STOPHAZ : A TOOL SUPPORTING SAFER PROCESS DESIGNS

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STOPHAZ is a 3 year collaborative project supported by the European Commission under the ESPRIT III programme. It aims to improve the economic and process SHE (Safety, Health and Environmental) performance of the design process. The aim will be realised through the provision of a set of support tools for the designer and safety engineer.

This paper describes the background of increasing legislative and social pressures on today's industry which led to the project conception, the process which determined the requirements for the tools and the resultant scope and specification for the project. It also considers the information systems issues surrounding the project.

Keywords: Process safety, knowledge-based tool, process design, process operations, Hazard and Operability studies, European, collaboration.

INTRODUCTION

In recent years the world has witnessed a series of major industrial accidents: Seveso, Bhopal, Pipe Alpha, Pasedena City. These have arisen due to such factors as unforeseen operating conditions, inadequate process design and human error. The safer design, construction and operation of industrial processes has become an essential requirement of modern society. A safer process is invariably a cleaner and environmentally more friendly process. The accidents above have provided leverage to enabling and enforcing legislation such as the UK's CIMAH and the US OSHA 1910.119 for highly hazardous chemicals.

At the same time as social and legislative pressures are leading to a tightening of safety standards in process design, industrial companies are under great pressure to improve their economic performance. Increasing competition, particularly from developing economies, is forcing operating companies to bring plants on line ever faster and at reduced costs. This results in a reduction in the time available for design. These conflicting pressures, the first pushing for more rigorous design and the second pushing for faster design, can be satisfied by providing support for the process designer.

Currently the prime focus for those involved in the design of process plant is on operating costs, efficiency and technical effectiveness. Conformance to SHE standards, both regulatory and self imposed, is often not checked until a later stage in the design.

The resultant late identification of potential hazards within the design, at a stage where modifications to assure satisfactory SHE performance are costly both financially and in terms of a delayed project completion, reduces the competitiveness of that design. The adoption of inherent SHE concepts will avoid the penalties of late identification of hazards by including SHE considerations at every stage of the design.

Designers adopting inherent SHE concepts require access to an enormous amount of data, from many diverse sources and in a variety of formats. Much of this information is available, although some is not currently captured in a form which makes it useful, but a method of accessing the appropriate data in a timely fashion does not exist. STOPHAZ will provide this access.

Having produced a design, with an inherently good SHE performance, the need to verify this by completing a safety check, remains. Hazard and Operability (HAZOP) studies have been in existence for over 25 years, having been pioneered by ICI, and through sharing and training have become adopted as one of the leading methodologies for PHA (Process Hazard Assessment) throughout the world. Legislation is increasing the need to perform PHAs , in fact the recent OSHA regulations insist on studies being completed for hazardous plants and that studies are reviewed throughout the operational life of the plant.

Unfortunately HAZOP techniques are fairly complex to apply, demanding on the user engineers, and potentially costly in terms of elapsed time and resources consumed. Their effectiveness however, as underpinning to all process safety related design and operation, has been confirmed throughout the world. STOPHAZ will reduce the amount of time required to complete HAZOP studies thus reducing project times and freeing up scarce resources.

The STOPHAZ project aims to provide the process design community with tools to support design and operation methodologies embracing best practise techniques and inherent SHE principles. In particular the project will support the front end design, embracing the development of Engineering Line Diagrams (ELDs/P&IDs) from Process Flowsheets (PFDs), and the associated hazard studies.

The project is being undertaken by a consortium of 10 European organisations, with ICI as the overall project manager.

Imperial Chemical Industries Plc. (UK)	SFK - Software for Knowledge (UK)
Snamprogetti SpA (Italy)	Intrasoft SA (Greece)
Loughborough University (UK)	TXT SpA (Italy)
VTT Safety Laboratory (Finland)	Bureau Veritas SA (France)
AspenTech Europe SA (Belgium)	Hyprotech SL (Spain)

USER SURVEY

In order to ensure that the solutions, which STOPHAZ will deliver, satisfy the most urgent needs of the users, an industry-wide survey of user needs and views has been completed. The breadth, depth and currency of the survey make it unique in the SHE / loss prevention area. 85 people from 27 separate organisations in 6 European countries were interviewed. They comprised operating companies, consultants, contractors, constructors and safety specialists in R&D. Offshore / Oil and gas, petrochemicals and fine chemicals were represented. The detailed results have been published elsewhere (ref. 1).

The survey identified 18 specific issue areas including training, 2D-3D CAD, passing on design information, incident memory, inherent SHE, inexperienced engineers, operating instructions, design memory , standard safety design problems, legislation, codes and standards , HAZOP meeting dynamics, documentation, HAZOP methodology, HAZAN, layout, computerised plant and technical information.

Following analysis of the survey results the STOPHAZ partners identified three key areas where computer tools will provide great benefit to those involved in safety-related design. The three areas cover many of the issues identified in the survey and are to:

Offer context sensitive design advice, calculations and supporting data to those developing, checking, modifying or auditing an ELD.

Check the ELD, at various stages of development, for inherent hazards.

Assist in the efficient development of effective operating instructions for plant personnel.

STOPHAZ will address these three areas through three functional modules.

ELDER (ELD helpER)

HAZID (automatic HAZard IDentification)

CHOPIN (Computerised Helper for OPerating Instructions)

The functional modules will form part of an integrated tool, supported by a Common Software Environment. Through this environment the main modules will have access to a variety of external data sources which may include incident data bases, physical properties data, legislation and calculations. The external data will be used to support the advice and algorithms provided by the main modules.

Figure 1 shows a representation of the STOPHAZ architecture. The central 'box' represents the common software environment, the functional modules being shown on the right. External data sources are shown at the bottom of the figure. To the left are shown the tool which will generate the plant description, which is accessed by HAZID and ELDER, and an interface to a CAD system.

The first prototype of STOPHAZ, including the ELDER and HAZID modules, will be completed during the summer of 1995. The second prototype will be completed a year later, with the current project ending in December 1996. The prototypes will be tested and evaluated within the consortium and by selected other process industry companies.

STOPHAZ USE

STOPHAZ has a variety of target users including process engineers (carrying out process designs and modifications), safety specialists (carrying out safety studies or specifying appropriate SHE standards), commissioning teams (completing operating instructions or understanding the design philosophy), functional engineering designers (developing the process engineering package into detailed design).

Figure 2 illustrates the tasks which STOPHAZ will support throughout the design lifecyle, be they applied to new plant or plant modifications, and shows at which stage of the design process the support is most appropriate. The left hand column shows the milestones in the design process. The design phases which progress the design are shown in the second column and the next three columns detail the tasks which will be supported by STOPHAZ.

ELDER

The purpose of ELDER is primarily to offer to the developer, or checker, of an ELD advice which assists them in determining the suitability of process equipment configurations by advising on appropriate SHE considerations. The advice offered will represent current best process design practice and the system will provide back up information, when requested, to justify the advice. Incident data and standards will be related to the advice as will back up calculations which will be required to determine leak rates etc. The system will also be of help to those auditing existing operating plants.

ELDER will provide advice appropriate to the task which the user is carrying out and takes into account decisions which the user has taken. This context sensitivity will result in the user being offered less irrelevant advice e.g.. no information on explosions will be offered to a user who is considering the pumping of pure water.

ELDER will assist the user in taking decisions based on best practice advice and will not automatically check that the user has adopted best practice i.e. it is an advisor not an auditor.

The advice offered by the system will be fully adaptable to a particular user's needs. Access to common information such as standards and legislation will be provided as well as a framework to allow company specific codes, incidents and experience to be added.

An example of the sort of advice which ELDER will offer is that when considering tanker loading the user will be prompted to consider a number of potential problems, for example 'protection against impact'. Should the user not have considered this problem fully then ELDER will provide some possible arrangements to provide the protection and detail some incidents which have occurred when impact protection was not adequate. Another example would be, if the user has not considered the effects of leaking connections then the system will prompt the user by detailing the problems which may occur because of leaks, provide some information on the likely frequency of leaks, detail incidents which have occurred due to leaks and provide a simple calculation to determine leak rates.

HAZID

The purpose of the automatic hazard identification module of STOPHAZ (HAZID) is the identification and reporting of feasible and important hazards inherent in the design of a chemical processing plant. The hazard identification is to be based on a plant description and to be achieved through the use of generic knowledge of process streams and process equipment and through the application of an inferencing procedure.

It is assumed that the problem is tackled no earlier than when draft engineering line diagrams or piping and instrumentation diagrams have been prepared. Draft layout and operating

instructions may also be available. The design may be for `green field' or `brown field' situations. The design may be for a continuous or batch chemical process.

The style of tackling the problem is an emulation of the hazard and operability study technique (HAZOP). Access to similar data to that used by a human HAZOP team is therefore an important requirement. The earlier, cheaper and more certain (in some respects) identification of hazards is the primary goal.

Elimination of the conventional use of hazard and operability studies is not the primary goal. On the other hand, significant savings in time spent in HAZOP meetings, and particularly in following up actions arising from HAZOP meetings, are anticipated. Benefits should also follow from making any necessary changes earlier in the design life-cycle. In particular earlier attention to hazard analysis (leading to earlier conclusions on necessary protections) and fewer late modifications will shorten the critical path of the design. Another benefit will be in the capture of expertise relevant to hazard and operability study and the access to this expertise for younger engineers.

The visible output envisaged is primarily in the form of tables similar to those produced in HAZOP. Typically a table has columns for location (`Item/Line/Stage'), deviation, cause, consequence (`effect or hazard'), protections (`Preventive or corrective measures') and some columns related to actions arising. The invisible output will be a database of cause-to-consequence chains which can be operated upon or manipulated. One such manipulation will generate the HAZOP forms but other manipulations are to be considered and may prove attractive.

SYSTEMS ISSUES

In order to maximise the potential user base for STOPHAZ it will be targeted for a PC/Windows platform. In order to maximise functionality and flexibility the design and implementation of the modules and common software will follow the object orientated paradigm using C++.

STOPHAZ will appear to the user as an integrated set of tools operating within a common, open software environment. STOPHAZ will integrate commercially available, "best-in-class" modules to provide specific functionality, replacing individual modules as more advanced products become available. This philosophy means that STOPHAZ will integrate easily with future information sources and systems without the expense of rewriting software. It also introduces a number of integration issues including data exchange protocol standards (e.g.. STEP and PDXI) and interfacing to process plant data and CAD information.

CONCLUSIONS

A unique survey, which identified the key needs of those involved with safety related process plant design, provided the project with a firm foundation on which to build. The three modules which emerged from the analysis of user needs will support those carrying out front end process design, enabling them to efficiently produce designs in which the safety and environmental issues have been fully considered. Evaluation of the first version of STOPHAZ will begin in the summer of 1995. The system considerations have also been discussed.

ACKNOWLEDGEMENTS

The authors acknowledge the contribution of the STOPHAZ partners in the project. They would also like to thank Imperial Chemical Industries PLC for permission to publish.

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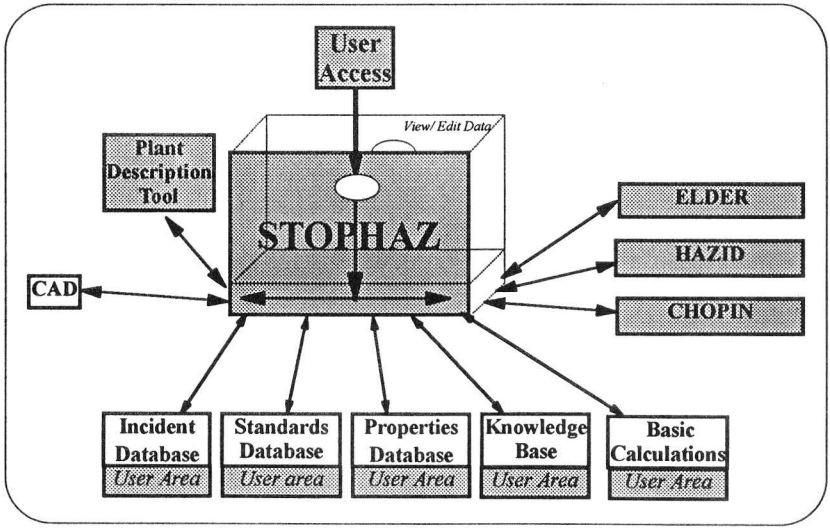

Figure 1. Representation of the STOPHAZ architecture

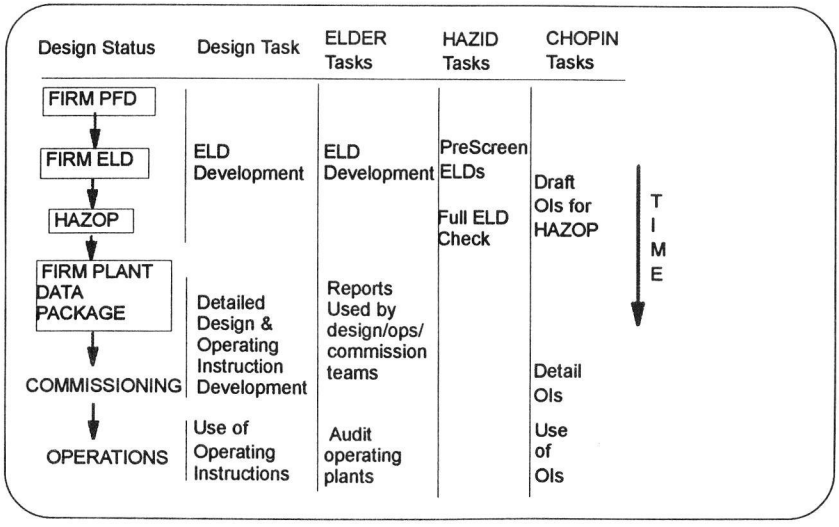

Figure 2. The use of STOPHAZ against the design life cycle