DOCUMENT RESUME

ED 190 154 IR 008 689

AUTHOR Cohen, Karen C.; Klensin, John C.
TITLE Information, Education, Communication--Developing an Innovative System.
INSTITUTION Massachusetts Inst. of Tech., Cambridge. Center for Advanced Engineering Study.
SPONS AGENCY National Science Foundation, Washington, D.C.
PUB DATE 80
NOTE 9p.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Data Bases; *Engineering Education; *Information Retrieval; Information Science; *Information Systems; *Online Systems; *Professional Continuing Education; Professional Development; Thesauri
IDENTIFIERS Project PROCEED

ABSTRACT

This paper describes an innovative information system known as PROCEED (Program for Continuing Engineering Education) which is being developed to assist engineers in coping with mid-career crisis. Research involving components of mid-career crisis indicates that obsolescence or fear of obsolescence is a primary factor. It seemed reasonable that a system involving education, information, and communication focused on delivering problem solving "know how" to the professional engineer relevant to the problem he is currently working on could be of real benefit in updating professionals and increasing their productivity. The resulting interactive system PROCEED is described, including its personalized access system, an associated database, and a set of self-study educational materials. A special feature of PROCEED is the Adaptive Reference System, an interactive series of questions and choices presented to the user by the computer to help him define and refine his problem, so that the system can search its database to find the most relevant and appropriate consultants, aides, or other sources of information to solve it. (Author/RAA)

Massachusetts Institute of Technology
Center for Advanced Engineering Study
Cambridge, Massachusetts, 02139

INFORMATION, EDUCATION, COMMUNICATION - DEVELOPING AN INNOVATIVE SYSTEM

KAREN C. COHEN, Ph.D.
PRINCIPAL RESEARCH ASSOCIATE

JOHN C. KLENSIN, Ph.D
PRINCIPAL RESEARCH SCIENTIST

INFORMATION, EDUCATION, COMMUNICATION - DEVELOPING AN INNOVATIVE SYSTEM

Karen C. Cohen, Ph.D.
John C. Klensin, Ph.D.
Massachusetts Institute of Technology
Cambridge, Massachusetts

Abstract

This talk describes an innovative information system under development at M.I.T. The system is the result of a research and development project originally intended to help engineers cope with "mid-career crisis." Research involving components of "mid-career crisis" indicated that obsolescence and/or fear of obsolescence was a primary factor. It seemed reasonable that a system involving education, information, and communication focused on delivering problem solving "know-how" to the practicing engineer relevant to the problem he is currently working could be of real benefit in updating professionals and increasing their productivity. As we worked further with the problem solving process in engineering we realized that a unique type of information system could serve these needs. The following paper details the challenges which we and information scientists working with us were forced to address in developing the system which we call PROCEED (Program for Continuing Engineering Education).

This work was supported by grants from the National Science Foundation and the Control Data Corporation. The opinions are those of the authors and do not necessarily reflect those of the sponsors.

INFORMATION, EDUCATION, COMMUNICATION - DEVELOPING AN INNOVATIVE SYSTEM

Karen C. Cohen Ph.D.
John C. Klensin, Ph.D.
Massachusetts Institute of Technology
Cambridge, Massachusetts

I. The Purpose of PROCEED

The motivation for undertaking a project like PROCEED (which stands for "Program for Continuing Engineering Education") was to do something to help engineers with or through the mid-career crisis. In the early seventies several scientists and engineers at the Massachusetts Institute of Technology were quite concerned with this phenomenon. A faculty group started to think about the problem, and a main realization was that one very important way of attacking the mid-career crisis would be to attempt to prevent it by devising a new and better system for keeping people up to date. Obsolescence was seen as the crux of the mid-career crisis. The estimated shelf-life of a current engineering degree is ten years or less.[1] Only three percent of practicing engineers in fact participate in regular, organized, updating offerings such as short courses or term-long courses offered in industry, by professional societies, or through universities.[2] Given the documented ninety-seven percent of people who are not participating in any sort of formalized continuing engineering education efforts, it was hoped that if we could devise a system that was more attractive and more useful to the practicing engineer we could help more people update themselves.

General parameters of the system and therefore operating guidelines were that whatever evolved must allow the engineer to deal with problems he was currently working on (so that the motivation would be job-driven rather than by some other need), that it be available to the engineer at his place of work and during the time when he was working, that it consist of components which involved self-study and could be self-paced, and that - of course - it be appropriate, accurate and convey the best state of the art for each covered.[3]

II. The Content of the System

Given these guidelines we realized if we were to help the practicing engineer our thrust should abet the problem solving process that engineers actually go through. We therefore went out and tracked over two hundred real worked solutions in one topic area, industrial energy conservation. In the process of tracking these problems and their solutions we were interested in discovering:

- what kinds of things people had to know and do to solve them,
- what kind of processes they went through,

This work was supported by grants from the National Science Foundation and the Control Data Corporation. The opinions are those of the authors and do not necessarily reflect those of the sponsors.

- who they contacted,
- when they contacted them,
- when they hit dead ends, what they did, and
- how they worked through to the final solution.

This enormous set of data, based on empirical solutions to real energy conservation problems gathered from thirty-five different industries throughout the United States, then, became the basis from which we developed the framework of our system. There are three major components in the system itself: the first is a personalized access system, the second is an associated data base, and the third is a set of self-study educational materials.

The Adaptive Reference System

The purpose of our Adaptive Reference System is to help the individual define and refine his problem so that the system can search its data base to find the most relevant and appropriate consultants, aides, educational informations, etc. to solve his/her particular problem. To the user it is an interactive series of questions and choices presented to him by the computer to which he responds by using simple commands. The user is shown what the commands stand for, so other than knowing how to log in on any kind of terminal, he need not know how to use computers.

Hidden to the user is an elaborate hierarchical tree-like structuring of the problem solving process which guides his search and helps locate the precise sets of information which are appropriate to the problem.

The Associated Data Base

Consists of files of information, including sets of consultants (accessed by location and capability), educational materials, bibliographies, special purpose laws and standards, product and vendor data to name but a few. When the user has placed his problem in a particular part of the problem solving process, he or the system will search the data base to come up with the type or types of information required to help work the solution.

The Educational Modules

To which the user may be referred to by the search consists of a full set of self study, competency-based materials. Each is 100-150 pages long and can be ordered through the system. We are also experimenting with electronic delivery. There are also case studies and other materials such as videotapes.

III. The Information Science Challenges in Making it Function

The most interesting information science challenges we faced (and are still facing) in making a consistent, coherent, and useful system involve the Adaptive Reference System. This system uses mechanisms well known to the information scientist, but it uses them in novel ways. First, in our application, we borrow from the concept of an on-line hierarchical thesaurus system (Salton, et al,)[4] using the thesaurus at retrieval time. Traditional uses of a thesaurus at storage time to enrich a data base do not permit flexibility in changing structure or adding synonyms without rebuilding the entire document data base.[5] Our system does. Second, the content of the thesaurus is, itself, novel. Rather than being a classical hierarchical dictionary, it is organized along the lines defined by problem solving techniques in the discipline.[5] Consequently, rather than reflecting ordinary words and hierarchical relationships among them, it reflects increasing levels of detail and stages of the problem solving process. Nodes closest to the root are associated with the most general terminology of problem solving models, e.g. "analysis of the problem" or "synthesis of a solution." As we move further from the root, the terms become much more specific to the problem area, e.g. "retrofitting a boiler." Beyond this peculiar type of definition structure, the thesaurus itself is quite conventional.

The use of the thesaurus, however, is novel. Conventionally, a hierarchical thesaurus is used in one of two ways: 1) Key words are given with a set of Boolean operations, documents are selected that match each key word, and '' i the lists of documents selected are unioned or intersected . juired.[6] Systems with key word retrieval but without the Boolean operators are, from this standpoint, simply trivial cases. 2) The alternative has been to use the thesaurus, perhaps in some combination with an explicit user scheme to assign weight to individual key words or groups of key words.[7] For example, one might decide that, if a document matched a particular key word, it was to be retrieved, regardless of what other key words did or did not appear. If the key word did not appear, then retrieval of the document would require the appearance of two or more of the other key words on th user defined key word list. Such weights can be part of the thesaurus itself, associated with the concepts there, or they can be assigned by the user as he estimates their relevance. Both approaches are well suited to batch retrieval in which the user prepares a series of queries, leaves them to be processed by a computer and picks up the results later.

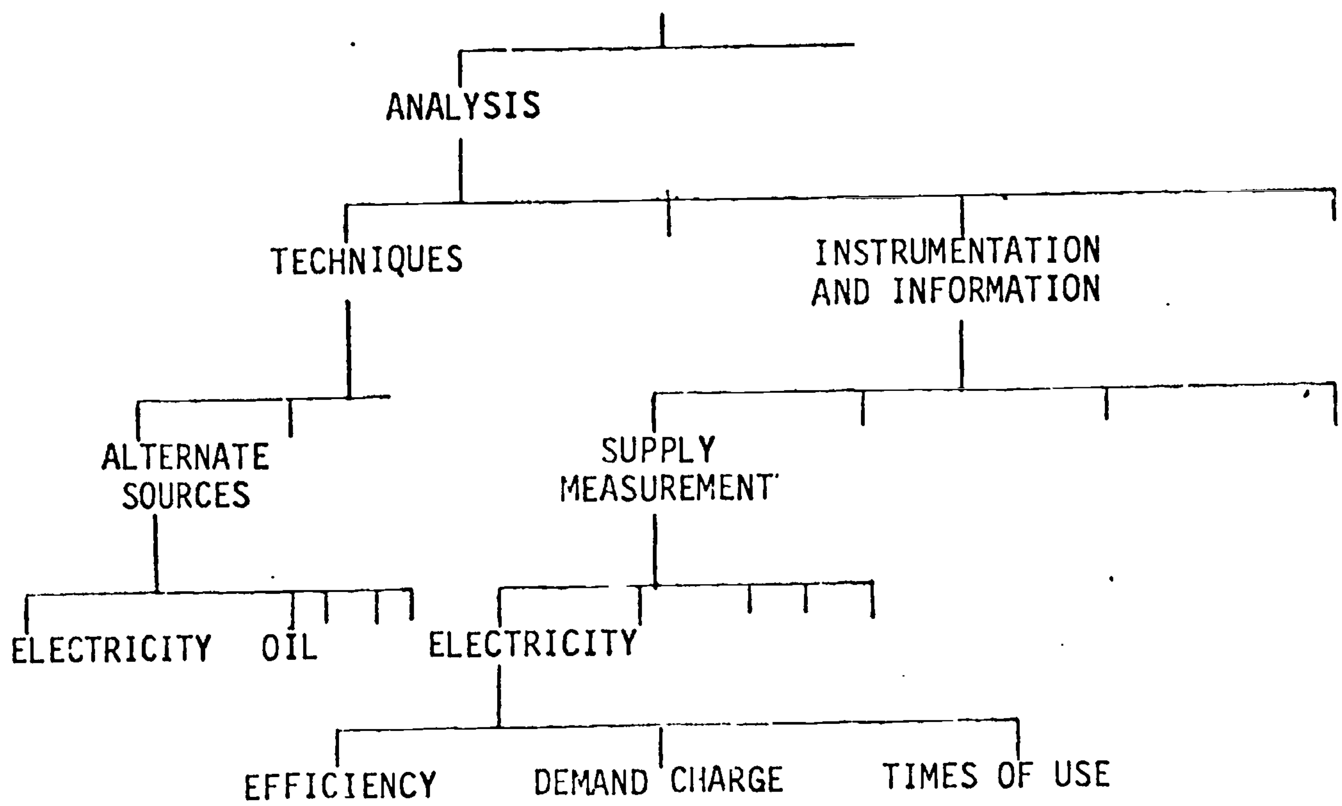
For our adaptive reference system, we chose to create an interactive environment in which the user would participate in the concept selection process. As a result, we use a hierarchical structure based on the assumption that the intent provides us far more information about interrelationships and problem solving steps than any particular classical thesaurus. In particular, we assume that we should be able to uniquely identify both the next need of the user and specific content modules or pieces of information through each position on the hierarchical structure. Our goal is not one of identifying the set of concepts that seem applicable to a particular query, but of locating the user's requirements at one single concept.

Table I. Sample Adaptive Reference System Concepts

technology	shift schedules
plant operation	peak bills
maintenance	boiler-pressure
controls	

This is a very stong assumption that deserves testing in whatever ways we can devise to test it. A particular key word provided by the user may , and typically will, appear in the thesaurus associated with several different concept nodes. We resolve ambiguities in the association between such a keyword at a particular position in the structure by querying the user about the context in which the various instances of the keywords appear. The context itself is derived from the structure. This is done by first selecting a pair of nodes at which the keyword exists and searching at more general levels until a common node is found. We then assume that the nodes one more specific(i.e. back toward the user-supplied keyword) define the context for distinguishing between the uses of the keyword. Special provision must be made when there are no intermediate nodes, such as assuming that the referenced keyword provides its own context. We have found that this does not cause a severe problem if the keywords that are likely to be selected by the user are synonyms for more detailed explanations of the meaning of each node. An example is illustrated by Table II.

Table II. On Locating A Context



The assumptions required are either reasonable or unreasonable depending on what is contained in the thesaurus. If the thesaurus is a conventional grouping of terms, the assumptions may be unreasonable. If, on the other hand, those terms are grouped so as to represent a problem solving structure that is reasonably compatible with the user's problem solving model, then encouraging the user to walk through the structure to find the relevant node may be very effective.

In addition to the location-finding facilities described above, the adaptive reference system also provides the user with some additional unusual capabilities once a general focus of inquiry is found. Since, in principle, each node of the thesaurus is associated with educational materials or references at some level of detail, the user may examine the structure to find topics and materials that are more general - essentially going up the tree toward the root - or more specific - examining the descendents of the same parent in geneological terms -

or may examine all or a major portion of the problem solving structure by repeatedly descending from the root.

The following drawing outlines the system components.

I

ADAPTIVE
REFERENCE
SYSTEM

II

ASSOCIATED
DATA
BASE

III

EDUCATIONAL
MATERIALS

Table III. Schematic of PROCEED

Perhaps the most innovative feature is the adaptive reference system which interacts with the user in defining his problem precisely. The system or the user can then search the data base for highly specific and hopefully appropriate sets of information and relevant materials to help with finding a solution. The problem solving process orientationof the system encouraged our developing a new kind of hierarchical structure such as the one just described. The essence of the uniqueness is that processes and procedures define the hierarchical arrangements rather than words.

Through borrowing heavily on many traditional information science structures and imposing the notion of process orientation we have developed something a) that is new and different, and
b) that works in an R and D setting.

In a few months we will know how helpful this system is in the actual world when we attempt to have users work with it in their own companies and on their own current problems.

NOTES

1. Kaufman, H.G. (1974) "Factors Affecting the Relationship Between Continuing Education and Performance," in National Science Foundation, Directorate for Science Education, Continuing Education in Science and Engineering, Government Printing Office, Washington, DC.

2. Morris, Albert J. (1978) The Return on Investment in Continuing Education of Engineers, NSF Grant No. EPP75-21587, Genesys Systems, San Francisco.

3. Cohen, Karen C., "Making Education and Training Impact on Industry," Proceedings of Second Annual Conference on Industrial Energy Conservation Technology, Houston, Texas, 1980.

4. Salton, Gerald, Automatic Information Organization and Retrieval, New York, McGraw-Hill, 1968. pp. 38 ff.

5. Battelle Columbus Laboratories, BASIS Thesaurus Guide, August, 1979.

6. Salton, op cit, pp 388-392, pp. 221-228.

7. Lancaster, F. Wilfrid, Information Retrieval Systems: Characteristics, Testing and Evaluation, Second Edition, New York: John Wiley & Sons, 1979. pp. 172-175.

"Adaptive Research System" (set of tools on which it is based)

Rogers, Rosemarie and Elaine C. Franklin, The Project Diana Automatic Document Encoding and Retrieval System, Cambridge Project TR74-1, Massachusetts Institute of Technology, 1974.

Klensin, John C., editor, Consistent System Handbook of Programs and Data, Laboratory of Architecture and Planning, Massachusetts Institute of Technology, updated periodically.