subjects in the second free-form condition complained about not remembering the meaning of their own terms.

We measured the number of information search strategies in which subjects employed the labels (and other terminology-based elements). We call these "trust" strategies, as they were applied when subjects, in their own words, "trusted their labeling". The opposite are "no-trust" strategies in which information is found by flipping pages. We also measured the depth of search when using labels.

Subjects	Label depth of search	"Trust" strategies
Expert	1.67	78%
Novice	1.39	48%

Table 1. Label search depth and "trust" strategies

The differences between expert and novice users were statistically significant (see Table 1), but the differences between user interface conditions (58%, 71%,and 66% used "trust" strategies respectively) were not. We defined expert users as students who had some professional engineering experience. The results suggest that expert users are able to better apply categorizations and use them more consistently in retrieval. This is confirmed by a higher degree of trust in their own information classification.

CONCLUSION

Results of this study indicate the advantage of free-form interface with structuring occurring after note-taking. They show the importance of carefully selected terminology for categorization and indicate that a combination of predefined and user terminology may be appropriate.

An important issue raised, but not fully answered, by our study is how much structuring should be used in engineering note taking. The degree of structure is certainly task dependent, and as our study points out, a domain expert may appreciate the structure as helping him to focus and cover all the elements relevant to the task at hand.

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