Information Behaviors of HCI Professionals: Design of Intuitive Reference System for Technologies

Eunkyung Yoo, Myunghyun Yoo, and Yongbeom Lee

Samsung Advanced Institute of Technology
P.O. Box 111 Suwon, 440-600, South Korea
{ek.yoo,mh.yoo,leey}@samsung.com

Abstract. Technology roadmaps are often referred for better decision making by HCI professionals who connect human factors with product development and innovation. We conducted user study that explore information seeking and tracing behaviors in using technology roadmap. The research revealed that HCI professionals exhibit distinctive patterns in using technology roadmap, depending on their expertise in technical knowledge and work experience. Finally, we designed new user interface of an interactive technology roadmap system based on the research findings. We demonstrated its usefulness in seeking task-dependent information, intuitiveness in information visualization, and easiness to use as a reference for technologies.

Keywords: Information behaviors, Interactive reference system, Interactive technology roadmap, User interface, Interaction design.

1 Introduction

HCI literature defines HCI professionals as bridge builders who deliver user-related information to the engineering process [2]. They need to consider tradeoffs such as technologies or business needs during user-centric design for new product development or innovation processes. A technology roadmap (TRM) is a tool HCI workers utilize for product decisions involving tradeoffs between human factors and technologies. Generic TRM is a time-based chart, comprising a number of layers that typically shows how a technology can be aligned to product, business strategy, and market opportunities [7]. A recent survey [7] confirms why most research on TRM has been concentrated in roadmapping process, instead of user interaction with TRM. It also answers why most TRM has static presentations even though it reflects diverse perspectives. These suggest that there is a need for study on user-centered interface design of TRM that is customized to user behaviors with respect information handling.

There are a number of studies on human information behaviors in various work contexts, [8] for example. However, there is little such literature in the context of HCI field. A recent article summarizes four information-seeking modes and its relation to the application design [5], but it mostly covers generic behaviors and web design.

In this paper, we focus on the information behaviors of the corporate HCI professionals and interactive visualization design. We describe user research on HCI

M.J. Smith, G. Salvendy (Eds.): Human Interface, Part I, HCII 2007, LNCS 4557, pp. 237–246, 2007.

workers, in terms of their needs and methods in seeking and tracing information on technologies. Based on the research findings, we propose a novel interaction design of interactive TRM system for HCI professionals. Finally, we present evaluation results on the usefulness, intuitiveness, and learning curve of our design.

2 Related Works

Our work builds on two different areas of related works. First is the design of interactive visualization for decision making tools, and the second is the studies on information seeking and tracing behaviors.

There are only a few examples of interactive visualization design for decision making tools. U.S navy developed a 3D system that visualizes undersea battlefield. This enables rapid and accurate decision making and planning. By tracking objects with consistent color scheme, the system supports easy navigation through a complex set of information [6]. In industry, Advanced Micro Devices Inc. [1] provides Flash-based interactive technology outlook which partially supports list of related products, and detailed information about selected items.

Previous research shows that there are various behavioral patterns in seeking and tracing information. A recent article establishes four different modes of approaching information [5]. Google-based intensive search, fact finding, and browsing behaviors for information gathering were also observed [4]. There are also diverse tracing methods for information re-use. With emergence of the web, people use functionalities of web browsers such as bookmark [3].

3 User Research

In this section, we present our in-depth user study on user tasks, information search patterns, and information tracing behaviors using TRM. The user sample is a representative set of HCI workers at Samsung. We employed a mock-workplace setting to obtain natural user behaviors with TRM. In the following, we first describe study methodologies and then present our research findings.

3.1 Methodologies

In this section, we describe our user study methods. We first delineate the user sample and the testing setup. Next we present the test procedures and analysis methods.

Our user sample consists of nine HCI professionals from six different business units, taking their expertise on TRM into account. They are mostly designers in emerging User Interface (UI) development and product UI planning, without engineering background. As shown in Table 1, participants have diverse range of work experience in HCI, ranging from 1 to 12 years. They also have at least ten years of web experience, and wide range of TRM experience from zero to 12 years. We divided their expertise level on TRM into novice (less than 3 years), intermediate (3 to 5 years), and expert (more than 6 years).

For test setup, we prepared a mock-workplace setup consisting of a computer and a printer. We surveyed four colleagues and found that computers are the predominant

medium through which people access TRM. Thus we prepared HCI-related TRM in two different file formats - Acrobat PDF and Microsoft PowerPoint. One contained texts as well as images, while the other was text only. With pilot trials, we confirmed that indeed the two prepared digital formats comprise the majority of TRMs used at Samsung. We also found that in some cases people prefer to print the files for easier referral. To accommodate and encourage the most natural work behaviors using TRM, we allocated a printer at the mock-workplace setting.

The actual test consisted of interviews and observations while a participant used TRM. Each session took approximately an hour. For the interview and data analysis, we generated a set of open-ended questions. The question generation was dynamic in the sense that new questions were developed based on user responses. A representative set of major questions consistently employed during the tests are:

- To what degrees are you familiar with technical terms?
- What are the needs of your HCI related tasks for information on technologies?
- How do you find desired information with or without TRM?
- How do you keep the found technological information?
- How do you retrieve previously found information?

A facilitator led the session and two observers took notes, and the session was captured via digital audio recording and computer screen recording. Camtasia Studio, a screen recording software, was used to track down the participants' behaviors in using TRM. The observers recorded the participant's movement along TRM on prepared papers.

Features of the test data were extracted with respect to user expertise and job type, and then each user data was associated with appropriate stage of seeking and tracing process. Similarities between participants, information seeking and tracing patterns, as well as representative answers to test questions were formulated from the data. We analyzed how well the information needs, seeking and tracing behaviors observed in this test matched previous research findings.

Table 1. Summary description of participants

No	Job Title	Age	Exp. in HCI	Background	Experience on Roadmap	Years on Web
P1	Product UI planning	30	6	Industrial design	1 yr / Novice	10
P2	Product UI planning	33	1.5	Design planning	0 yr / Novice	13
P3	Product UI planning	35	12	Product design	12 yrs / Expert	13
P4	Emerging UI strategy	28	3	Graphic design	3 yrs / intermediate	10
P5	Product UI design	30	5	Cognitive science	4 yrs / intermediate	10
P6	Emerging UI design	32	6.5	Ergonomics	6.5 yrs / Expert	12
P7	Product UI planning	34	10	Industrial design	8 yrs / Expert	12
P8	Emerging UI planning	29	4	Product design	0 yr / Novice	8
P9	Emerging UI development	33	5	Computer science	5 yrs / intermediate	11

3.2 Findings

The result of this study suggests that an individual's level of technical expertise, type of HCI work, and web usage style are key influences on TRM usage behaviors. Specifically, the technical information-handling behaviors of the Samsung HCI professionals were highly dependent on their familiarity to technological terms on TRM, gained from work experiences. Another factor that influenced the TRM usage behavior was the web-surfing style in finding and tracing information.

Information Seeking. Our study shows that information seeking strategies are distinctively different by users' task and knowledge level on the relevant technology. This confirms Maurer's four modes of seeking information (2006).

Expertise. Expert users, with substantial TRM experience in HCI field, utilize TRM in order to acquire the possibility of technical implementation. They have clear project scope and are confident on what to find and how to approach the target information on TRM. As Maurer (2006) stated as 'known-item' mode and suggested several design approaches, expert users are aware of what they want, what words to use to describe it, and where to start to find it. Experts begin by pressing the short key combination for keyword search within TRM document, regardless of their file formats. When they find good matches, they start to explore details around the search results. In case there are no matches, they move onto the alternative step, 'Exploratory' mode. Experts' exploratory behavior is similar to that of intermediate users, but spends significantly less time. Moreover, expert users usually have better acquaintance to the technical terms, and they can better grasp what new terms mean. When confronted with highly technical terms, they employ a search engine to find out what it exactly means. To summarize, expert users have concrete methods for seeking target information with or without TRM.

Intermediate users have rough ideas of what they need to know but are not sure on what word to search for, as Maurer (2006) named this type of users as 'Exploratory'. Therefore, they begin by scanning through category, which is usually in the form of table of contents or bookmarks. When they encounter a seemingly-related terminology, they proceed to dissect the associated sub-categories and keep on narrowing down the categorical path. Once a relevant terminology is detected, the users expand the scope to neighboring contents. After exploring the neighborhood, they move on to unexplored categories and repeat the above steps until they find the target.

"According to my experiences in several types of technology roadmap, relevant information seems to be placed close to each other. Because I rarely find the target information at first stage, my strategy is to look for a keyword first, set it as an anchor and then explore further based on it." (Interview of Participant 9)

Novice users have vague ideas of what they need to know and where to start, due to lack of work experience and exposure to TRM. They exhibit similar patterns to the 'exploratory' mode in terms of browsing through the bigger categories and narrowing down to the details. However, novices spend more time and take larger number of

steps, as they tend to examine the entire. They also spend more time to look for the meaning of unfamiliar terms.

All users search the internet for unfamiliar technological terms. They heavily rely on Google and Wikipedia. This is consistent with a recent study about search-based information gathering pattern with Google [4]. For more specific information, they look up corporate intranet.

Task. Information approach patterns are dependent on the users' tasks. The task of product UI planners is to generate new UI ideas for products to be released by certain timeline. For each targeted product, they consider industrial paradigm, market status, convergence issues, and so on. However, there is an important condition to meet – technologies should be mature enough for the production to meet the scheduled release. Therefore, on TRM, they look for a set of potential technologies that are feasible for implementation by the specified time.

On the other hand, the timeline of the emerging UI developers is more flexible. They usually look two to three years ahead for the advanced UI development. For example, when their project deadline is due at year 2009, they consider a series of technologies that will be usable for a UI development in 2009. See Fig. 1-D to compare the different timeline flexibility depending on the tasks.

Interestingly, both product UI planners and emerging UI developers emphasized the need for connecting with internal experts, since it is easier to reach and collaborate with them than those outside of their own organization.

"To get information about applicable technologies to implement in a product within 2-3 years, the best way is to have a meeting with engineers who develop those technologies. A few hour of discussion provides tacit knowledge within entire corporation on the technology, such as organizational strategies and vision." (Interview of Participant 7)

Information Tracing. Information tracing is defined as retrieving [5] what users have already seen. Results show that users have various methods to track the previously-seen information. Once finding desired information on TRM, 78% of the participants directly copy and paste the findings into their project documents. They claim that this method allows easier access to the findings. As for simple recording of the findings, users have several tactics to trace it. In our study, three users wrote down the list of technologies on their paper diary or on a digital file. Four users captured the screens and saved them with detailed file names, so that they can easily recognize the contents from the file name. Three of them utilized 'Snapshot Tool' of Acrobat (Reader) application to keep only the relevant parts. The other two users printed TRM out, highlighted the relevant technologies, and saved it in project folders.

As for detailed information of unfamiliar terms found on the web, all users first bookmark the website to keep their findings. They explain that bookmarking is their most usual behavior to store the information resources while surfing the internet. Similar to the keeping behavior on TRM mentioned above, most users recycle detailed information from the web in their documents or personal repositories for data storage.

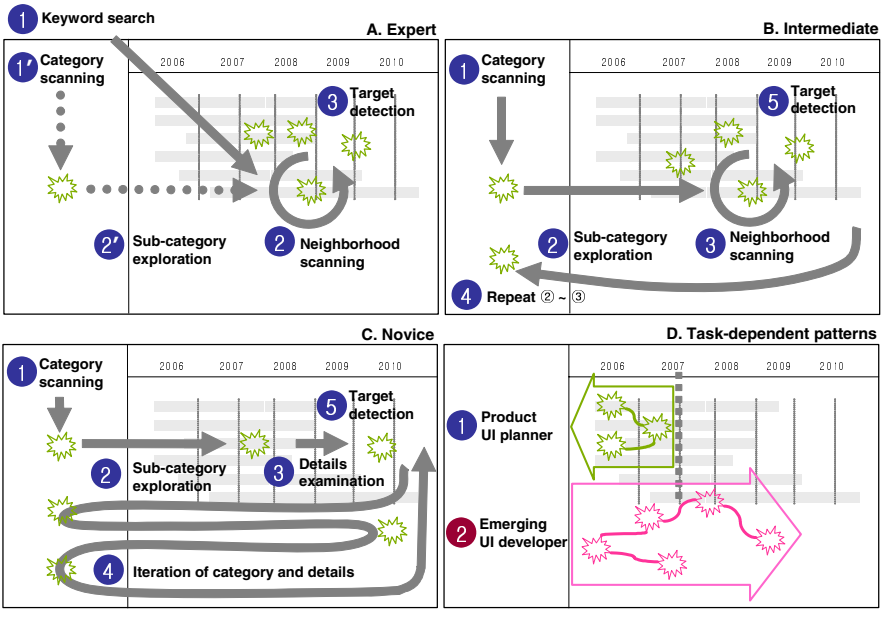

Fig. 1. Schematic diagrams on information-seeking patterns. Expertise-based patterns (A~C): expert (A), intermediate (B), and novice (C), and Task-dependent pattern (D).

4 Design of Interactive Reference System for Technologies

In this section we illustrate a novel user interface for interactive reference system on emerging UI technologies that we designed and implemented with Flash. We put together the test analysis results on HCI workers' information needs and behavioral patterns in intuitive ways. Reducing the learning curve for a new system is one of the most vital design factors for busy corporate users, considering the nature of the data-intensive system with enormous amount of technical information. In order to address this aspect, we adopted familiar terms from the web (e.g. bookmark, hyperlink), in naming our TRM functions. Our interaction designs are described with respect to the user needs on TRM and their behaviors in information seeking and tracing.

4.1 Expertise and Task-Focused Navigation

We propose three types of starting points - keyword search, overview explorer, and product navigator - for enhancing navigational experience and accuracy in finding the desired information. Each starting point reflects one of the primary information search methods of expert, intermediate, and novice or product planning users, as explained in Section 3.2. This multiple starting points provide users to choose their own approach to information seeking in TRM.

As for expert users, keyword search has the most potential for enhancing information seeking experience, by reducing the search time. Simple text input search returns the list of matched technologies. Matched keyword is highlighted in red, and the returns include not only the matched technological term but also related

technologies within the same category, so that users can refer to them and explore further if necessary.

For the users in 'Exploratory' mode who begin the search by category scanning, there is the 'Overview' explorer that supports an easier exploration with assorted categorization. This supports hierarchical tree-search methods, with the first tier of primary categories shown initially, and lower-tier categories are shown once their corresponding higher tier category is selected.

The 'Product navigator' is designed for product UI planners or novice users who are unfamiliar with technical terms and need a browsing approach toward detailed technical information. It consists of sampled UI ideas in each product group. When a user selects a product idea, it shows the relevant list of technologies and their categories. Users can navigate further from the listed technologies.

4.2 Linkage of the Related Technologies

Our design provides links between related technologies, to support the search for a set of multiple technologies as well as the search patterns in which people seek related technologies from an anchor technology. The visualization of linkage between related technologies can be beneficial to those who are interested in further search. Selecting the icon 'R' in the label of a technology, which stands for 'relationship', displays lines that connect the anchor technology with the related ones.

4.3 Detailed Description

Our design also supports pop-up box containing details on the selected technology or category, to provide potential one-click answers. In particular, novice users can take the most benefit from this method, since such concise answers can satisfy the initial information need, as Maurer suggested (2006). This pop-up includes internal expert information, overview, technical specification, research examples from competitors or academia, patent strategies, images and diagrams, and other introductory information.

4.4 Bookmark

Bookmarks facilitate tracing and retrieving saved information. Descriptions of the bookmarks are automatically tagged, based on the stored content. Each icon has distinguishable design to indicate the saved content as an easy reminder for the users.

Each icon is automatically created depending on the elements in the saved content. Its variable features are layout, color, and tagged description. The layout is a miniature of the saved screen, so as to help users recognize previously seen content.

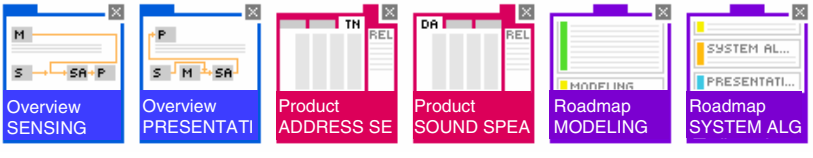

Fig. 2. Bookmark icon examples. Each color represents one of the starting points. Tags and inner images can differentiate different contents.

Each bookmark icon is automatically tagged for intuitive reminder, based on the stored content. TRM system creates a tag for each bookmark label using the associated category. For instance, when a user bookmark at the screen of sensing category in overview explorer, tagged icon is labeled as 'Overview-Sensing'.

Interaction with bookmark is done by a single click of mouse. One-click of the 'Bookmark' button at the top left of the screen generates a tagged icon with the current status of the screen, and places the icon at the bottom of the screen. Users can trace stored bookmarks by a simple click on the icons.

5 Evaluation

We evaluated the usefulness and intuitiveness of our proposed design as a technological reference system. We first present the evaluation process and then summarize the results.

Our design was evaluated via expert review by five corporate HCI professionals, in the form of a test questionnaire shown in Table 2. This questionnaire addresses the usefulness for their tasks, intuitiveness in searching for target information, and learning curve of the new interface. Seven-scale measure was used for the survey, and additional comments were obtained. The results are shown in Fig. 3.

Table 2. Expert review questionnaire

<table>
<tr><td colspan="2">[Overall evaluation]
1) Overall, the new interface of the technology roadmap is helpful in decision making for your usual task.
2) Overall, the new interface is easy to use in finding technological information.
3) Overall, I found the new interface of the technology roadmap easy to learn.</td></tr>
<tr><td colspan="2">[Detailed evaluation]
I found the following aspects are particularly:</td></tr>
<tr><td>4) useful for your task.</td><td rowspan="3">- bookmark (creation, retrieval, deletion)
- linkage between the related technologies
- keyword search
- overview browsing
- product navigation
- detailed description</td></tr>
<tr><td>5) intuitive to notice and understand the meanings.</td></tr>
<tr><td>6) easy to learn as new interface.</td></tr>
<tr><td colspan="2">[Comments]</td></tr>
</table>

On average, the participants voted 6.2 for usefulness, 5.8 for intuitiveness, and 5.7 for learning curve. In particular, bookmark and linkage between related technologies, and detailed description stood up as the most useful features in decision making process. Bookmark and keyword search gained the highest score for the intuitiveness and easiness to learn. Three different information approaching methods, keyword search, overview explorer, and product navigation were positively assessed by 72%.

However, the results also show that there are rooms for improvement on the proposed interaction design. There is a 28% gap between usefulness and the other two measures, intuitiveness and learning curve. According to the participants' comments,

the 'R' icon is rather obscure and not very intuitive. Additionally, it does not solve the fundamental issue of text-intensive TRM. These results suggest the necessity of improvement in future studies.

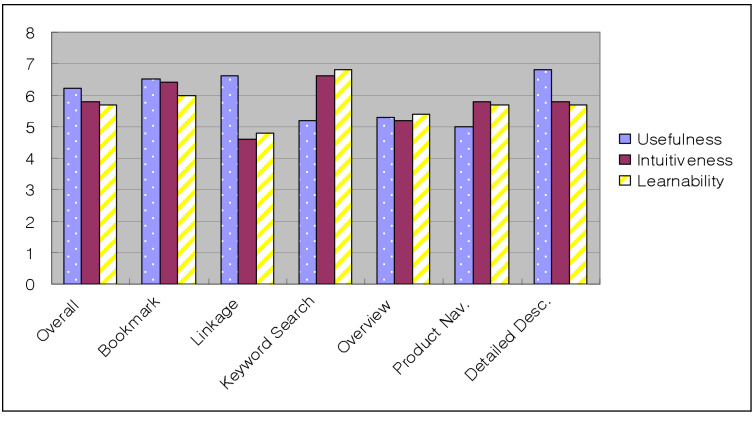

Fig. 3. Evaluation results in usefulness, intuitiveness, and learning curve of the new interface

6 Conclusion

We conducted user study with corporate HCI professionals to investigate their behaviors in seeking and tracing knowledge on technology roadmaps. Depending on the users' expertise level of technical knowledge and their task types, information seeking behavior was significantly different. Based on the research findings, we proposed an interaction design of an interactive technology roadmap system for HCI professionals. With new interaction methods, referring TRM can be more useful in HCI-related decision making. The new interactive reference system of the future UI technology overcomes the conventional static roadmaps by providing intuitive and easy-to-learn ways of information presentation.

In the future research, we need to develop intuitive methods to visualize unfamiliar but useful functions, such as icon and label that indicates the linkage to other technologies. We also need better visualization that covers text-intensive nature of TRM in order to improve the intuitiveness.

Acknowledgments. Thank for all the participants of the user research for this study.

References

1. Advanced Micro Devices, Inc.: Three Year Technology Outlook (n.d), http://www.amdcompare.com/prodoutlook/
2. Iivari, N.: Understanding the Work of an HCI Practitioner, Proceedings in the 4th Nordic conference NordiCHI (2006)

3. Jones, W., Dumais, S., Bruce, H.: Once Found, What Then? A Study of Keeping Behaviors in Personal Use of Web Information. In: Proceedings in ASIST 2002, Information Today Inc., pp. 391–402 (2002)
4. Kellar, M.: An Examination of User Behaviour during Web Information Tasks, Doctoral consortium in CHI, pp. 1763–1766. ACM Press, New York (2006)
5. Maurer, D.: Four Modes of Seeking Information and How to Design for Them, http://www.boxesandarrows.com/view/four_modes_of_seeking_information_and_how_to_design_for_them
6. Maxwell, D.: TALOSS: Three-Dimensional Advanced Localization Observation Submarine Software (2003), http://www.linuxjournal.com/article/6978
7. Phaal, R., Farrukh, C., Probert, D.: Technology Roadmapping: Linking Technology Resources to Business Objectives, Centre for Technology Management, University of Cambridge (2001)
8. Reddy, M., Dourish, P.: A finger on the pulse: temporal rhythms and information seeking in medical work. Proceedings in CSCW, pp. 344–353. ACM Press, New York (2002)