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Expert Systems: OSHA's Interactive Advisors Project

William J. Daniels and Stanley Salisbury, Column Editors

Reported by Edward Stern

Expert systems are software tools that simulate the decision-making processes of knowledgeable people or "experts." The software can do this because it has captured the reasoning and logic of the experts into rules. For example, *if* a worker can enter bodily into a space, *and* the worker can perform work in that space, *and* the space has physically restricted entry, *and* it is *not* designed for continuous use, *then* it is a confined space under Occupational Safety and Health Administration (OSHA) rules. (This example is an approximation of the specific OSHA confined space rules.)

By pulling together the dozens or hundreds of decision rules used by an expert to determine a matter, it becomes possible to assist the nonexpert in making an expert decision. Needless to say, the nonexpert doesn't want to read, absorb, and apply all of those rules if he or she can avoid it. The trick is to use expertise without first having to become an expert. The expert system prompts the user with questions on the computer screen to gather facts to determine which conclusions are appropriate for the user's case.

In its simplest terms, expert systems have two primary components: a knowledge base and an inference engine. All the decision rules make up the knowledge base. It is the part of the system that has the required knowledge to help the user make a correct decision. Much like an engine draws a train, the expert system's inference engine draws the appropriate inferences from the answers provided by the user. The inference engine is the locomotive that pulls all that logic (the knowledge base) through the path of the user's facts. A well-designed inference engine does not go any farther than it must. It avoids asking unnecessary questions and only follows up when it needs more information to arrive at its concluding destination.

A regulation is information. Facts of a situation are information. However, the ability to determine how or whether a regulation applies to a set of facts is expertise. It is this expertise that people want and need. By using expert systems computer software, this expertise can be shared with many users. A particular advantage of such tools is efficiency in following only those lines of questions that are needed to resolve issues. By contrast, to know how a regulation applies, a reader ordinarily has to read all of it to find what applies and what does not. A user of an expert system only has to cover the areas that relate to the user's facts. The user does not have to know all about the regulations in advance!

OSHA began cautiously to look into the use of expert systems to provide help to the regulated community. It issued GOCAD, the cadmium biological monitoring advisor, in 1994, the Asbestos Advisor in 1995, and the public test "beta" version of the Permit Spaces Advisor (renamed Confined Spaces Advisor) in 1996. Public enthusiasm for GOCAD encouraged the effort for the Asbestos Advisor. The overall acceptance by the regulated community for these products has encouraged OSHA to continue work on other interactive expert tools.

OSHA is now in the process of developing several expert systems, including advisors for lead in construction, fire fighting and emergency evacuation, and lock-out/tag-out (all scheduled for beta testing this year). This is appropriate because resolving occupational safety and health issues can be highly technical. Solutions are often not intuitively obvious. There are other areas of occupational safety and health that are not inherently complex, but which have different requirements for different workplace practices and situations. OSHA can address some of these difficulties through interactive advisors.

OSHA creates these advisor tools from several materials. It starts with the regulation and its interpretations and clarifications. It also uses materials from mandatory and nonmandatory appendices to regulations and from studies containing information of value to employers. OSHA has shared early rough cuts of these tools with representatives of interested trade associations and labor organizations. Labor and industry officials and their lawyers raised questions and suggested improvements. OSHA and its attorneys used these suggestions and refined the tools to share them with a larger audience in a public testing, using downloadable beta versions on the OSHA web site (http://www.osha.gov/oshasoft). So far, only a small fraction of the people who downloaded the advisors have responded with comments by mail, e-mail, or phone. These have been thoughtful, useful comments which OSHA has used to polish the final products.

Most of the topics addressed in the advisors have been recommended by OSHA's senior managers, executive staff, and attorneys (Charles Adkins, John Martonik, Tom Seymour, Leo Carey, Ray Donnelly, Marthe Kent, and Charles Gordon). The Lead in Construction Advisor was first requested by the National Multi Housing Council and later by various industry and military callers. The departmental experts who advise on the development of the advisors come from the OSHA Directorates of Health Standards Programs, Safety Standards Programs, Compliance Assistance, and Technical Support and Policy, and from the standards and litigation sides of the Occupational Safety and Health Division of the Solicitor's Office.

The following review of the Permit Spaces Advisor offers insight on the latest of this systems software, which is designed to help the regulated community interpret and comply with OSHA standards.

A Review of OSHA's Permit Spaces Advisor (Beta Public Test Version)

Reported by Stan Salisbury

The Permit Spaces Advisor (PSA) (soon to be renamed Confined Spaces Advisor) is the latest in a series of expert systems rule-based software applications being offered by OSHA as freeware to the general public. The PSA is a run-time appli-

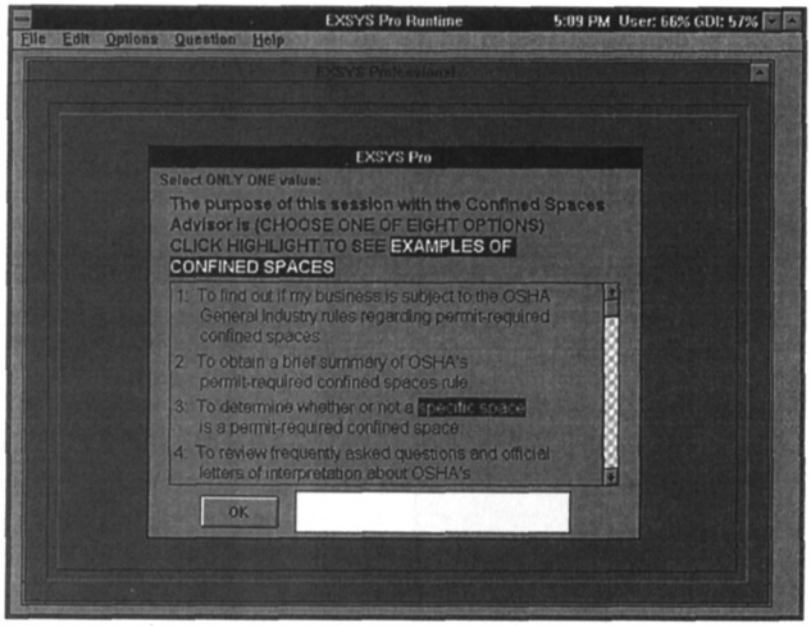

FIGURE 1. PSA: initial options screen.

cation developed by Dyncorp and Consad Research Corp. using an off-the-shelf version of EXSYS Professional from EXSYS Inc. It has a similar look and feel to OSHA's Asbestos Advisor, but the PSA is OSHA's first advisor tool to run under Windows® 3.1, 3.11, or Windows 95. At the time of this review, a beta test version of the PSA (dated March 20, 1996) was available for download from the Labor–News BBS and from OSHA's web site at http://www.osha.gov/oshasoft. The PSA is also included on the 1996 June and September releases of OSHA's CD-ROM. OSHA was asking potential users to download and test the product before its final release.

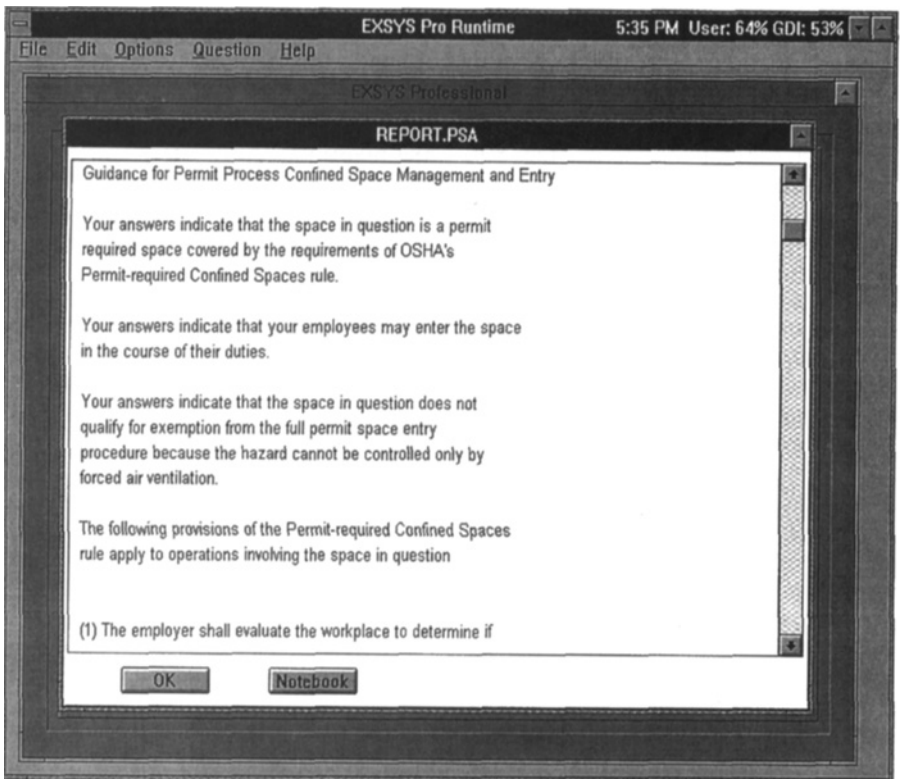

FIGURE 2. PSA: guidance report.

Although it is still a little rough around the edges, the beta-test release was easy to install and offered a good example of how OSHA is employing expert systems software to help the regulated community understand the technical requirements of the permit-required confined spaces standard (PRCS) (29 CFR 1910.146). PSA is downloaded as a compressed, self-extracting zip file (PSA.EXE). Download time is fairly quick because the file size is less than 1.4 MB, which, if desired, can be saved to a single 3.5-inch floppy diskette. To install PSA, the user must manually create a directory (a folder for Windows 95 users) on their PC's hard drive, copy the PSA.EXE to this directory, and run PSA.EXE to expand the compressed files. Once expanded, the program files consume only about 3.2 MB of disk space (after deleting the original PSA.EXE file). Windows 3.1 or 3.11 users must then create a new program group using the Windows Program Manager and key in the C:£SA£SA.GRP file name to create a group window containing the PSA icon. Windows 95 users need only run the PSA.GRP file using the Windows 95 Start menu, which automatically creates a new entry and icon in the Windows 95 Start menu. The PSA icon properties contained in the PSA.GRP file expect the PSA files to be saved to C:£SA.

After creating and clicking on the program icon, the program brings up an introductory statement. To continue, the user clicks a continue button to load the initial options window (Figure 1). This load can take up to 30 seconds on a 486-33. Once loaded, the user is asked to select one of eight options to help the user: (1) find out if their business is subject to the PRCS; (2) obtain a brief summary of the PRCS rule; (3) determine if a space is a confined space that requires a permit; (4) review frequently asked questions (FRQs) and letters of interpretation on the PRCS; (5) review a glossary of PRCS technical terms; (6) print or obtain a text file copy of a PRCS checklist or permit form; and (8) obtain guidance on selected special topics. Only one option

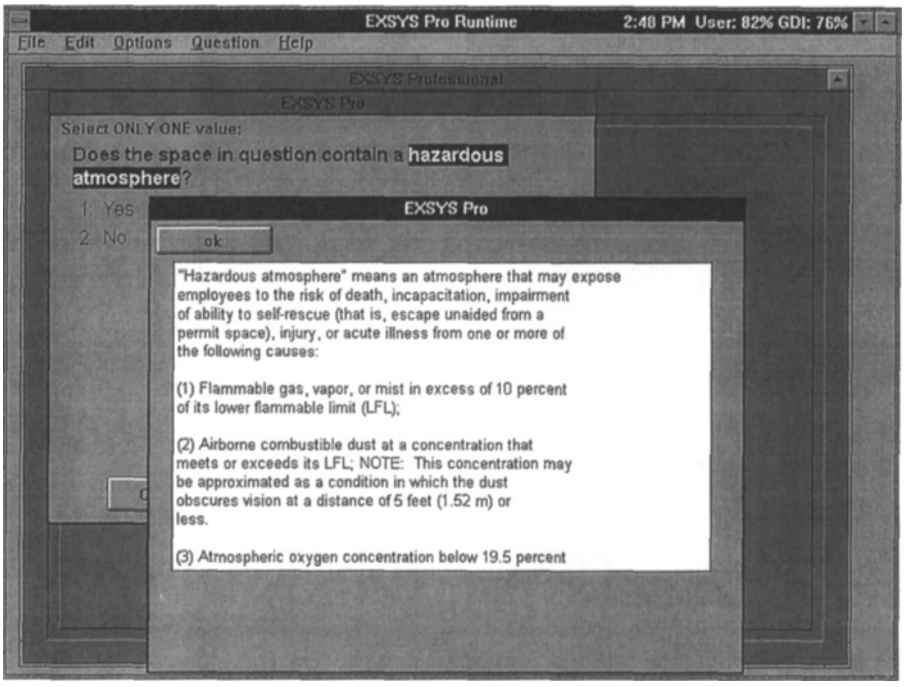

FIGURE 3. Hazardous atmosphere definition screen.

should be selected. Selecting more that one will lock up the program.

The heart of the program is based on selecting option 3. Here the user is questioned to determine if the space in question is a confined space. Once that is established, additional questions are answered to determine if permitting is required by OSHA. Some questions have keywords highlighted. Clicking these keywords will bring up clarifying definitions. Questions can also be clarified by clicking "Question" on the pull-down menu bar and then clicking "Explain."

After the user answers all questions, the PSA displays specific guidance on what actions are needed to ensure OSHA compliance (Figure 2). This guidance consists of a review of the answers given for the session, followed by a summary of what the answers indicate. Appended to this text is a numbered checklist stating what the user must do to comply with the PRCS regulations for the specific space described, followed by the text of all provisions of the PRCS rule that apply.

At this point, the PSA session is finished and the user is given the option to rerun the PSA for additional spaces. Session results are saved to an ASCII text file under the name REPORT.PSA. The user must copy or rename this file; otherwise, subsequent running of the PSA will overwrite the report.

For the most part, the PSA works as expected, but in the beta-test version a few problems were noted. However, by the time this article is published these bugs will probably be corrected. The final release is expected by January 1997. One problem is that on slower 486 PCs some of the knowledge bases take considerable time to load. For example, selecting option 4 from the opening screen (FRQs and letters of interpretation) requires nearly 2 minutes. During that time there is no visible movement or hourglass cursor indicating that any activity is taking place. The most common user reaction would be to think the program is locked up. The user is advised to be patient if using anything slower than a Pentium processor. Only 21 seconds is needed to display this screen when using a Pentium 90. Another problem is that some windows contain text that extends beyond the display window, but no scroll bar is present to prompt the user to read all the information presented. For example, when clicking the highlighted text on a question asking if the space contains a hazardous atmosphere, the definition displays only the first three of five conditions that must be considered (Figure 3). As a result, the user could easily make an incorrect decision. Elements 4 and 5 describe atmospheres containing toxic contaminants, whereas elements 1, 2, and 3 discuss explosive hazards, combustible dusts, and oxygen deficiency. This problem has been corrected by OSHA for the final release. As a reminder, the beta version of the PSA is for testing purposes and users are not to rely on the guidance it provides.

The general impression from using this latest of OSHA's expert system applications is that it is an excellent learning tool. It does a good job of letting the OSHA regulation deal with the user instead of the user attempting to deal with the regulation. After a few sessions with the application, the user should be able to learn from it and eventually apply its guidance without even running the program, thereby becoming an expert on PRCS rules as they apply to his or her specific areas of responsibility.

EDITORIAL NOTE: Edward Stern is the Expert Systems Project Manager with the Department of Labor, Occupational Safety and Health Administration, Washington, DC. Stan Salisbury is the Director of the NIOSH Atlanta Field Office, Division of Surveillance, Hazard Evaluations, and Field Studies, Atlanta, Georgia 30333.