CAD expedites major safety project

Compiling a hazop review for a large refinery and petrochemicals complex that is over 20 years old is no mean task. *Jim Tysiak* and *Larrie McCollum*, faced with a tight development schedule, describe how they set about it using a standard industry CAD package

The Uno-Ven Company owns and operates a refinery located about 20 miles south-west of Chicago with 750 employees and a crude oil capacity of approximately 150,000bpd. The company is jointly owned by affiliates of UnoCal Corporation's Union Oil Company of California and Petroleos de Venezuela. Refinery products include gasoline, diesel fuel, aviation turbine fuel and home heating oil, and a petrochemicals complex on the site produces speciality solvents such as xylene and toluene, plus a range of other products.

The adoption of a recent Occupational Safety & Health Administration (OSHA) regulation requires Process Hazards Analysis or Hazard Operability ('hazop') reviews of many petrochemical processes. Even before the regulation, Uno-Ven was moving ahead in the field of process safety management and has been reviewing the refinery's processes for potential dangers.

The hazards

Some of the primary hazards in petroleum refining are:

- flammability of crude oil and products manufactured from it;
- toxic hydrogen sulphide by-product of desulphurisation, and
- high process temperatures and pressures.

As part of Uno-Ven's commitment to maintaining a healthy environment for its employees and neighbours, the company has instituted a process safety management programme encompassing a wide spectrum of activities such as employee training, emergency preparedness, fire protection and – most importantly – operating and maintenance procedures designed to prevent incidents occurring in the first place.

On February 26 1992, OSHA regulation 29 CFR 1910.119 was adopted. A portion of this regulation requires certain petrochemical processes to be subject to a Process Hazards Analysis (PHA). One of the widely recognised PHA methods, hazop, provides a detailed and systematic review of every part of the refinery operation.

A hazop team typically includes a technically skilled manager responsible for leading and reviewing the process; a process engineer to resolve technical issues; a secretary to record the results of the review, and operations and other employees to provide qualified on-the-spot operating information and experience.

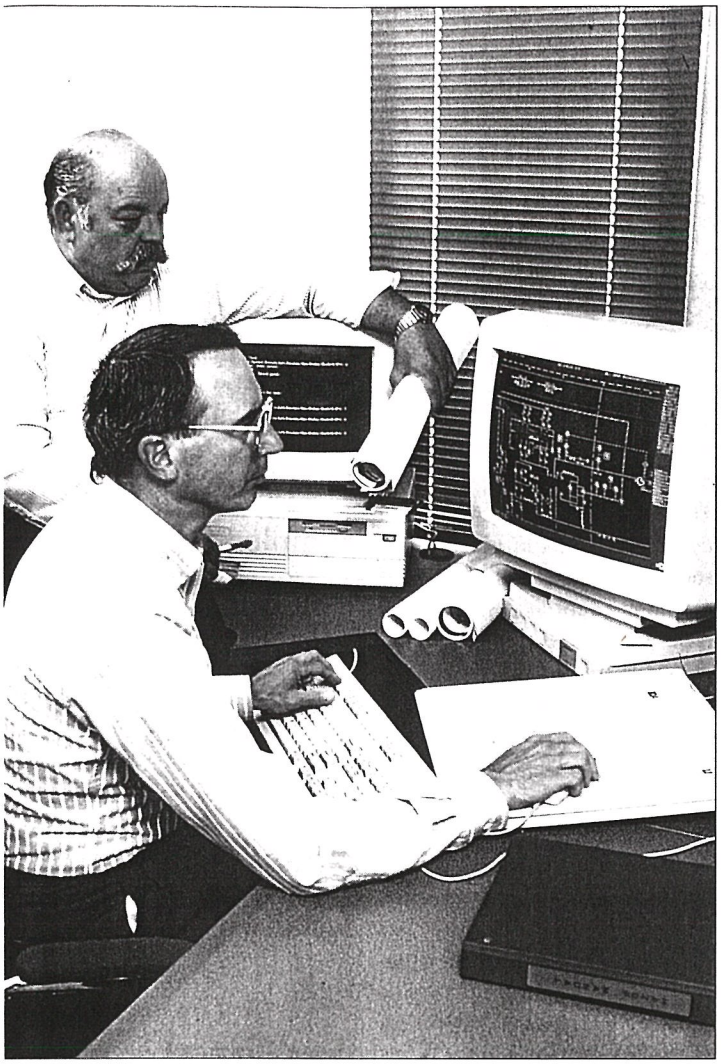
The results of each hazop include a detailed analysis of process unit safety conditions and a series of recommendations for improvements to help keep potentially dangerous events from occurring. A review begins with the basic process design under normal operating condition. The team goes through the process, step by step, and considers the effects of deviations from the norm of basic process parameters such as pressure, temperature, flow rate and composition.

For example, what happens if a process that normally runs at 100psi is suddenly increased to 500psi? All of the equipment involved in the process is examined to determine whether it is able to handle the changed conditions. Provisions for alerting plant operators of new conditions and shutting down the process are also considered.

A review will often identify possible safety enhancements. In this case, the team is charged with the responsibility of making recommendations to correct the problem. Obviously, a considerable amount of information is required to perform a hazop. A process and instrumentation diagram (P&ID) is the basis for each review and, in addition, the specifications and limitations of equipment in the process and operating parameters are also required.

The major portion of the Uno-Ven refinery was built in 1970 and, as would be expected, was designed

LEFT Uno-Ven operators, like Rich Serafin and Ray Crotty pictured here at the refinery, help provide critical operating information during hazops



ABOVE The authors, Jim Tysiak (seated) and Larrie McCollum discuss a P&ID layout

using manual drafting techniques. Before beginning the company's hazop initiative, Uno-Ven decided to convert the drawings to computer-aided design CAD format because of the age and cumbersome nature of the original manual drawings.

In addition to the P&IDs, large amounts of information such as operating conditions, equipment ratings, etc are required for a hazop. Uno-Ven's employees decided to see if this information could be incorporated into the CAD drawings to improve their accessibility and thus reduce the time required to perform a hazop review.

Many oil and petrochemical companies in the USA have elected to convert their plant drawings to CAD prior to undertaking detailed hazops. One reason is that the paper drawings used to design virtually all of these plants are difficult to update and in most cases have long ago become outdated.

The CAD approach, on the other hand, allows rapid changes to be made to drawings, and enables new plots to be run out which look as good as the originals. Information which needs to be added to the drawing as part of the hazop can be easily accommodated in CAD by placing the data on a separate 'layer' in the drawing.

Uno-Ven temporarily assigns an experienced piping designer/CAD operator to each unit; he or she begins by taking old drawings and then walking through the unit in order to verify the relevant drawings and equipment. The same designer is primarily responsible for data entry on the unit. That is because the person who marked up the drawings is often in the best position to understand what they mean. Any changes observed in the process area are duly marked on the old drawings.

Selection

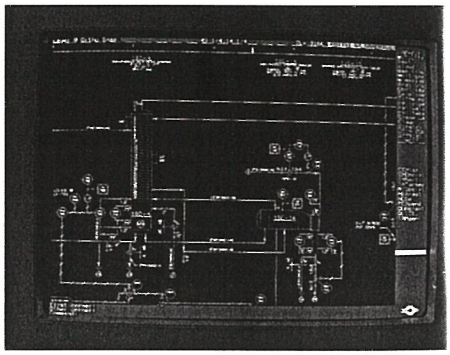
When the decision was taken to go with CAD, Uno-Ven faced the next problem: selection. A CAD package identified as one which offered the ability to store textual database information along with the drawings was AutoPlant P&ID from Berkeley, California based, EDA. AutoPlant was originally designed for oil/petrochemical/chemical industry applications, in any case, but the thing that attracted Uno-Ven to the package was its unusually powerful database capabilities.

The program allows a virtually unlimited amount of textual information to be stored along with each item on the P&IDs; Uno-Ven, for example, stores approximately 25 different pieces of data (attributes) with each instrument or piece of equipment. Information for each item on the drawing does not have to be separately entered by the CAD operator; instead, a secretary types the data into a separate textual database which contains an entry for each type of equipment in the plant

This database is imported to the drawing file using an EDA add-on product called 'Data'. The information contained in the external database automatically updates every instance of each equipment type. Changes can be made simply by updating the textual database and each type of equipment needs to be changed only once, even if there are ten or 15 items of that type in the plant. Another benefit of this approach is that the textual database can be manipulated separately from the CAD system; for example, it can be used to calculate the safety factor of a pump based on the latter's rated capacity and operating conditions.

A major advantage to Uno-Ven of the AutoPlant package is that is can be modified to meet a particular documentation standard. The program runs within AutoCAD and a large proportion of its codes are written in AutoLisp which means that the program can be customised in a number of ways.

Uno-Ven employees set about determining the information, procedures and format requirements of the hazops review, and the database modified accordingly. This also involved modifications to the data entry routines which prompt the user to enter information.



ABOVE Close-up of a P&ID created using AutoPlant (courtesy of EDA)

Symbol libraries were also modified to match the company's style requirements. Besides being easy to modify, the program also proved easy to learn. Before purchase, Uno-Ven employees prepared a benchmark test that covered a number of typical design tasks; eight leading packages were tested, and both the time and number of keystrokes required for one of the company's operators to complete

the benchmark were measured.

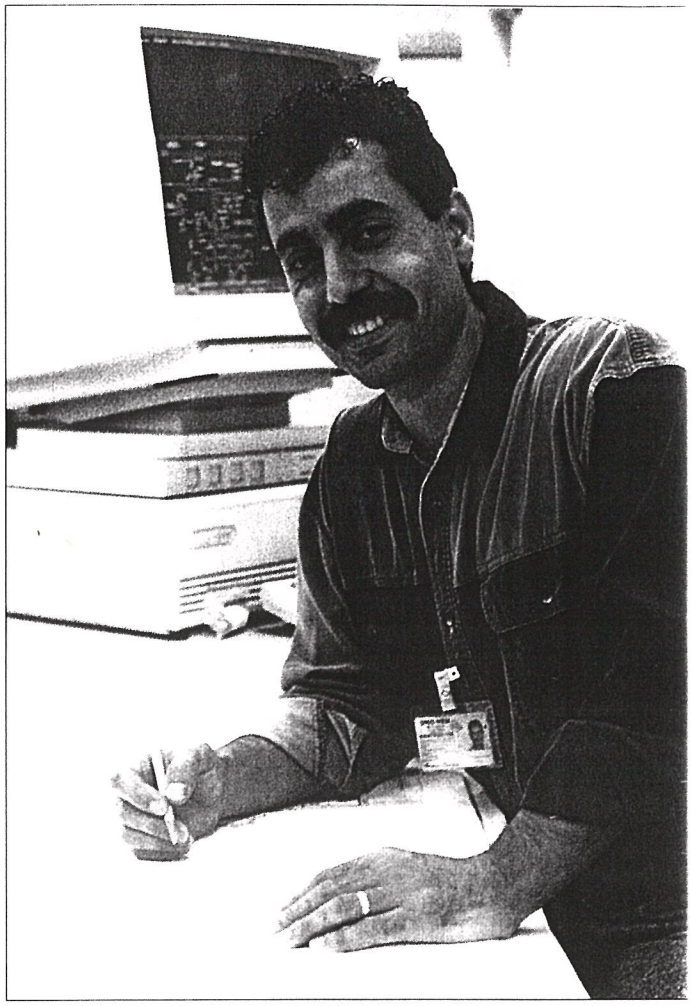
AutoPlant proved to be the fastest program and the one that required the least keystrokes.

Two years on, and progress on the hazop project is moving apace. As each hazop is performed, the procedure is enhanced. Of Uno-Ven's 40 different process areas, five have been completed on the CAD system. In addition, the specifications of much of the equipment in the refinery have been further organised and are now being entered into a textual database.

A schedule has been created which defines when each of the 40 refinery process areas is entered into CAD and the appropriate hazop review performed. The entire project is due for completion in 1997.

A network is also being installed that will make the company's drawings and database available to all areas of the refinery.

The process of converting manual drawings to CAD and performing hazops is well under way and Uno-Ven expects to complete its PHA within the regulatory time frame. Employees, meanwhile, remain enthusiastic about the way CAD has assisted them in forging ahead with their process safety management programme.



RIGHT Uno-Ven employee, Husein Qaiesi performs P&ID mark-up and verification from blueprints

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