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Support System Indexing for Learn-by-Doing Educational Environments

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Abstract

Learn-by-doing training environments are becoming more prevalent, and with them, the need to provide easy access to relevant information. One approach to providing such information is with an electronic information system. In this paper, we describe an information system designed for use in a particular training environment to deliver content to the learners. We focus on the indexing methods used to prepare information of various media for immediate use, as well as for open exploration. We present the training context that gave rise to this system, the challenges posed by this context, the indexing methods used to design and construct the information system, the lessons we learned, and finally our plans to extend the system.

Introduction[1]

Over the last four years Andersen Consulting Education (ACE) has been exploring uses of technology for corporate training (Acovelli and Nowakowski 1994; Montgomery, *et al.* 1994; and Campbell and Monson 1994). Three basic initiatives have emerged: self-contained computer-based multimedia products, standard tool-based training support environments, and Integrated Performance Support for Learning (IPSL) Systems.[2] This latter initiative involves creating an integrated environment for (1) relevant information access, (2) work product creation and maintenance, (3) technology-based tutoring, and (4) computer-supported collaboration. The impetus to create such an integrated environment arose in a specific school, "Architecting" Business Change (ABC). ABC participants engaged in non-computer-related activities required easy access to large libraries of multimedia resources, the first of these four areas of support. In this paper we present the school context that gave rise to the requirement, the challenges posed by this context, the methods used to design and construct the information access system, and finally our plans to extend the system to the other three requirement areas of the IPSL.

The ABC School

In the "Architecting" Business Change school, Andersen Consulting Senior Managers and Associate Partners practice establishing rapport and a shared vision with client executives. Over the course of a single week, the school simulates a much longer Andersen engagement with a client organization. To complete the school, participants focus intently on forming a team, meeting with client executives, and gaining executive commitment to a future consulting relationship. Participants frequently comment on the intensity and fidelity of the school to real engagement life. Yet unlike a real engagement, they value the coaching from faculty and feedback from client executives they receive as they go through the experience.

Participant teams are self-directed. No Andersen partner sits with the team to establish plans, determine priorities, or direct work. Instead, participants must develop their own sources of information and expertise from among themselves, the industry experts to which they are given access, and other resources placed at their disposal. The environment is complex and under-structured purposefully to assist the participants in developing judgment in planning, organizing, and executing their work.

The specific industry in which the simulated client company operates serves as the engagement context. To date three different industry versions are in operation (utilities, retail financial services, and government) with more to come. In spite of the

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[1] Cynthia L. Bernstein and Richard E. Osgood are employed by Andersen Consulting Education in the Professional Education Division, St. Charles, Illinois. The authors gratefully acknowledge the work of the ABC Indexing Team (especially Ranjani Iyengar, David Pedergnana, and Carl Puccio), the IPSL Technical Team (especially Steven Holleran and Jennifer Szarzynski), and the ABC Design Team. Copyright 1995 by Arthur Andersen & Co., SC.

[2] IPSL is the natural extension of Integrated Performance Support (IPS) systems (Winslow and Bramer 1994).

industry context, most of the participants' activities throughout the week are much the same among the versions. In the early part of the week, participants attempt to demonstrate their understanding of the client's situation. In the second part of the week, the participant teams work closely with the client to establish a common agreement on the path from the current client situation to the envisioned future.

The school has become a vehicle for supporting strategy-focused training of Andersen Consulting personnel and is continuously being improved with the addition of industry and cross-industry information.

The Need for an IPSL

The ABC participant teams experience the intensity of a compressed realistic client engagement. The complex case problem and the ambiguous goal situation cannot be addressed adequately by any individual. This combination of factors creates risk and a desire to seek out useful sources of help from among the faculty and the resources of the IPSL.

Providing a helpful system is not an easy matter. The combination of the intensity of the setting and the openness and ambiguity of approaches to participant work means that the support system must deliver relevant information with ease from its large store of potential material. For example, a participant team working on a proposal wants to ensure its appeal to the clients. Such participants have little time and inclination to learn an interface and an organization for available material. The pace of the school prevents participants from searching for resources to any great extent.

Keyword or full-text search information retrieval systems are inapplicable in this setting. Time away from pursuing the primary learning objectives is at a premium, and content is often not text. The recall and precision problems of typical retrieval strategies distract participants from their goal-directed activities (Blair and Maron 1985). Also, standard full-text systems are inapplicable because much of the material available to participants is in media other than text (model graphics, video stories, and pictures). Some is not even on-line for copyright reasons or because it is unavailable in softcopy form. Other material resides in databases maintained by organizations outside of ACE. The IPSL must access or at least reference each of these media quickly and as needed by participants with little regard for its format or location.

The applicability of material varies throughout the week's work. Relevance to specific work activity is the greatest determinant of the value of resources included in the IPSL. Early in the week much of the background material achieves its maximum relevance, whereas by week's end, material suited to application of knowledge is more relevant. The system must make the material most appropriate to a participant's task most easily accessible without circumscribing access to other material for participants with differing interests. In the client proposal example, participants consult the IPSL under their current focus, "Get Client Reactions to Possible Solutions," to find the expert advice they need. Other teams working on other tasks will look elsewhere in the system to find appropriate resources.

Not only is providing a helpful system difficult, maintaining such a system is equally challenging. The differing industry versions of the school must be easily accommodated without compromising access to commonly relevant cross-industry material. New industries must be brought on-line and new cross-industry content areas included with minimal rework of existing content. The system must be dynamic, as other refinements suggested by participants and faculty are added and as outdated engagement cases are updated or replaced.

We have developed a basic systems architecture for an IPSL and a method for developing and maintaining an IPSL that meets these requirements. The architecture supports presentation of and navigation through content-based indices to resources. The method employs questions for content indexing of resources and is itself supported by a specialized indexing tool that creates and maintains the indexing structure.

Approach

Our approach to meeting the IPSL requirements is similar to that of an ASK system (Osgood 1994). In this type of hypermedia browsing system, the user zooms into a topic of interest, views the content there, and then selects any one of a set of follow-up questions, each of which leads to another piece of connected content. Adopting the ASK Michael approach to information access (Osgood 1994), we recognize the need for two types of user interfaces: (1) a *zooming interface* (or *zoomer*) that gets the user into the content, and (2) a *browsing interface* that permits further exploration to follow up on the initial content presented. In the subsections below, we discuss the purposes of these two types of interfaces and how we constructed them.

Zooming to Use-ready content

Our primary goal for the IPSL is to get the participant to a helpful piece of content. To do this we must anticipate what content will be most useful when, and how it must be elaborated and explained to make it *use-ready* for participants engaged in the activities of the school. This requires an understanding of the goals of typical users, as well as their background knowledge. Because ABC participants are Senior Managers and Associate Partners, they require little information on the fundamentals of consulting work and Andersen culture. ABC participants want information to help them with important tasks in the school, such as building rapport with the clients, working together in teams, and evaluating the case company's position within its industry. What we need, first, is to delineate the activities of participants with these goals, and then assemble specific content applicable to each activity.

ABC school designers developed a school *Process Guide* to participant activities, a plausible outline of work at three levels of detail: steps, associated tasks, and subtasks. We selected the best content available to help a participant with each activity. We labeled and abstracted it in a way that explains its relevance, then associated it with the activities at the appropriate level in the Guide. The Guide forms the primary zoomer for the IPSL (see *Fig. 1*). When an IPSL user clicks the mouse on any step, task, or subtask in the Guide, a list of relevant questions is displayed, each of which is connected to a piece of use-ready content that answers the question and helps with the task.

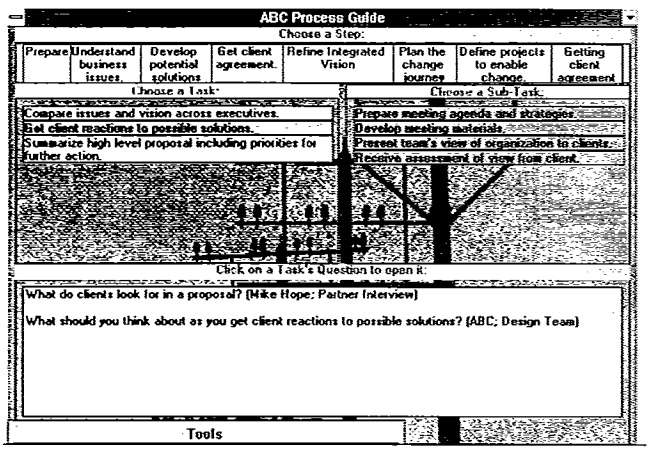

Fig. 1: The Process Guide zoomer in the IPSL. The Process Guide steps, tasks, and subtasks are displayed at the top of the screen; questions that lead to use-ready content are at the bottom.

Browsing Related Content

From the Process Guide, ABC participants reach a small list of use-ready pieces of content. Once they have selected one, the browsing portion of the system displays the content and any available connections to more detailed elaborations, explanations, helpful comparisons, or other advice on the selected content (see *Fig. 2*).[1] By selecting one of these, the participant can explore an item or issue in more detail to the extent that our gathered resources will support. However, participants have little time for exploration, and so we limit the available follow-up content to that needed to complete a story or a major point.

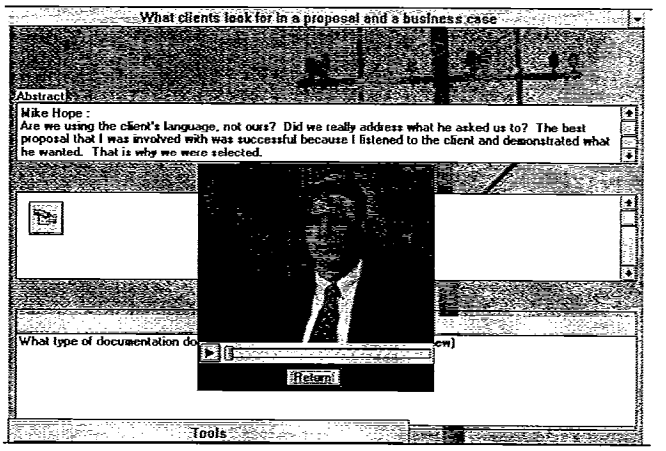

Fig. 2: The browsing interface in the IPSL with a video playing. The segment's title and abstract are displayed at the top of the screen, and a follow-up question is listed at the bottom. Clicking on the video icon in the middle of the screen started the video.

To create and link these related pieces of content, we selected from our resources segments that provide complete yet concise answers to likely participant questions of the four general types above. Typical segments in the ABC IPSL include one- to two-minute video clips, two-page subsections of text documents, and several-page slide presentations. For example, a short video clip that tells a war story about a teamwork disaster is a segment from a resource consisting of a set of interview tapes. To more fully make the point, several additional clips from the interview tapes are linked to the primary one to answer several of the major questions that may be lingering in the mind of the participant.

[1] Offering these four types of follow-up information was inspired by the theory of all possible continuations to a text used by ASK Systems (Osgood 1994).

Question-based Indexing of Segments

We have developed a systematic indexing process aided by a specialized indexing tool that creates and maintains the zooming and browsing relationships presented to participants by the ABC IPSL. The complex nature of the useful relationships among content needed for the growing number of industry versions of the ABC school made it necessary to adopt a more rigorous approach than for a single industry.[1]

Indexing process

To index video or text, the ABC indexing team (the *indexers*[2]) selects segments from a resource, labels them for IPSL use, and links segments to zoomer categories and to related segments[3].

Segment Selection. To identify segments, indexers look for stand-alone chunks of content that make a clear point. They must be concise enough to maintain user's attention, yet developed enough that navigation to them is worth the trouble. Segmentation heuristics vary with the type of resource. Segments from text documents often correspond naturally to the subsections of the original document. Similarly, segments from videotaped interviews can correspond to individual answers to interviewers' questions. Most of the time, however, individual answers are much longer than two minutes because the interviewee often repeats information. A concise form of the interviewee's statement can often be identified by finding a good punch line and extracting the surrounding context. We focused on video content containing vivid examples and analogies, avoiding vague descriptions and generalizations.

Labeling. To prepare material for the IPSL, indexers recorded information for both whole resources and the segments extracted from them. For each segment, ABC indexers composed a *title* descriptive of the purpose that would be served by showing the segment to our participants, an *abstract* (the main points made by the segment) that should help them better decide its value to them, and the name of the author or interviewee (see *Fig. 3*). They also recorded the segment's origin (e.g., partner interview, client interview, school case material) and a variety of other housekeeping information (e.g., access control, content categories, and segment location). For segment linking, indexers developed two types of questions: questions for which the segment offers a good answer, and questions the segment is likely to raise. These questions form the basis of the *question-based indexing* approach.

Linking. Linking via question-based indexing involves making connections, or *links*, between related segments. Links are located by matching a question raised in one segment to a similar question answered by another. They can be made between segments within the same resource or between segments in different resources. Indexers also select and link segments to appropriate steps, tasks, and subtasks of the Process Guide zoomer.

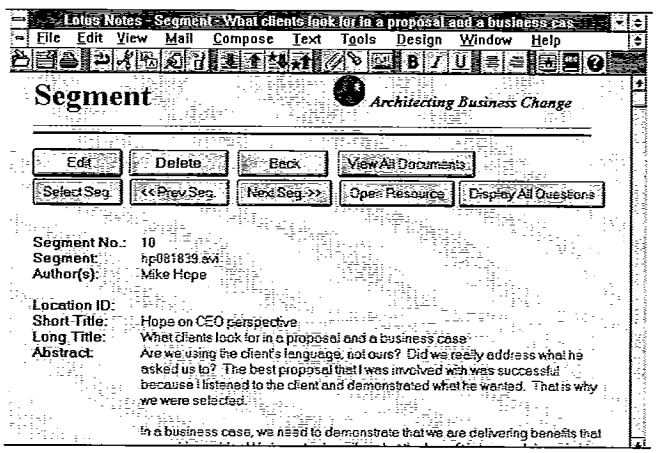

Fig. 3: Display information for an indexed segment in the resource database.

Use of the ABC Indexing tool

The ABC indexing team developed an indexing tool to enter, view, modify, find, and use indexed content. All indexing and linking information was stored in a set of databases.[4]

The indexing tool maintains multiple interrelated databases. One database, the *resource database*, is the central repository for all content. Segments are attached to the individual top-level resources from which they were extracted. Questions answered and questions raised are attached to their associated segments. Links between segments are children of the two questions they connect. All documents in the resource

[1] Tool-assisted indexing approaches have been used in fairly large scale ASK Systems (Bareiss and Osgood 1993).

[2] An indexer is responsible for getting content into the system and connected to other content and zoomers. In other settings, indexers are often called *content analysts*. At ACE, indexers are the instructional designers building the course support.

[3] In this section we focus primarily on making connections between segments. Space does not permit a discussion of how to connect segments to zoomers.

[4] All ABC IPSL information is stored in Lotus Notes™, a registered trademark of Lotus Development Corporation.

database can be viewed hierarchically, as shown in *Fig. 4.*

Other databases contain the information for the supported zoomers. We have built zoomers for the Process Guide, video personalities, key themes of the cases, and tables of contents of the cases. The structure of each of these zoomers is stored in a zoomer database. Links from each zoomer to segments are also stored in the corresponding zoomer database.

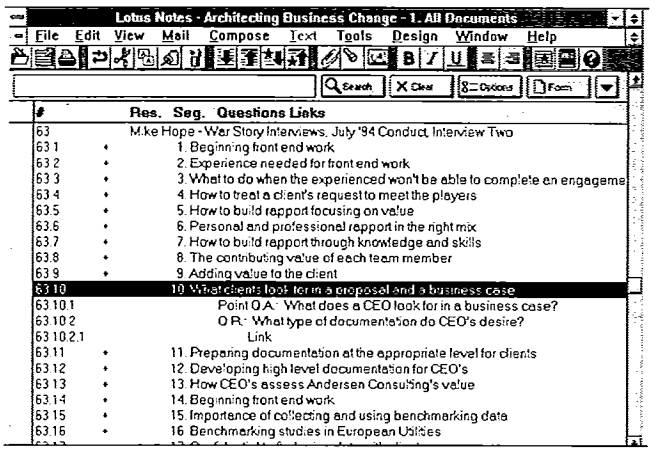

Fig. 4: View of all documents in the resource database.

The indexer first enters a resource, and then adds its constituent segments. The segment content itself is stored either as an on-line document, the name of a video file[1], or a text string. The indexer then composes and attaches the segment's questions. To match questions forming a link, the indexer either views a list of questions sorted by category, executes a full-text search for key words in the text of the question, or peruses the hierarchy of all documents in the resource database. The indexer starts with questions raised to form outgoing links to follow-up segments. The indexer starts with questions answered to create incoming links. The indexing tool automatically records housekeeping information, such as who entered the content and when, for all documents.

In practice, the indexer who enters a particular resource is generally responsible for its linking. This often involves linking to unfamiliar content. In this case, the indexer must rely on the information recorded by other indexers, most importantly the segment's title, abstract, and author. To expedite cross-resource linking, a pair of indexers might get together to discuss potential links between the locally connected content indexed by each. For example, the indexer who indexed the case material for one school had a lengthy discussion with the indexer who indexed the industry resources for that school. High quality links between the case material and the industry resources resulted from the collaboration of the two mini-experts in related content.

IPSL

The IPSL consists of a database retrieval function, zooming and browsing interfaces, and media viewers for each type of segment. The IPSL retrieves the structure and content for its zooming interfaces (e.g., the ABC Process Guide) from the databases created and maintained by the indexing tool.[2] When the user finishes navigating through a zooming interface, the IPSL retrieves a list of relevant segments from the resource database. The primary zooming interface, the Process Guide, discussed earlier and shown in *Fig. 1*, displays the steps, tasks, and subtasks, as well as the initial collection of links to segments. For any segment reached by the participant via a zooming interface, the IPSL retrieves related segments for display in the browsing interface. This interface presents a segment's title, abstract, and author (shown earlier in *Fig. 2*). To view the segment content using an appropriate media viewer, the participant clicks on the application icon; i.e., a word processor application icon for text documents, or a video camera for a video file. Text displays in a scrollable window. Video plays back over a fastlink connection to a video server which supports simultaneous multi-user access.[3]

Lessons learned

The indexing effort that began last year with the ABC school has yielded two types of useful lessons. We know a great deal more about the value of an information-access IPSL in learn-by-doing settings and substantially more about efficiently indexing for them.

[1] Technical issues that arise in digitizing video segments will be listed in the next section.

[2] The IPSL retrieves content from Lotus Notes™ indexing databases using VB/Link™ 2.02d from Brainstorm Technologies for use in Visual Basic™ 3.0 from the Microsoft Corporation.

[3] The ABC video is software-compressed and played back using Video for Windows™ 1.1, a trademark of Microsoft Corporation. Many digital video issues were researched for this implementation, including playback platform (i.e., video server and CD-ROM), compression algorithms and formats, capture and compression hardware, and editing software.

IPSL in a learn-by-doing environment

The successful educational use of content-indexed systems rests on our ability to predict the activities that our participants will be engaged in, to locate and deliver use-ready packets of relevance-assured resources through technology, and to support follow-up questioning. Participants receive access to needed resources without search by simply mapping their own task to the task model we display in the Process Guide zoomer. In practice, for the participant to recognize the value of a resource, its label must communicate its relevance to the participant's task. Though of less importance, successful delivery of use-ready packets to participants also requires that all media be more or less equally accessible. Therefore, we delivered video "live" over the network just as we would text from a common database.

Our systems have been increasingly used by our participants from school to school because we have better positioned the IPSL by showing participants some of its uses for their actual work and because we continue to improve the indexing. Initially, we allotted insufficient time for participants to learn the value of the content stored within the system. Now, with specific guidance at the start of the school week, we are seeing greater acceptance of the system. Our system got high levels of usage in the March 1995 run of the ABC school, demonstrating that participants will use a very large and complex on-line library if it is well indexed and the content is quickly accessible--even under highly goal-focused, time-constrained circumstances.

Indexing for a learn-by-doing environment

In the process of delivering an effective well-indexed IPSL, we have learned a great deal about efficient delivery. In four months, the five people on the ABC indexing team used an indexing tool to index over 900 different segments and to link to six different zoomers. The indexing tool adequately stored our indexing information, but we pushed its limits of performance and functionality. Performance problems were related to the database architecture. For example, the reason for the slow performance of complex searching and sorting operations is that Lotus Notes is a document manager and thus does not directly support relational database operations. As the resource database grew (to over 5000 documents presently), processing time for the macros which simulate relational operations increased substantially.

As the indexing team became more adept at indexing, we recognized the need for functionality that does not exist in our current indexing tool. For instance, we discovered that linking segment pairs can be a very time consuming part of the indexing process, which should be addressed by new tool functions. Several of the most desirable features of an improved indexing tool are the following:

- View two question lists, side-by-side on the screen to find matches.
- Make multiple links simultaneously from one segment to any number of others.
- Indicate whether a given segment has links to or from its questions.
- Move and copy questions between segments and segments between resources.

We also improved our ability to deliver the right content to participants. We use a single resource database in all industry versions of the IPSL. Access codes set in the links determine which content the participants of a particular school are allowed to see. For example, video content on client relationships is marked for access by all ABC schools, whereas utilities-specific industry content is accessible only by participants in the utilities version. Because all indexing information is stored in databases accessed by the IPSL, we were able to continue indexing and linking during the schools as new content was located or as participants themselves suggested improvements.

This real-time refinement of the content and the process has speeded the professionalization of indexing at ACE. What began as a research experiment last year has now matured into a profession with subspecialties (video interview capture and indexing, case study indexing, industry resource indexing, for example), rules of good practice (every segment is labeled by the point it makes, labels are most effective when they state what a resource is good for), and subdivision of labor (an indexer works with the segments of an individual resource producing rich local connectivity, then with another indexer to produce cross-resource connections).

Future work

Our work to date on the ABC school extends in several directions. First, we have established a continuous pipeline of new content acquired during each run of the school. Much of it is video interviews of Andersen partners and clients serving as faculty. We will continue to select and index relevant video

or additional participant-suggested resources for use by future participants. The index maintenance environment makes it easy to position the best of our new content nearest the surface in the indexing structure for easiest access by participants. Over time, less valuable material naturally migrates away from the surface as indexers work the new material into the resource network.

Second, our experiences indexing under the rigorous requirements of the ABC school have refined both our process and our requirements for an indexing tool. We are now engaged in a tool revision to meet some of the near term needs referenced above. We believe the expansion of the tool's capabilities will enable this indexing method to scale in large applications.

Third, our current participant interface only supports information access. We are also engaged in extending the functionality of the IPSL to the other three areas: creating work products, providing tutorials, and supporting collaboration. The current plan is to extend the physical work-setting (a team workspace) into the interface where work products (i.e., flip charts, presentation materials, idea sheets, and notes) can be given new functional characteristics (e.g., a flip chart with bullets and videos on it). Existing tutorial products will be integrated into the same workspace interface and offered as options (e.g., watch a video on how to solve a specific team work problem). We see tutorials as an extension of human coaching at the school. Collaboration among participants and with remote experts is also an element of our plan for this work. We even see possible integration with the Internet in the future--accessing resources, bulletin boards, and other services expanding the repertoire of services participants can use in their work. Indexing of school-relevant content makes such enhancements possible without compromising the time constraints on participants.

Overall, we see significant contributions from content indexed IPSL's in the future designs of training products at ACE. Other ACE programs and courses have already tapped into the ABC index database, extracting content for their purposes. Two other courses are in final stages of development using a similar IPSL approach. The role of indexing continues to grow across our organization as a new strategic discipline for instructional designers.

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