Interactional Digital Libraries: Uses and Users

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ABSTRACT

This article defines and describes interactional digital libraries. Uses and users of these libraries are discussed in terms of 1) interactivity, 2) information behaviors, and 3) language.

INTRODUCTION

"The new digital libraries will have features not possible in traditional libraries, thereby extending the concept of library far beyond physical boundaries. They will provide innovative resources and services. One example is the ability to interact with information: rather than presenting a reader with a table of numbers, digital libraries allow users to choose from a variety of ways to view and work with the numbers, including graphical representations that they can explore. With the extensive use of hypertext links to interconnect information, digital libraries enable users to find related digital materials on a particular topic" (PITAC, 2001). This vision of digital libraries is not unusual. A combination of interactive resources and services, such that one no longer knows where the resource ends and the service begins, is being encouraged in digital library research and development by funding agencies such as the National Science Foundation. For example, the Informedia Digital Video Library, as early as the mid-1990s, created a multi-media database where 'synthetic interviews' with Einstein are possible. In the 'synthetic interview' a student asks a question and the answer is a video of an interaction between a human who plays the role and a sophisticated multimedia database from where the actual quotations and excerpts of sound are taken. In the synthetic interview, actor Jerry Mayer plays the role of Einstein and answers questions (Kiernan, 1998). Another new vision, the 2002 movie version of the H.G. Wells classic science fiction novel, 'The Time Machine' portrays the library of 2030 as Vox, a holographic character who walks, talks, and sings excerpts of the library materials in response to user queries. Vox calls himself a 'compendium of all human knowledge" (Time Machine, 2002).

While a talking, moving librarian-cum-library, along the lines of Vox, seems futuristic, advances in Internet technologies have made it seemingly possible and easy to create digital archives, collections, repositories, and libraries. Supporting diverse information uses that facilitate interaction in these repositories and libraries beyond searching and browsing is however, still in the early stages. Interactive digital libraries like Vox, or interactional digital libraries as we prefer to call them, are still evolving. Such dynamic and multimedia-based interactivity is important as distances across the globe shrinks, brings diverse cultures into contact with one another, and the research and learning functions of a library are better fused to help in both activities.

Coleman and Oxnam (2002) define interactional digital libraries as being made up of information spaces, learning spaces, and interaction spaces. McKnight (2000, p. 730) uses information space to mean "objects (real or virtual) to which the individual turns to acquire information". In the interactional digital library, information spaces are increasingly made up of heterogeneous formats which can be called complex objects. These objects are structured as learning spaces; i.e., they display the best information for learning in an optimal manner; they incorporate

intelligent, interactive information retrieval, customized for or controlled by users' learning styles (Coleman et al, 2001). Users may use these complex objects and transform them when interaction spaces, both free the user from physical limitations as well as provide the benefits of virtual interactions (for example, asynchronous interactivity) and communities to digital libraries (Winograd, 2002, p. 260).

Summarizing, we can say that interactional digital libraries are:

- Information spaces with complex objects, which
- Provide interactions beyond information discovery, searching and retrieval Components of such libraries are:
- Collections (content)
- Services (information discovery, searching, identification, inventory, metadata creation)
- Tools for information uses (annotation, personalization)
- Interfaces (for searching, for browsing, for creating metadata)

To build interactional digital libraries we must have very clear ideas about the uses of an interactional digital library and its users. We must able to understand and accommodate both current use as well as potential and future uses of information. This paper discusses some ideas about uses and users of interactional digital libraries, by examining the notions of interactivity, language, and information behaviors.

INTERACTIVITY

There are many architectures and frameworks for design, development, evaluation and interaction described in the literature. For example, the Kahn-Wilensky (1995) framework defines the design of digital objects for services and focuses on mechanisms that assist in the discovery and retrieval of those objects and Choudhury et al (2002) have proposed a framework for evaluating digital library services. However, Hansen (1998) notes that information access tasks in digital libraries pose special interaction and interactivity challenges for user interfaces in digital libraries that transcend information retrieval research. Digital library applications require a wide variety of interfaces; these interfaces may control simple tasks such as presenting digital objects for learning or more advanced tasks such as controlling the level and amount of interactivity.

Many different types of user interfaces exist for digital library tasks that underlie reading, including searching, collecting and manipulating, and these have been discussed in the literature. For example, Belkin (1993) reports on research about interactive information retrieval, and Schneiderman (1998) discusses how textual manipulation tasks include highlighting, searching, cutting and pasting, and hyperlinking. Visual interfaces for digital libraries are also emerging as viable alternatives (Weiss-Lijn, 2001). Winograd (op. cit.) has proposed a high-level human-centered interaction theory that is moving us away from the desktop and towards immersive information environments.

Interactivity is studied and investigated by disciplines such as Human Computer Interaction (HCI), Marketing (specifically Advertising and Consumer Behavior), Education (specifically, Educational Psychology and Instruction Design), and Communications. Here are some definitions of interactivity and interaction.

Interactivity is “the extent to which users can participate in modifying the form and content of a mediated environment in real time” (Steur, 1992). Rafaeli and Sudwecks (1997) define interactvity as the “extent to which messages in a sequence relate to each other, and especially the extent to which later messages recount the relatedness of earlier messages.” The *Oxford English Dictionary* defines interaction as "reciprocal action; action or influence of persons or things on each other" and includes the Human Computer Interaction (HCI) definition limiting the scope to information processing and flow of information between computer interfaces and people. Information processing is a fundamental cognitive activity that underlies information uses such as learning. Caroline Arms, for example, notes: “libraries have always supported interactions with the fund of knowledge, interactions that come in many shapes and sizes…Interacting with knowledge is what lifelong learning is all about.” (Arms, 2000). The information processing aspect of interactivity highlights the benefits and drawbacks. Benefits include:

- User involvement
- User Satisfaction
- Enhanced Learning

Drawbacks are:

- Active Learning (learning by doing is only one learning style and there are others)
- Overload (there is a cognitive overload necessitated by interactivity)

Key attributes of interactivity are:

- Reciprocity – there must be a reciprocal action when the user does something.
- Feedback – the amount and type of feedback provided to the user must just right.
- Immediacy - both reciprocity and feedback must be immediate and immediacy differs on task, context, and user preferences.
- Relevancy – relevance is calculated based on task and context.
- Synchronicity – the degree to which users consider their input into system and system response is felt to be simultaneous.
- Choice – the user can always choose among alternatives.
- Immersion – experiences are immersive.
- Play – a sense of play is used stimulate and motivate learning.
- Flow - this is related to users’ cognitive flow and locus of attention.
- Multi-dimensionality – the sensory experience has more than one dimension.
- Control – the voluntary and instrumental action that users have over the outcome or rate, sequence, and type of feedback.

These characteristics, from areas besides HCI and instructional design, such as online consumer behavior (Liu, 2002) are often used to drive the design, development and evaluation of interactivities in digital libraries such as the Geo-Technical, Rock and Water resources digital library (Budhu and Coleman, 2002). Interactivity is an excellent design goal for digital library development as it can be tied to formative and summative evaluation of components such as interfaces, content, search engines, etc.. For example, control and flow can be measured by using interactivity scales in affective response surveys or by building consumer involvement profiles (Wu, 1999; Novak, Hoffman, Young, 2000).

INFORMATION BEHAVIORS

Typically, digital library design initiatives include some aspect of scenario planning or user modeling to precede the software requirements and library development process. However, digital library development is complicated by many factors, and since there is no such thing as a typical library user, the task of user modeling for an interactional digital library is a complex one as well. The features and functions of a digital library are also harder to specify, since the different communities who may access the digital library have diverse needs. Therefore, modeling information behaviors and generating requirements based on those models is more effective. In such modeling, we distinguish between three types of information behaviors: information seeking, information searching, and information use. We can also seek to design for avoiding other phenomena such as information overload.

Information seeking behavior is "purposive seeking for information" while *information searching* is the "'micro-level' of behavior employed by the searcher in interacting with systems of all kinds." *Information use* behavior consists of "the physical and mental acts involved in incorporating the information found into the person's existing knowledge base. Therefore, it may involve physical acts such as marking sections in a text to note their importance or significance, as well as mental acts that involve, for example, comparison of new information with existing knowledge" (Wilson, 2000). *Information use behaviors for learning* can be identified using any number of educational theories. For example, using Bloom's Taxonomy of Educational Objectives, information use behaviors may include: memorization, classification, categorization, comprehension, construction, calculation, diagramming, and interpretation. (Bloom, 1956).

Libraries, whether traditional or digital, generally focus on providing solutions to the problems of information searching/discovery by managing collections and developing services to support searches and uses. Digital libraries, however, are expensive propositions and must be designed to be widely usable; that is, information uses beyond mere information retrieval must be accommodated. For example, educational digital libraries that support learning are quickly becoming important (Zia, 2001). This is not an easy transition of library purpose, and many still question the importance given to the learning uses of a library over its more accepted scholarship/research (information discovery) functions. Nevertheless, the broad thrust and goals of interactional digital libraries includes:

- Avoiding both information and cognitive overload
- Enabling contextual information (the presence of standard reference tools for each 'snippet' of information –see Xrefer (http://www.srefer.com) and Atomica (http://www.atomica.com) as examples)
- Facilitating user activities – such as highlighting, annotating, transforming, converting, personalization, recommendation, etc.

LANGUAGE

Language is a primary tool for human communication. In libraries, several broad processes massage language for information organization and retrieval. They do so by creating public knowledge organization schemes, systems, and tools. These can also be referred to as public knowledge structures and include, library catalogs, thesauri, indexes, subject headings, library classification schemes, terminologies, and taxonomies. As early as 1944, Swank pleaded for a critical discussion that recognized the interrelationships between classification, library catalog,

indexes, and bibliographies (Swank, 1944). While in the digital world these tools are certainly merging and can be merged, our analysis shows that other critical interrelationships that need to be considered for the development of interactional digital libraries are the ones that integrate knowledge structures and reference sources. This means that we should explore the merging of knowledge structures such as classification schemes and thesauri with reference works such as encyclopedias and dictionaries. Included in this list are glossaries, gazetteers, and terminology lists. Only when such integration is done are the 'novice learners' served by the library tools as much as the researchers. Our current schemes of organization often require the use of mediators (in the form of reference librarians); interactional digital libraries should facilitate users who are both novices and experts. This may be done through the unveiling of language to reveal all kinds of relationships between concepts and types of concepts during library organization processes such as cataloging and indexing.

In library cataloging, books and other items are assigned one or more subject headings that represent their content, to assist users in locating information by subject. In indexes and bibliographic databases, the subject headings assigned to documents are called descriptors. Topics and subjects in library classifications are associated with document aboutness. In library cataloging subject analysis has traditionally been carried out on the summarization level that is finding the one overall subject concept that encompasses or can represent what the whole item is about. Alternatively, the 20% rule is invoked where 20% of the document is about the subject (Taylor, 1999).

Within the broad processes, concept, subject, and facet analyses are others by which public knowledge structures are used and created. They are familiar activities to librarians and distinctions between them are often not made. Concept analysis, usually done by indexers, uses an indexing language or thesaurus. Subject analysis as done in library cataloging is the process of assigning subjects (subjects are much broader than concepts or facets) from a controlled vocabulary list (or a thesauri) to a document. Discourse communities interpret facet analysis in different ways. Classificationists, designers of classification schemes, perform facet analysis when they try to identify the fundamental classes needed or inherent in a subject. Facet analysis, comes from the original work of Ranganthan, and is currently used by the Facet Analysis Theory project to create subject-based portals for the WWW (FAT, 2001). Facet analysis is the "rigorous process of terminological analysis where the vocabulary of a given subject is organized into facets and arrays, resulting in a complex knowledge structure with both semantic and syntactic relationships clearly delineated" (Broughton, 2002).

These analyses techniques are used to solve the *disambiguation* problems of *semantics* in information retrieval. When the user searches using a word or phrase, do the records that are retrieved with the same words or phrase really mean what the user meant? Classificatory structures take care of semantic problems such as synonyms and homographs in many different ways. For example, thesauri use qualifiers and parenthetical statements. They also specify relationships between terms. Semantics therefore refers to the meaning of the term, both its dictionary definition as well as all the associations to it. Definitions are called the *reference* or *denotation* and associations are called *connotation*. Definitions are limited and often standardized by community consent and usage but connotations may be infinite since they are determined by personal experience. Thesauri select associations and include them in three kinds of semantic relationships; indexing languages try to describe many more associations. In general, much, much more associations (*connotations*) and definitions (*denotations*) need to be specified and described for the interactional digital library if uses beyond mere retrieval (such as learning, creativity, and invention) are to be increased.

CONCLUSION

This paper has discussed how uses of interactional digital libraries can be developed using information behaviors to drive user modeling and interactivities to measure and evaluate the outcomes. The generic vocabulary problems of digital libraries have also been briefly explored.

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