CHEM
Advanced Decision Support System for Chemical/Petrochemical Manufacturing Processes
IMS #99002

Integrated process supervision saves money, improves quality and reduces risks

The CHEM project successfully developed a decision support system based on a series of process control and simulation 'toolboxes' that can be integrated to provide a new platform for improved process plant operation, safety and quality in refining, chemical and petrochemicals.

Unscheduled plant shutdowns and other abnormal situations are the cause of economic losses amounting to billions of euros each year for the chemicals and petrochemicals industries. Product quality, environmental and safety concerns raise still more problems – and accident prevention is a constant issue.

Advances in sensor technology, distributed control systems and computer technology are dramatically increasing the amount of data that can be collected on the operation of such industrial plants. However, the sheer volume of these inputs makes it extremely difficult for human operators to react appropriately.

Today's control systems include more and more monitoring equipment, delivering increasing volumes of data. However, the gains accruing from closer process management can often be offset by losses arising from time spent in dealing with unexpected situations.

Human operators continue to face the responsibility for making important and complex decisions, frequently within a very limited timeframe. And incidents such as Three Mile Island, Bhopal, and Chernobyl provide chilling examples of faults that turned into disasters, partly due to improper actions on the part of operators, who were probably faced with information overloads.

Easier decision making

The objective of the three-year EU-funded CHEM project was to eliminate such risks and improve the efficiency of refining chemical and petrochemical processes by automatic processing of the available data. An eight-nation consortium led by the Institut Français du Pétrole (IFP) set out to provide a flexible decision support system (DSS), within which individually designed measurement, modeling and analysis software toolboxes can be combined to digest and interpret the mass of control data.

The successful outcome of this exercise owes much to the complementarities of the expertise provided by the various team members. The Université des Sciences et Technologies de Lille (USTL) and THALES Airborne Systems, together with the Warsaw University of Technology (WUT), are specialists in fault diagnosis. The Universitat de Girona (UdG) leads in process trend analysis, and the Universitat Politècnica de Catalunya (UPC) in reactive scheduling. Lund University has done important work in decision support structures, while the Technical Research Centre of Finland (VTT) is a major actor in safety and risk analysis and KCL a major actor in tools dedicated to the paper industry. Software vendor Computas is deeply involved in statistical process control. And Gensym specializes in on-line integrated software products that model, simulate and manage critical operations across a broad range of industries.

Objectives fulfilled

When the initiative reached its conclusion in March 2004, 23 such toolboxes had been developed – for trend analysis and situation assessment, fault diagnosis and alarm management, decision support and reactive planning.

A methodology was established to define how the toolboxes could be used, both individually and together, so that new supervision applications can easily be built for differing processes. Integration is based on Gensym's commercially proven G2 software platform.

The DSS is designed to interface with commercial plant databases and process control software. A final version of the integration platform was delivered during the lifetime of CHEM, and has been used by the industrial members of the consortium to demonstrate applications in real-life situations.

Widespread application

Facilities provided by the partners allowed evaluation on pilot and full-scale plants running processes ranging from fluid catalytic cracking (IFP) to coal gasification (UPC), steam generation (USTL), papermaking (UPM-Kymmene), gas scrubbing with recovery of useful constituents (Corus) and urea manufacturing (ZAP – a subcontractor to WUT). Most of the toolboxes were tested on at least two industrial sites; as well as on a steam generator at Lille University.

At the Redcar blast furnace of Corus UK, for example, the system was used to provide advanced warning of aerodynamic instability in the process. The consequence of unstable operation is usually seen as a high heat load to part of the furnace wall, and/or a sudden

vertical movement of the iron ore and coke within the furnace, known as a ‘slip’. With the aid of three CHEM tools, it proved possible to generate advance warning of potential slips in time for the operators to take appropriate preventive action.

Control of the fluid catalytic cracking pilot plant at IFP illustrates a particularly complex application. The process runs with a closed catalyst circulation loop, and requires the detection of faults ranging from leakages and blockages to abnormal process behavior, problems with sensors and controllers, and variations in electricity and gas supplies. When tested in several representative scenarios, the DSS made early identification of the faults, without generating false alarms.

Integration and co-ordination in a distributed environment of toolboxes running online with a reconfigurable process cell pilot plant, located at UPC in Barcelona, were also demonstrated live on the Internet.

Reducing accidents and pollution

By preventing or managing abnormal events, CHEM’s tools should reduce accidents and pollution – thus playing a major role in safety and environment protection. Users will benefit from the ability of integrated supervision to improve the efficiency of their operations, and thus reduce costs and protect product quality. It will also enhance working conditions by easing operators’ tasks and removing potential sources of stress.

“Some of our toolboxes are already in the public domain, and others are being incorporated into the commercial offerings of our partners,” notes coordinator Sylvie Cauvin of IFP. “We have made many contacts with interested potential users, and are hoping to introduce a follow-up project under the Sixth Framework Programme, which will allow us to introduce even more flexibility into the tools.”