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Database management systems for process safety

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Abstract

Several elements of the process safety management regulation (PSM) require tracking and documentation of actions; process hazard analyses, management of change, process safety information, operating procedures, training, contractor safety programs, pre-startup safety reviews, incident investigations, emergency planning, and compliance audits. These elements can result in hundreds of actions annually that require actions. This tracking and documentation commonly is a failing identified in compliance audits, and is difficult to manage through action lists, spreadsheets, or other tools that are comfortably manipulated by plant personnel. This paper discusses the recent implementation of a database management system at a chemical plant and chronicles the improvements accomplished through the introduction of a customized system. The system as implemented modeled the normal plant workflows, and provided simple, recognizable user interfaces for ease of use.
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Keywords: Process safety management; Database management system

1. Discussion

Historically, database development and implementation has been considered the enterprise of a relatively few programmers who, almost without exception, are not practitioners in the field of interest. When addressing PSM, the programmers were rarely proficient in the nuances of operational safety concerns. Software applications were cumbersome and only "user friendly" to the few. Companies were often asked to adopt the workflow of a software offering, and were not provided customized solutions that fit their workplace. This has changed somewhat in recent years as a result of the rise of Visual Basic® applications, object-oriented connectivity, and other, more truly "user friendly" programming techniques. Put succinctly, the programming techniques of today have become sufficiently efficient and robust that safety and environmental practitioners have begun to program their individual work processes.

The best database management systems today are based on the premise that persons or companies who have successful workflows do not wish to change the workflow to fit an arbitrary computerized system. Instead, the system should adopt the proven workflow and model the user interfaces such that workers are actually using the forms and reports with which they are familiar. Familiar interfaces enhance end-user acceptance.

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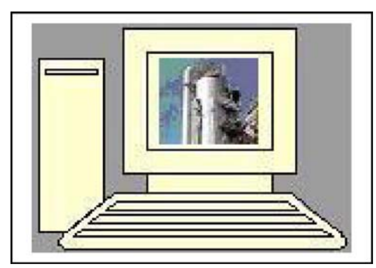
2. PSM



The PSM standard includes many elements that require data development and management. A partial list includes:

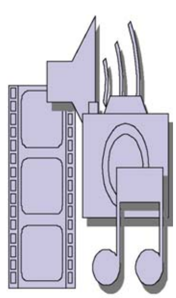
- Process safety information including:
  - Inventories;
  - Process parameters;
  - Materials of construction;
  - Piping and instrument diagrams (P&ID's);
  - Electrical drawings and equipment data;
  - Relief system calculations, drawings, maintenance records;
  - Safety systems;
  - Codes and standards used in design, maintenance, inspections, testing.
- Process hazard analysis (PHA) basis information, recommendations and tracking of the recommendations.
- Operating procedures including revision control.
- Training requirements and training documentation.
- Contractor programs, training logs, injury and illness logs.

- Pre-startup safety reviews (PSSR) with punch lists and action lists.
- Mechanical systems, inspections and tests.
- Management of change (MOC).
- Incident reporting and recommendation tracking.
- Miscellaneous audits and recommendation tracking.

3. Example Development

The database management system (DBMS) development for one chemical company included the following workflows:

- MOC initiation and tracking, including signoffs and e-mail notifications.
- PHA recommendation tracking with notifications and approvals.
- PSSR close-out item tracking.
- PSM audit corrective actions tracking.
- Safety incident reporting and corrective action tracking.
- Environmental incident reporting and corrective action tracking, including on-line reporting.
- Spill release and community awareness and emergency response (CAER) notifications.
- Customer complaint/quality assurance actions tracking.
- Generic actions tracking.



The package above included electronic document attachments for MOCs, PHAs, incident investigations, etc. While the documents could have been included in the database, there was a concern that the database might become unstable as it grew. Since even the most stable database platforms can become slow when data management involves numerous and sizeable files, attachments were maintained in existing drawing locations (and native formats), and attached to the database using object linking exchange (OLE). Such formatting also allows for sounds, photos, videos, etc.

The DBMS includes report functions to provide for periodic status reports. It also includes e-mail reminders to appropriate personnel as schedules dictate. It is readily seen that e-mail prompts will enhance real-time performance monitoring and improve regulatory schedule compliance through automation. Unfortunately, an avalanche of compliance-related e-mails can also be a frustrating experience.

Complex DBMS models will allow electronic signatures based on embedded securities, as did the model shown in this paper. Such DBMS can meet Federal Department of Agriculture (FDA), Hazard Assessment and Critical Control Point (HACCP), ISO, or other industry initiatives or regulatory requirements. In this regard, data historians can be added to maintain a history and assure the DBMS integrity. For this example, it was determined that too much complexity was undesirable, as it might result in a cumbersome tool.

An interesting outcome of the desire to keep the model simple for the user was that the programming became more complex. For example, the initial plant personnel naming convention was simply the employee list including e-mail addresses. As the program evolved, it became apparent that auto-lookup/completion of the names was more user friendly. Another example is that MOCs were searched using the Microsoft® Access field search function initially. Later, an embedded data grid resembling a spreadsheet was incorporated. These and other "program simplifications" required additional programming efforts.

4. Other database possibilities

Other data functions that are particularly suitable to a DBMS environment include:

- Training record keeping and scheduling (e.g., documentation of MOC training was included in this model).
- Safety critical instrumentation lists, scheduling of calibrations, etc.
- Job safety analysis reporting and action tracking.
- Maintenance of craft certifications, especially, where it can impact the efficacy of the mechanical integrity program,
- Work order system linkage, either direct or by tie-ins for purchase order information, for example.
- Car seal list management and scheduling of field checks.
- Maintenance of line numbering, equipment or component nomenclatures.
- Resolution of security vulnerability assessment corrective actions.
- Rapid access to material safety data sheets.
- Look-aheads for compliance requirements of any type.

5. Improvements

Several PSM and safety program improvements have been shown to occur when implementing a DBMS, including:

- MOCs are generated at the control room computer, making it easier for an operator to initiate.

- MOC training is documented and prompted electronically.
- CAER notifications are done on-line with documentation for backup.
- First reports of incident are documented efficiently and actions are prompted.
- A generic action database is utilized as a “catch all” for items desired to be tracked and documented.

As the puzzle is resolved, one will note the following:

- Improved management oversight—allowing for revision of priorities when resources are limited.
- Reduced paper transfers.
- Reduced confusion during multiple signature processes (knowing where the document is in the signature process without misplacing the document).
- Improved accountability due to workers’ ability to query commitments, determine time lines, and stay abreast of completions,
- Enhanced management ability to query commitments and track performance.

6. Difficulties encountered

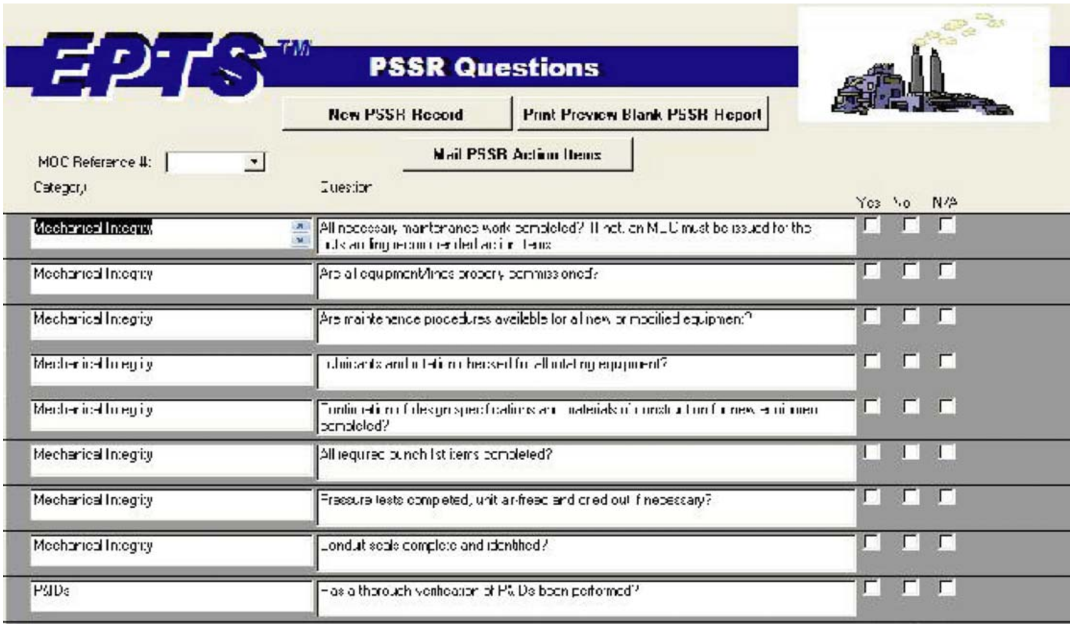
Many difficulties may be encountered during system development and implementation. To list a few:

- System securities are limited in Microsoft Access® and need to be developed in Visual Basic®.
- Since the various modules are often maintained separately to avoid excessive growth, the securities became more complex (each module has separate securities that must interact seamlessly, requiring validation of network certificates).
- Several versions of Microsoft® Office (1997–2003) exist, and this has to be addressed along with multiple versions of operating systems.
- ActiveX® controls in Microsoft Access® are limited in capability and can impact e-mail functionality, requiring additional OCX and DLL files.
- Visual Basic® has the effect of making the program more capable, but at the same time less flexible.
- Excessive e-mail notifications can swamp or frustrate system administrators.
- Naming conventions for personnel require some Visual Basic® scripting for flexibility (could be linked to Peoplesoft® at a larger facility).
- Network functionality issues.
- Time predictions for development efforts are often optimistic and difficult to meet.

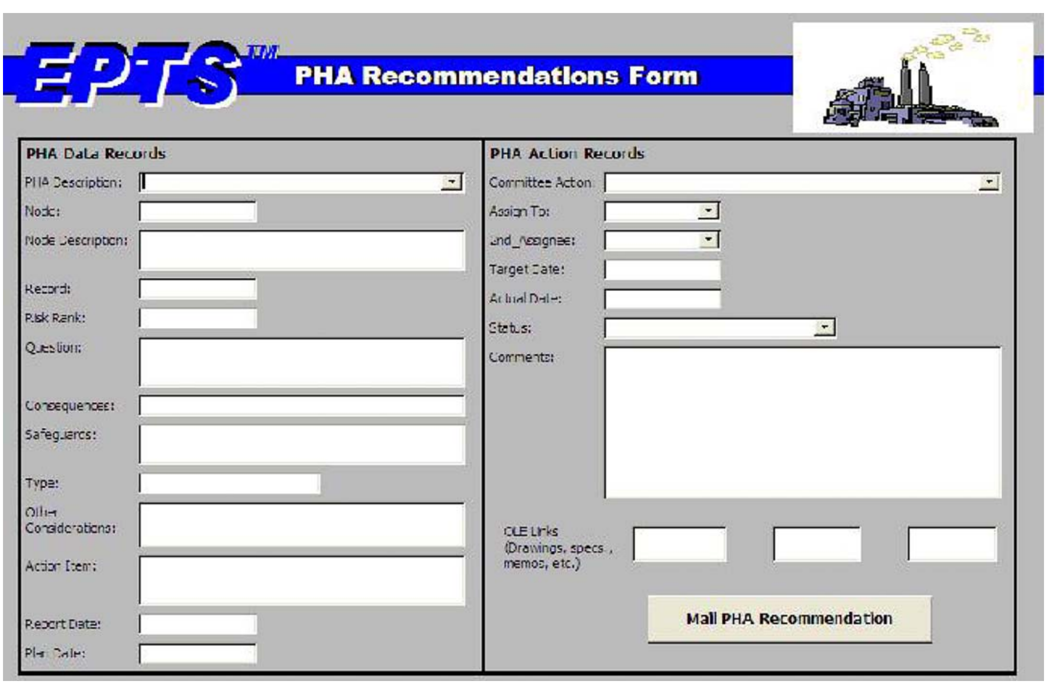
7. Example DBMS screens

The DBMS is managed through a main switchboard. A screen capture of the switchboard indicates the simplicity of the user interface.

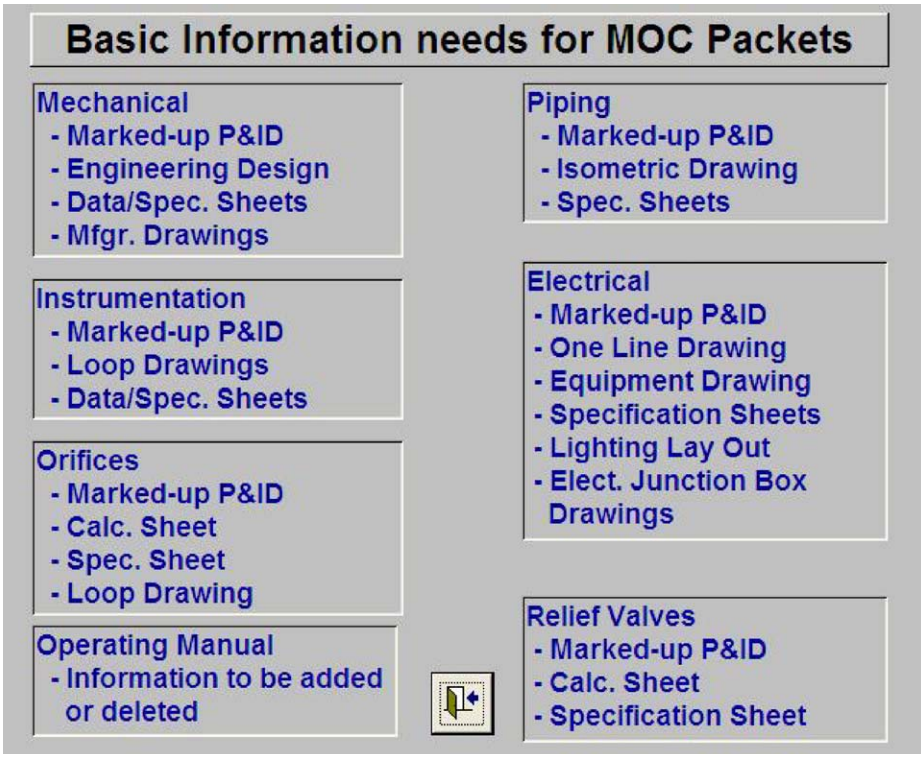
From the main switchboard, users launch other modules. An example screen is taken from the pre-startup safety review.



While screens such as for the MOC can be complex, others are quite simple. An example is the PHA recommendation tracking screen.



Needed information, such as the recommended attachments for an MOC, can be provided within the program.



8. Summary

Database systems today have become far more user friendly and useful as tools to develop customized, configurable systems to match workflows in the office setting. While programming techniques still remain a bit complex and cumbersome, they do allow practitioners familiar with the workflow to model the workflow in software. This is a major change from the historical systems where the software designer had no knowledge of the workflow requirements.

Further reading

[1] 29 CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals.
[2] 40 CFR 68, Risk Management Programs for Chemical Accident Release Prevention.
[3] G. Shen, W.F. Early, 1994. Workflow Management of Technical Documents, Process Plant Safety Symposium, February 1994.
[4] 21 CFR 120 Hazard Analysis and Critical Control Point (HACCP) Systems.
[5] 21 CFR PART 11—Electronic Records, Electronic Signatures.

William F. Early, PE is a chemical engineer with over 30 years experience in the process industries. He has been involved with the Mary Kay O'Connor Process Safety Center at Texas A&M University since its inception, and has contributed to several AIChE Center for Chemical Process Safety projects over the years. Early Performance Tracking Systems™ (EPTS™) is a new line of business for the company, but is a logical extension of the historical process safety management and risk management consulting business.