Needs Assessment and Evaluation of a Web-Based Information System for Self-Initiated Biomedical Education

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Abstract

The Internet and Intranet have emerged as convenient and cost effective media for information retrieval and dissemination. Recently, many bibliographic systems, medical databases, knowledge-based systems, and online books have been built to improve access to biomedical information. Although all facilitate access to biomedical knowledge, each system is only accessible individually and often any system does not contain an adequate constellation of databases with non-overlapping content to satisfy the needs of a designer. Maintaining applications is costly and learning from them is awkward.

This paper describes a joint effort of the Stanford Health Information Network for Education (SHINE) [1] and the Medical Device Network (MDN) [2]. We aim to examine the potential value and enhancement of efficiency of a biomedical digital library system that offers the biomedical information needed during conception and design of a medical device. We explain why understanding the use patterns of medical information and facilitating presentation of focused medical information are very important for the design of a biomedical digital library system. We also explain the needs assessment analysis that is used to modify SHINE, an existing web-based integrated digital library system, as a medical information system specifically sensitive to the engineer's work. We believe that the results of this study can improve the understanding of the information needs of biomedical engineers at various levels of responsibility and the functional requirements of designing an integrated web-based information system. Using these results, we can modify SHINE to better support self-initiated biomedical engineering education.

I. Introduction

The medical device industry is challenged with diverse and complex requirements and regulations for design of the breath of technologies that it wishes to develop. The diverse knowledge requirements of this industry include basic data that applies to biomedical engineering. Such data usually is not delivered in schools of engineering and constantly changes in the world of medicine as more is learned about various diseases, their management and

complications. If such knowledge is deficient in the process of building a device, the creativity of the responsible engineers is stilted. The void in knowledge usually can be attributed either to communication barriers or lack of access to valid and understandable information about the disease for which a device is being considered built. Clearly more than delay in device design results. Design errors also may result and lead to abandonment of an otherwise perfectly valid project.

Recently, many bibliographic systems, medical databases, knowledge-based systems, and online books have been built to improve access to medical information resources. Although all facilitate access to medical knowledge, each system only accesses individual and most system do not contain an adequate constellation of databases with non overlapping content to satisfy the needs of a designer. Maintaining applications is costly and learning from them is awkward.

The Stanford Health Information Network for Education (SHINE) is an integrated Web-based medical information system that can be used to support the answer to a patient generated query. Its use is self-initiated by the physician in the course of medical practice. As it provides strategic aids in medical decision making and medical education for the physician, so might it be adopted to provide medical education for medical device engineers.

Using a broker-mediator-based approach, SHINE will be able to integrate with the electronic medical record (EMR) and other tools of decision support and learning with a variety of databases that are crucial to the physicians' work and learning [3]. It can be used to provide continuing medical education (CME) in the course of such self-initiated search for answers to the patient's problem[4]. The later has far reaching implications as a mode of learning that will be able to be substituted for ineffective didactic learning that requires attendance at conferences. SHINE's users will be able to get CME credits in the course of becoming more effective practitioners of medicine; so might engineers be helped in their practices by employing a system that allows access to a learning base that focuses on self-initiated and self-contained responses to genuine issues of product design.

To examine the information needs of the medical device designers and the usability and usefulness of SHINE, the SHINE program was examined within a large diverse biomedical device company by over one hundred users for four months. Forty-eight users participated in the surveys and interviews. The research focused on two parts: needs assessment and system evaluation. The aim of needs assessment research was to study what medical information was needed for medical device design and how ready access of such information might affect the speed and quality of design as well as substitute for the personal communication between physician and engineer otherwise required. The evaluation research aims to examine the usability and usefulness of SHINE. Using the results of the research, we can not only understand of information needs of biomedical device engineers for self-initiated learning, but also improve SHINE to better fit into medical device engineers' information needs.

II. Research Aspects

The research includes two areas: needs assessment and system evaluation.

Needs Assessment:

The needs assessment aims to identify the unsatisfied needs for information needed for medical

device design. The research tries to answer the following questions:

- How is medical information used in different stages of design of a device?
- What is the frequency of need for information access at various stages of conceptual and actual design of a product?
- Can an online system like SHINE answer most of the medical questions?
- Can we identify all other information resources, besides medical information, that are needed for medical device design?

SHINE evaluation:

The system evaluation intends to measure the effectiveness of SHINE as a tool for self-initiated education, and to identify potential applications using an integrated information system like SHINE for medical device engineers. The research includes the following subtasks:

- Evaluate the ease of use of the interface
- Evaluate the usefulness of the system
- Learn possible aspects of SHINE that can be improved to increase the users' satisfaction
- Explore the potential applications
- Analyze the usage patterns
- Answer the assumption that ready access to focused medical information can help engineers fulfill their needs in device conception and development.
- Summarize the reasons for using or not using the SHINE program

III. Methods and Settings

Our data collection methods included a general survey for the qualitative and quantitative medical information needed in the course of product design and a general survey for evaluation. Both were accomplished by questionnaires, users interviews, and sampling of the users' system access log records. Two online surveys were sent out during the experiment. The first survey focusing on the needs assessment was sent out before the users accessed SHINE. The evaluation survey was sent out close to the end of the research period. All participants filled out the first survey. Thirty-five (73%) participants filled out the evaluation after four months' usage of SHINE. SHINE currently has over one thousand registered users. System logs were reviewed with over one hundred participants from the medical device industry. The log collects information about users' transaction time, transaction type, machine IP address, search terms, documents retrieved from the searches, document viewed, and information resources used. Fifteen design engineers were selected for interview. Interviews were done after the surveys to explore the real reasoning behind the data.

We use Technology Acceptance Model (TAM) [5-8], a generally accepted model for predicting and explaining utilization of information systems, for the evaluation questionnaires. Davis [5]

conceived that based on TAM's belief-attitude-intention-behavior relationship, the perceived usefulness and ease of use can be used to predict the user acceptance of information technology. Researchers has thus validate TAM using several different applications including, web, email, voice mail, word processing, and spreadsheets [9]. Perceived usefulness is the degree to which a person believes that using a particular technology would enhance his or her job performance. Perceived ease of use is the degree to which a person believes that using a particular system would be free of effort. In addition to predicting the acceptance of SHINE, we also investigate the content issues and real work setting factors in order to provide more detailed reasons of using and not using of the system.

The information resources in the study include fourteen well-known journals, one medical textbook, one drug database, a Medline bibliographic system, and a constellation of valid practice guidelines. Users participated the research by registering into SHINE and filling out the first pre-experiment questionnaire.

Demographics

Professional Status	Number
medical device design engineers	21
medical device design managers	4
other medical device engineers	9
other medical device managers	2
medical device research staff	4
others medical device professionals	8
total	48

Table 1. Demographic Information

Item	Mean	S.D.
Do you have your own computer at work with Internet access? (0:No 1:Yes)	0.79	
Do you have your own computer at home with Internet access? (0:No 1:Yes)	1.00	
How often do you use the World Wide Web or company Intranet at your company? (0:no access 5:very much)	4.56	0.71
How important is medical knowledge to your overall design processes? (0:not needed 5:extremely important)	4.29	0.92
Is it difficult for you to get medical information for your job? (0:very difficult 5:very easy)	3.42	1.27
If you do search online, do you do it mostly at home or office? (0:home 1:office)	0.87	
Have you tried any medical information providers on the Internet? (1:Yes 0:No)	0.37	
Do they offer the medical information you need? (Yes: 1 No: 0)	0.73	

Table 2. Users' Profile

As table 1 indicates, Forty-eight users from a large diverse medical device company participated in the survey. 52% of subjects were design engineers or managers. Table 2 shows that 100% of the users have computers at home and most of them have extensive experience using the Internet.

Although medical information is generally agreed as very important information, only 37% of the participants have experience using Internet-based tools for medical information searching. Medline [10] from the National Library of Medicine and Yahoo[11] are the major tools used for the information searching. From Medline search results, users only have the access of the document abstracts. According to the user interviews, after a user finds the potential documents, obtaining full text documents usually takes more than two weeks. By the time they ultimately receive the documents, they are often either not relevant or no longer needed for the tasks. Yahoo is valued as a friendly search engine, but filled with unfiltered, unreviewed, and unrelated information. Users stated they could easily work with Yahoo search engine for hours just to find the information they need. Furthermore, to obtain full text journal articles, they still needed to request them from librarians.

IV. Results and Discussions

Users were asked to rate all of the evaluation-related questions in the range of (–3) representing "strongly disagree" to (+3) "strongly agree. Questions were organized into categories to represent the major research questions. The evaluation results show that users have strong support for SHINE. They are especially satisfied with SHINE's capability of integrating heterogeneous distributed information systems. All users would continue to use SHINE, if it continues to be available to them. The results also show that SHINE needs to make more relevant information resources available online to increase the usefulness of the system.

Evaluation of the Ease of Use of the Interface

For the current interface of SHINE, do you agree with the following statements: (-3:strongly disgree 3:strongly agree)	**Mean**	**S.D.**
Allowing simutaneous search over many resources is a very useful feature to me.	2.46	1.12
Learning to use SHINE is easy.	2.23	0.94
Becoming Skillful at using SHINE is easy.	1.88	1.04
Getting information I want from SHINE is easy.	1.60	1.14

Table 3. The perceived ease of use of SHINE

Almost all respondents agreed during the interview that they would very much like a system that can integrate the information they need into one single system. The major usability problems reported in the interviews were difficulties with medical terminology and a lack of knowledge about the information resources available on SHINE. Since most of the medical device engineers did not have backgrounds in medicine, it is difficult for them to do searches without the medical dictionary and thesaurus. Although all of the resources, including full-text journals [12], drug database, textbook, and guidelines, contain only high quality information, many users reported they are not certain which resources were most likely to have the information they need.

Evaluating the Usefulness of SHINE

For the current information resources within SHINE, do you agree with the following statements: (-3:strongly disgree 3:strongly agree)	Mean	S.D.
Overall, I find SHINE to be advantageous in my job.	1.43	1.34
Using SHINE will enhance my effectiveness at the job.	1.31	1.08
Using SHINE will allow me to accomplish tasks more quickly.	1.29	1.25
Using SHINE makes it easier to do my job.	1.29	1.15
Using SHINE will improve my job performance.	1.17	1.25
Using SHINE increases my productivity.	0.97	1.36

Table 4. The Perceived usefulness of SHINE

Assume that SHINE could include ALL THE INFORMATION YOU NEED (biomedical journals, FDA regulations, patent information, company data, technical manuals, etc.). Do you agree with the following statements? (-3:strongly disgree 3:strongly agree)	Mean	S.D.
Using SHINE will enhance my effectiveness on the job.	2.23	0.88
Overall, I find SHINE to be advantageous in my job.	2.20	0.98
Using SHINE makes it easier to do my job.	2.20	0.93
Using SHINE will allow me to accomplish tasks more quickly.	2.14	1.03
Using SHINE increases my productivity.	1.91	1.04
Using SHINE will improve my job performance?	1.86	1.00

Table 5. The expecting perceived usefulness

All interviewees agreed that SHINE could produce information with much less noise. Especially, with the availability of full text journals and documents, users can get instant feedback about the relevance of documents without going through the trouble of requesting and waiting for the documents. However, with the limited number of information resources for the experimenting study, we are not sure that SHINE can support most users' information needs. Furthermore, many participants reported that they rely on the information material sent through emails, librarians, and company training to get the information they want. The tempered enthusiasm about SHINE's usefulness could also have been due to the company's readily available and easily accessible information. To evaluate the usefulness difference of SHINE due to the availability of information resources, we asked users to evaluate the usefulness of SHINE based on two criteria: SHINE with current content, as shown in table 4, and SHINE with more content to fit users' information needs, as shown in table 5. The perceived usefulness gain was 0.85 in average. This result shows that adding more relevant information into SHINE could significantly improve the usefulness of SHINE, therefore, increasing the system usage. This finding is consistent with the finding that adding more relevant resources can increase the usage of the system most in table 7.

Identifying the Relevant Information

If we are able to include more resources, what do agree that the following information resources are important for you?	Mean	S.D.
Government regulations	2.4	0.81
Engineering information	2.38	1.16
Company's competitors	2.26	1.15
Patents	2.17	1.15
Biomedical information	2.17	1.12
Company data	1.97	1.09
Company's suppliers	1.83	1.34

Table 6. The relevance of information

In order to facilitate the self-initiated learning, we needed to identify the unsatisfied information needs that are crucial for medical device design engineers. We first examined what medical information might be needed for medical device design and how readily available of such information could affect the speed and quality of design and could substitute for the personal communication between physician and engineer otherwise required. To determine the information needs, we first sent an email to company employees about the resources that they wished to have. The requested resources were organized into different information types. We then asked them to rate the importance of these information types in a questionnaires and interviews. The questionnaire results in Table 6 show that engineers have very diverse information needs.

Identifying the Reasons for Using and not Using SHINE

What factors would "INCREASE" your usage of SHINE?	Mean	S.D.
Availability of more relevant information resources	2.38	1.02
Integration with company intranet	1.66	1.76
Better quality of the resources in SHINE	1.65	1.18
More intuitive interface	1.65	1.34
More introduction/tutorial sessions by SHINE staff	1.35	1.41
Integration with company's continuing education program	1.09	1.7
Less work load	0.62	1.58
More secure system	0.18	1.31

Table 7. The future features that might improve SHINE

Comparison with Company Librarians

50% of the users responded they would have been content to SHINE alone, if the information they wanted was within SHINE. 47% of the users would have tired to do the searches themselves first before asking for help from librarians. Detailed comparison between the position levels shows that mangers use the help of company librarians most frequently. They send average 18.25 requests per month to the librarians, which is over 4 times the average value. However, all would like to do the search themselves first if the online information is available. Further interviews

show that getting instant feedback for the information is the major reason users prefer using SHINE, even though users have the advantage of being able to send the requests to librarians through emails without specifying the potential resources that can be used to answer the question.

Item	Mean	S.D.
Have you asked the company librarian to find information for you in the past?(0:No 1:Yes)	0.74	
If your answer to the above question 6 is Yes, how many times per month?	4.48	4.05
If the information you are looking for is within SHINE, do you prefer doing the search by yourself or asking a librarian? (0:Ask a librarian 1:Do the search yourself, then consult a librarian if your own search is unsuccessful. 2:Do it myself.)	1.42	0.56

Table 8. SHINE and librarians

Exploring the Future Applications

SHINE was designed as a self-initiated continuing education tool that provides an alternative or augmentative channel for medical education and training. However, from our study, we found out SHINE can also be used for:

- Document findings to facilitate sharing, and reuse of knowledge
- Research
- Explanation of the reasons why a designed function worked or failed for a clinical trial.

Do you agree that SHINE can be used for the following purposes?	Mean	S.D.
Medical related information	2.42	0.5
Research and development information	2.21	0.78
Self-education	2.14	1
Designing clinical trials	1.65	1.07
Engineering information	1.41	1.19
Marketing information	1.15	1.39
Operational information	1.03	1.09
Problem solving	0.94	1.32
Manufacturing information	0.71	1.37

Table 9. The potential applications of SHINE

Conclusions

This study shows that participants have strong support for the SHINE system. This investigation also has identified the information needed for medical device design and the potential application areas for SHINE. By understanding the designers' information needs, we also hope to provide the medical device industry with strategies to develop future medical/engineering information systems. This research also proves the following assumptions:

- Integrated search is a useful and important feature to the users.
- Using SHINE can save engineering time for information searching.
- Engineers will prefer to use SHINE when the information is within SHINE.
- Users will continue to use SHINE when they have access.

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