Coating Industry Knowledge Base Systems

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An Introduction to the SSPC Knowledge Center and the NIST Computer Integrated Knowledge Systems Network.

Introduction .

This presentation provides information about the proposed SSPC Coatings Knowledge Center and activities of a national program for a computer integrated knowledge systems network administered by the National Institute of Standards and Technology.

What is a Knowledge Base?

A knowledge base is a body of knowledge. In the context of this presentation, a coatings knowledge base is a series of integrated databases or applications that present to the user expert advice on coating system selection, surface preparation methods and similar topics. Though the session in which I present this introduction to coatings knowledge bases focuses on computer applications it is worth noting that other, traditional, media can play a strong role in a coatings knowledge base

What Goes Into a Knowledge Base System?

The typical content of a knowledge system is the combined expertise of others. This makes a knowledge base system similar to the electronic version of a specialized encyclopedia on a given topic. What distinguishes the knowledge system from traditional

media are the technical underpinnings and method of presentation of data. To help understand this difference it is best to examine an existing knowledge base system and understand what went into its making.

An Example of an Existing Knowledge Base System - HWYCON.

An example of a highly integrated knowledge base system is provided by the HWYCON expert system intended to improve bridge construction. The following is quoted from the Web Page for HWYCON taken from the NIST World Wide Web server at the following address: <http://www.bfrl.nist.gov/bfrlnews/v1n2.html#highway>.

Highway Concrete Expert System (HWYCON) Moves into Classrooms .

"As decision-making expert systems make their impact on the construction industry, a useful tool is HWYCON.

This computer-based system was created by BFRL's Lawrence Kaetzel and James Clifton in the Building Materials Division (BMD) as part of the Strategic Highway Research Program's "Optimization of Highway Concrete Technology." Key to HWYCON's oper
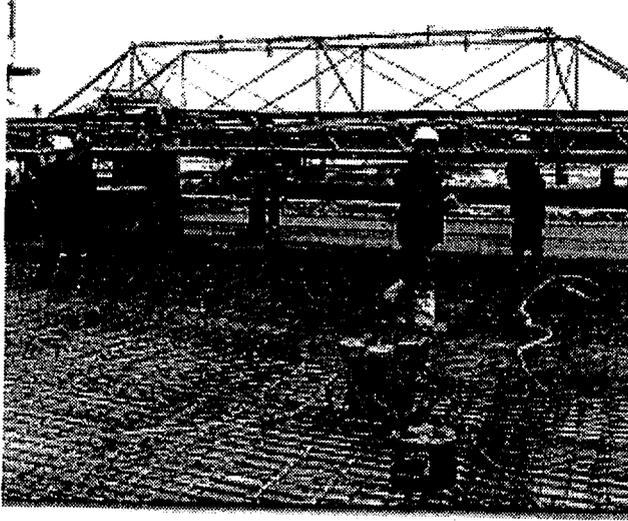
FIGURE 1. HYWCON Assists in Bridge Construction Options

ation is a base of expert knowledge, visual data (photos and drawings), and reference details on concrete pavements and structures. These elements serve three functions:

1) identifying distress and performing diagnoses;

2) selecting materials for construction; and

3) offering guidance on materials and procedures for many repair techniques.

HWYCON is designed to assist state transportation departments in the evaluation of condition of highway concrete in pavements and bridges. Given its expert knowledge, HWYCON is easily adapted for engineering classroom use.

Using HWYCON is akin to consulting an expert or mentor. The user first accesses a question-and-answer mode to identify a problem; at the end of this mode, the system offers conclusions or recommendations. The system also may use probabilities to quantify the validity of conclusions. The system suggests further tests to confirm its conclusions, or suggests consulting a materials expert. For all these steps, HWYCON demands Windows 3.1- equipped computers. As for classroom use, a typical application is in a University of Illinois graduate Civil Engineering course on durability of construction materials. The course is focused on the range of construction materials, and a key objective is to identify processes leading to materials deterioration and to adopt responses to its effects. Using HWYCON, which appeals to students because

it is interactive, instructors find its graphic and visual modes offer an added dimension in presentations."

Elements from Our Example.

The key elements from this example are that:

1. The system is computer driven

2. The system contains a base of expert knowledge, and

3. The system provides a means for providing answers to many types of questions

How Does The Knowledge Base System Function?

A knowledge base system functions by filtering the available knowledge in the database in response to a question posed by a user. Most commonly this is done by using Structured Query Language (SQL) requests of the database. SQL is simply a way to present questions in a way that a machine will understand without imposing on the user too many arbitrary constraints. SQL queries differ from the type of question you might ask in everyday life - which I will call natural language queries. The differences between these two approaches are implicit in their titles.

1. SQL queries are STRUCTURED they follow rules in which the parts of a query are combined.

2. Natural language queries are the type of question you might pose in everyday life.

To help a user frame an SQL query the knowledge system will ask preliminary questions to frame the scope of the user information request. If this is not done then any inquiry may lead to a large number of possible suggestions or solutions.

For instance, a typical user inquiry may have the general form

Question - What coating System should I use?

This question is far too broad, the knowledge system needs additional information to process the request. These needed information points are obtained **before** the user poses the simple question above. They both filter the range of data the knowledge base system presents to the use, and help form the final SQL presented to the knowledge base system.

Knowledge Base System Inquiries to User.

The first type of question asked is where and how the coating system is used. It is widely recognized that the severity of exposure to the elements and environmental stresses narrows the range of available options for coating system selection. The better the eventual exposure is defined, the fewer applicable systems the knowledge base system presents to the user. Let us look at a series of questions for new steel structures, Figure 2, below.

In the given example the user is asked the questions in a serial fashion. The knowledge base strings together the responses and options chosen to present only that information from its data sets which matches the form of the inquiry. In actual use the user will make these choices from an interface which will have all these options available.

What Does the Knowledge Base System Need To Function?

The knowledge base system needs -- knowledge. It should have access to the combined relevant expertise of the industry it seeks to serve. To provide a relevant match for the user inquiry the following types of data are required:

1. Knowledge about the compatibility of different combinations of surface preparation and coating materials.

2. Knowledge about the performance of these compatible combinations in a variety of environmental exposures.

3. Knowledge about the anticipated costs for applying these materials on new steel.

4. Knowledge about the anticipated costs of application on existing steel (maintenance).

The knowledge base system also needs a way to serve the information to a user. It needs a database engine which will handle complex structured inquiries.

The knowledge base system needs a way to filter a user query to reduce the volume, and increase the relevance of the knowledge base system response. It needs an easily understood user interface where preliminary questions are posed to the user.

What is the Current Status of the Coatings Industry Knowledge Base?

These are very early days for the Coating Industry Knowledge Base System (CIKS). Several activities are underway to help provide the needed knowledge, data verification, modeling assistance and data presentation requirements.

1. A technical committee on Knowledge Base Systems (C 4.10) has been constituted at SSPC.

2. The C 4.10 committee has surveyed the membership of SSPC to determine the level of computer expertise in and types of operating systems used by the SSPC membership.

3. A review is under way to determine the types of data sources available for inclusion in the CIKS.

4. The SSPC Coating Knowledge Center activities are carefully integrated with the activities of the C 4.10 technical committee.
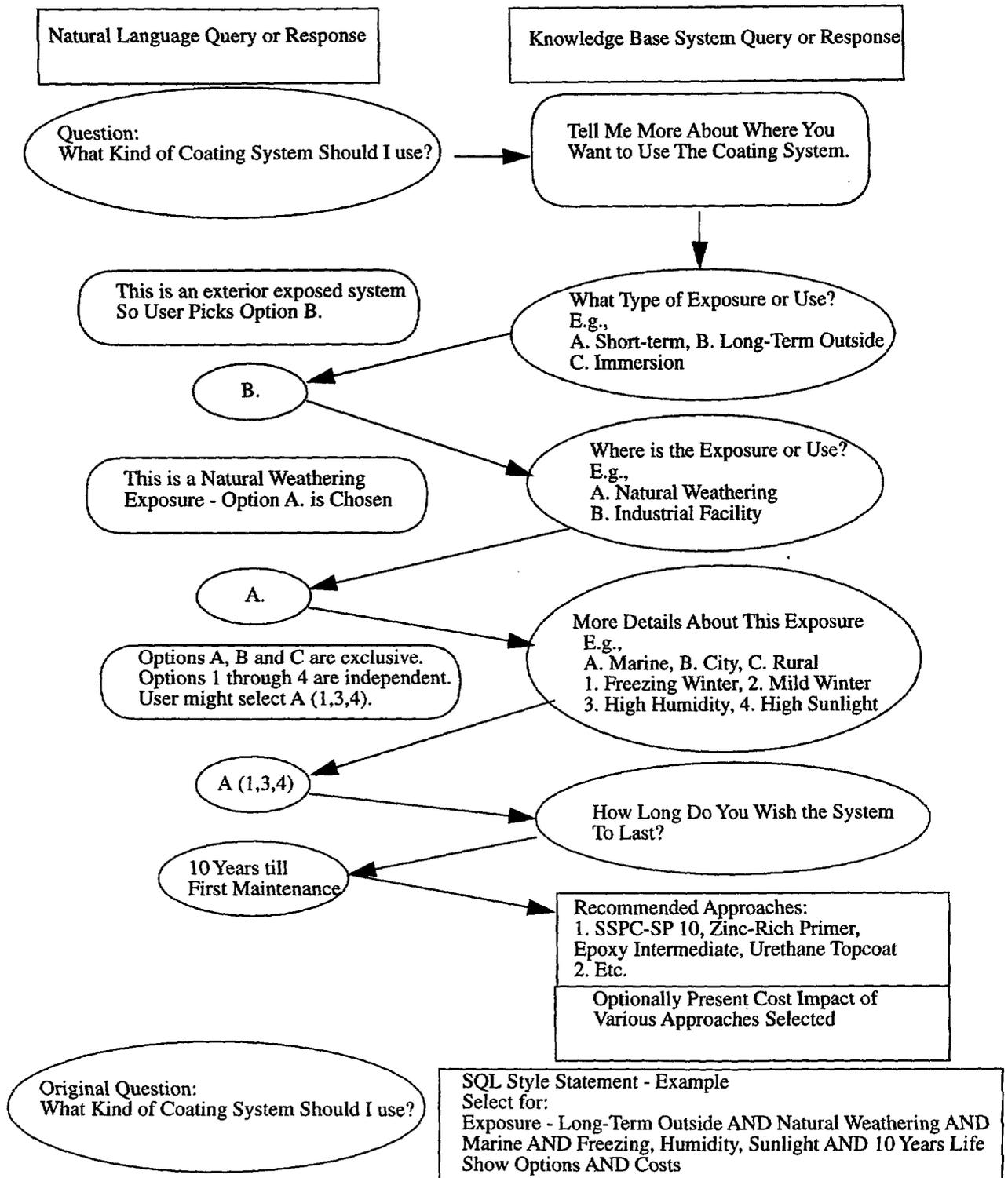
What Systems Do Are Members Use?

The vast majority of the users surveyed by the C 4.10 technical committee have access to a modem (72%) or a direct Internet connection (55%) whether via modem or through their company. (In an earlier survey of the SSPC membership the number were 45% and 30% respectively).

Reflecting current market statistics published by trade magazines in the computer industry there is a dominance shown for software running on the Intel-CPU platforms, Windows, DOS and Windows 95 - approximately 90% of all reporting users. Some 12% of reporting users have or use Macintosh operating systems, while a few users report access to Unix operating systems.

It would be easy to respond to these numbers by developing a product which only worked on Windows platforms. This is probably an error - we should not be excluding users, nor forcing them to employ a proprietary system, regardless of its current wide distribution. More to the point, such an exclusive policy is not required. While a stand-alone application might only run on the Windows platform a better approach might leverage the growing audience of users on the Internet.

FIGURE 2. Preliminary Questions Posed to a User by A Knowledge Base

| Natural Language Query or Response | Knowledge Base System Query or Response |

Question:
What Kind of Coating System Should I use?

Tell Me More About Where You
Want to Use The Coating System.

This is an exterior exposed system
So User Picks Option B.

What Type of Exposure or Use?
E.g.,
A. Short-term, B. Long-Term Outside
C. Immersion

B.

This is a Natural Weathering
Exposure - Option A. is Chosen

Where is the Exposure or Use?
E.g.,
A. Natural Weathering
B. Industrial Facility

A.

Options A, B and C are exclusive.
Options 1 through 4 are independent.
User might select A (1,3,4).

More Details About This Exposure
E.g.,
A. Marine, B. City, C. Rural
1. Freezing Winter, 2. Mild Winter
3. High Humidity, 4. High Sunlight

A (1,3,4)

How Long Do You Wish the System
To Last?

10 Years till
First Maintenance

Recommended Approaches:
1. SSPC-SP 10, Zinc-Rich Primer,
Epoxy Intermediate, Urethane Topcoat
2. Etc.

Optionally Present Cost Impact of
Various Approaches Selected

Original Question:
What Kind of Coating System Should I use?

SQL Style Statement - Example
Select for:
Exposure - Long-Term Outside AND Natural Weathering AND
Marine AND Freezing, Humidity, Sunlight AND 10 Years Life
Show Options AND Costs

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What Data Sources and Systems Are Available for the CIKS?

Data sources available to the C 4.10technical committee and CIKS fall into these categories:

1. Consensus opinions on coating performance and on coating costs (e.g., tables from Volumes 1 and 2 of the Steel Structures Painting Manuals, the system recommendations in documents under development by ISO TC35 SC14).

2. Historical data on coating performance from SSPC Research.

3. Historical data on coating performance from other non-manufacturer sources (e.g., US NAVY, State Highway DOTs, US Army CERL).

4. Historical data on coating performance from manufacturers of coating products.

Systems that CIKS may examine include:

1. The database engine and expert system used to develop HWYCON by NIST. (For presentation of a CIKS on a desktop computer - probably Windows operating system).

2. Custom database solutions for system selection such as CounselWare™ system selection and specification writing software.

3. Custom database solutions for system cost comparison and selection such as the Spec-Mate™ software.

4. Other systems identified by technical committee C 4.10 such as Butler/SQL - particularly useful for offering the CIKS in a platform independent manner to the widest possible rang of users.

How does the CIKS work with the SSPC Coatings Knowledge Center?

The CIKS concept can become one of the tools available for the SSPC Knowledge Center. The concept of the SSPC Coatings Knowledge Center is more far reaching than an expert system. It includes other tools and different methods of data presentation.

Components of the SSPC Coating Knowledge Center.

The SSPC Coating Knowledge Center - SSPC-CKC has the goal to provide access to the world's coating knowledge base. Note, this does not mean that the CKC will have all the data on coatings in one giant repository. There will be substantial quantities of coating and coating related information available to

members through the CKC. Still, where others have provided excellent resources that meet all a users needs, there is no need to reinvent the wheel. What a CKC should do is either hold or point to the best sources of information on a topic. Thus we would not replicate all the EPA's information on VOC regulations, rather we would be able to tell a user where to go for that information. The SSPC-CKC might have some or all of the following components to meet its goal of holding or pointing to the world's coating knowledge:

- Types of Media for Data Presentation

  1. Desktop Computer Based - typically platform independent portable digital documents as readable solutions, or platform dependent database solutions.

  2. Networked Computer Based - typically information accessed by a user over a modem via the Internet, probably over the World Wide Web. This type of presentation could provide a platform independent version of the CIKS.

  3. Hard Copy - deliverable via FAX transmittal. A FAX back system with the capacity to deliver individual copies of standards, or answers to frequently asked questions.

  4. "Soft" Hard Copy - deliverable via the Internet as Portable Document Format (PDF) files by user interaction with a web browser.

  5. Traditional Hard Copy - Books, magazines, newsletters.

  6. Phone lines for answers to technical inquiries - potentially a 1-800 number service. A human answering service.

- Vehicles for Data Presentation

  1. Traditional Hard Copy - via US Mail.

  2. On Disk or CD-ROM - particularly for Standards and Technical Reports.

  3. Via the World Wide Web - particularly if individual copies of documents are requested as PDF files.

  4. Via FAX-Back - again particularly well suited for single copies of material.

- Forums for Technical Inquiry & Answer

  1. SSPC's WorldWide Web Bulletin Board Service.

  2. The CIKS List-Server, recently launched and under development.

  3. The FAX-Back services noted above.

  4. The phone inquiry services noted above.

- Methods of Pointing to Other Available Resources

    1. Coatings Links Pages on the SSPC Online Site.

    2. A Listing of Available Resources in Hard Copy Form.

Current Status of the Coatings Knowledge Center.

The cornerstone of the SSPC-CKC is the SSPC Online site - which I describe in greater detail in another paper. From this site we can provide to Internet connected members all of the requirements to fulfil the CKC. We believe that the number of SSPC Online users will continue to grow, making the Online site the core of a Coatings Knowledge Center. The SSPC recognizes that not all members currently possess the required Internet connection to make use of this site. That is why our vision of a Coatings Knowledge Center includes access to traditional media.

To help SSPC control costs in providing materials in a variety of formats to a number of users with differing needs takes care. Our documents are in the end the primary source of information that a user will access. Thus we a re working to make our documents production efforts smoothly integrated with available and anticipated delivery systems. This means that SSPC can realize an efficiency of document production costs. All our documents are first reduced down to an electronic format. With appropriate software - such as Adobe FrameMaker™ and Adobe Distiller™ - it is possible to take these documents and make perfect electronically distributable materials for either the Web, a CD-ROM or for a FAX-Back service. SSPC realizes a three for one economy of effort and lowered costs for document distribution. You the user realize lower costs and higher flexibility for document acquisition.