Organizing Knowledge for Improved Process Safety

Jack Chosnek, Ph.D., P.E.
Knowledge*One*

Submitted to
The 2008 Mary Kay O'Connor Process Safety Center International Symposium

Abstract

Since lack of appropriate knowledge, be it technical, operational, or safety related, is one of the major causes of human error, it behooves us to maintain an organized repository of knowledge that can be easily maintained, updated and disseminated. Existing tools such as document management systems (DMS) allow us to create and share such a repository. By providing a suitable structure to the knowledge (taxonomy), it can be dynamically organized in a working environment and properly maintained. In this paper we will discuss the necessary features of a DMS for providing for information validation (we want our knowledge to be correct), security (to prevent information corruption), and updatability (to have the latest information), and for having the ability to be easily shared. A taxonomy that can be applied to an operating petrochemical plant that will allow achieving the objectives of collecting, reviewing, and maintaining the correct information will be shown.

Introduction

Lack of *appropriate* knowledge is one of the major causes of human error, which is often mentioned as being the single major root cause of incidents. The ability to rapidly produce information provided by computers and the Internet tends to aggravate the issue as the majority of the published information in the web has not been peer reviewed. Because the information is readily available and its sources seem to be legitimate, we tend to use it almost without question. The large quantity of material on the web is also a hindrance as it makes it extremely difficult to zero in on the applicable information. Anybody that has made a search using Google can be a witness to that. Therefore a method is needed to easily find the correct information. In order to do this, information needs to be reviewed to make it trustworthy and organized in such a way that it is easily findable. This paper will present a method and describe the necessary tools to achieve this objective.

Data, Information and Knowledge

Data are bits of information that get collected from sources of interest to the person doing the gathering. Temperatures, pressures, concentrations, etc., collected from a process represent the data for that process. But data by itself

has little usefulness. It has to be correlated, plotted, trended or analyzed in order to be useful. When we do that we have produced information about that process. We see for example that when we add a raw material the temperature rises exponentially. Now we can take that information and learn how the process behaves. Based on our learning and experience we can deduce that there is an exothermic chemical reaction that follows certain laws. By applying reasoning (adding intelligence) to the information we have created knowledge.

Since we have spent considerable effort in obtaining that knowledge, we want to preserve it and share it. Although we could share only the information that led to the knowledge, we benefit by having that added element of analysis and the expertise that produced it. Unfortunately, most of the readily available tools allow us to collect and hold only data and/or information in an organized manner. The most common of these tools are databases which started as computerized tables that could hold large quantities of data. With the advent of relational databases it became possible to store and retrieve complex information and not just data. Knowledge, though, requires a narrative, explanations, hypotheses and conclusions and it is difficult, if not impossible, to parcel it as pieces of data without losing some content. Thus, knowledge can be best captured in documents that can tell the whole story. These documents can be in any form such as a word-processing electronic document, a PowerPoint presentation, a picture, a video, an audio lecture, or even a database.

Document Management Systems

The most common knowledge systems are simple collections of documents. Libraries are the earliest examples of these systems and in order to be useful the documents (books) have to be catalogued following a predetermined classification and an index has to be produced to allow us to find the documents. With the current computer technology we can have vast repositories of documents that can be searched word by word (as long as they are in electronic form) which could lead us to believe that indices are no longer needed. But in effect, we can't cope with the amount of 'hits' resulting from such a search, and certainly we have no way of knowing the quality of the results. In addition, how can we search for the content of a picture, a video, or an audio clip?

In the last fifteen years document management systems (DMSs) have been developed to the degree that a flexible index can be created and a collection of documents maintained having high document integrity and custom search capabilities. These DMSs are relatively inexpensive and are proliferating among companies given their usefulness. As applications of these systems grow, their name is changing from Document Management System (DMS) to Content Management System (CMS) to promote their capabilities for maintaining libraries of non-traditional documents such as videos, music and web pages. They have moved from typical desktop interfaces to web interfaces enabling them to have

documents shared across wide geographical locations and multiple computer platforms. We will continue to refer to them as DMSs throughout this paper.

What capabilities do we want in a DMS? We have mentioned that document integrity and search capability are at least two of the desired characteristics. We want to have the latest document available but we don't want to lose the ability to look at previous drafts, and we certainly don't want to be confused as to which draft is the latest. We want to be able to share our documents but without losing control of them and while being selective about whom we share our documents with. We want to be able to change the document's name and not be dependent on remembering the name to find the document. And we want the ability to easily create an index with multidimensional categories that is flexible enough to allow us to easily change the category under which a document is filed, to change the interrelationship of the categories, or even to rename a category if we so desire.

In summary we want the following features of a DMS:

- Version control – allows us to automatically maintain well ordered and labeled drafts with the latest draft on top; we can decide how many drafts we can keep and we can decide to automatically purge some documents after a certain amount of time (or keep them forever).
- Document security – allows us to decide, document by document, or category by category, who can read, edit or publish a document, or even to make the document invisible to a person or to a group of people.
- Indexing – allows us to file the document in such a way that the document name, physical location and file format are not essential for their classification; the document can be related to one or many categories and we can change the document properties at any time (with the proper permissions).
- Search ability – enables us to easily find the document by either performing a full text search or by previously assigned keywords.
- Flexible library (folder) structure – allows building a file structure that is familiar and pertinent to the company's organization, yet can be easily changed if necessary. This library (folder) structure and the relationship between the document categories or classes is known as taxonomy.

Since we require location-independent indexing we want to have another feature: the ability to create virtual copies, that is, to be able to view the same document under different folders. We will see how this feature is applied and how it will help us create the taxonomy that we want. Last, we want an interface to the library that is platform independent, i.e. a web-like interface that can be accessed through the organization's intranet or, if the necessary security can be achieved, through the Internet.

By having the above features we now can have our Process Safety Information (PSI) in a repository that is secure and where all the information can be easily

maintained up to date without accidental corruption. We can also demonstrate that a document has not been altered and we can automatically comply with the organization's document retention policy. We can also share the information with the organization's employees while maintaining confidentiality for certain documents, and share the required PSI with contractors without having to divulge trade secrets or any technology that is not necessary to perform their job.

In order to achieve the above it is necessary to develop a taxonomy that is appropriate for the organization, and a workflow that will help populate and maintain the PSI. Although a taxonomy can be developed independently of any document security considerations, it is useful to include these considerations in its development. An example of the taxonomy for a process plant will be shown. Description of the desired workflow to easily maintain the PSI would have to be the subject of another paper.

Taxonomy for a Process Plant

The taxonomy of a document system has to follow the company's organization in order to be useful. Regardless of the company's organization there are certain functions that any company in the petrochemical field will certainly have among others: operations, process engineering, maintenance/mechanical integrity, project engineering, environmental, health and safety (EHS), process safety (PSM) and training. There may be other functions such as Human Resources (HR), R&D, logistics, financial, etc. It is very probable that documents generated by one of the functional groups will be used by other groups. For example; process descriptions generated by the process engineers will be used by operations for operator training, and by the PSM department to conduct PHAs. If there is a Training department then that department will need the descriptions to develop training materials. So where do we put these process descriptions? Under the Process Engineering group files, the Training department files, the PSM group files, or under Operations? The answer is: in all of the above (remember the ability to create virtual copies?).

An example of a simplified petrochemical plant organization is shown in Figure 1. For simplicity only the groups of interest will be shown in this example, but the concept can be extended to any degree of complexity. As mentioned above we will create a document folder organization identical to the organization chart. The structure of the Operations file folders could look like that shown in Figure 2.

On the other hand, the Process Safety department is probably going to be a pretty flat organization and its document structure should be more function oriented. A partial structure is shown in Figure 3 for illustration purposes. We use the traditional areas in process safety to build the structure because this is the way that people would expect to find and look for the information. The "parent" folder of PSM is the EHS folder since this is the way that this particular plant is organized as shown in Fig. 1.

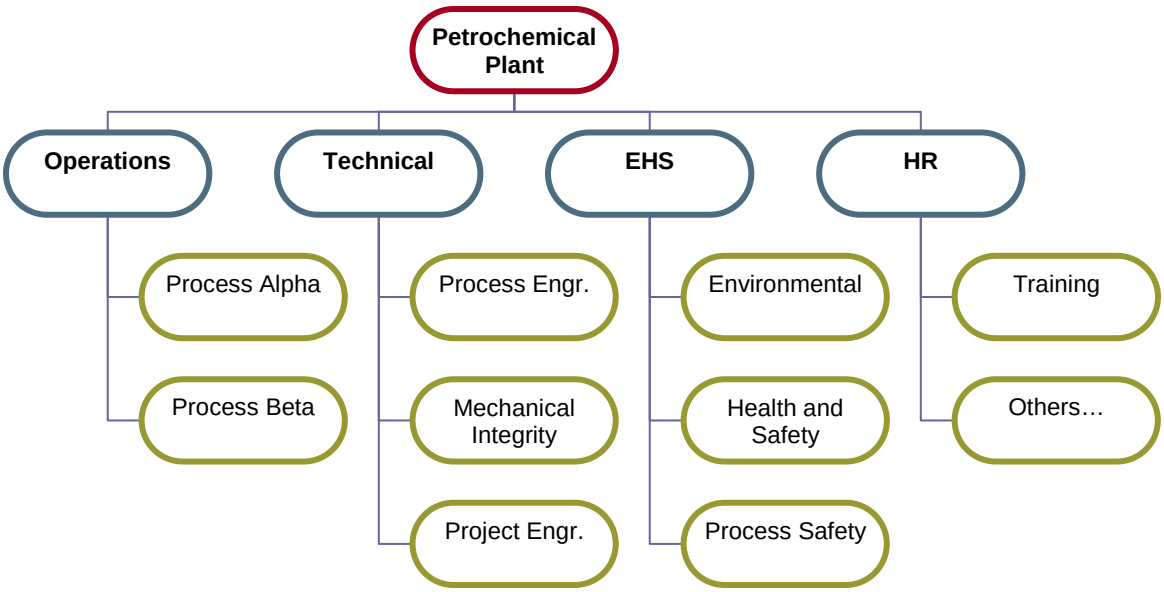

Figure 1. Simplified Petrochemical Plant Organization

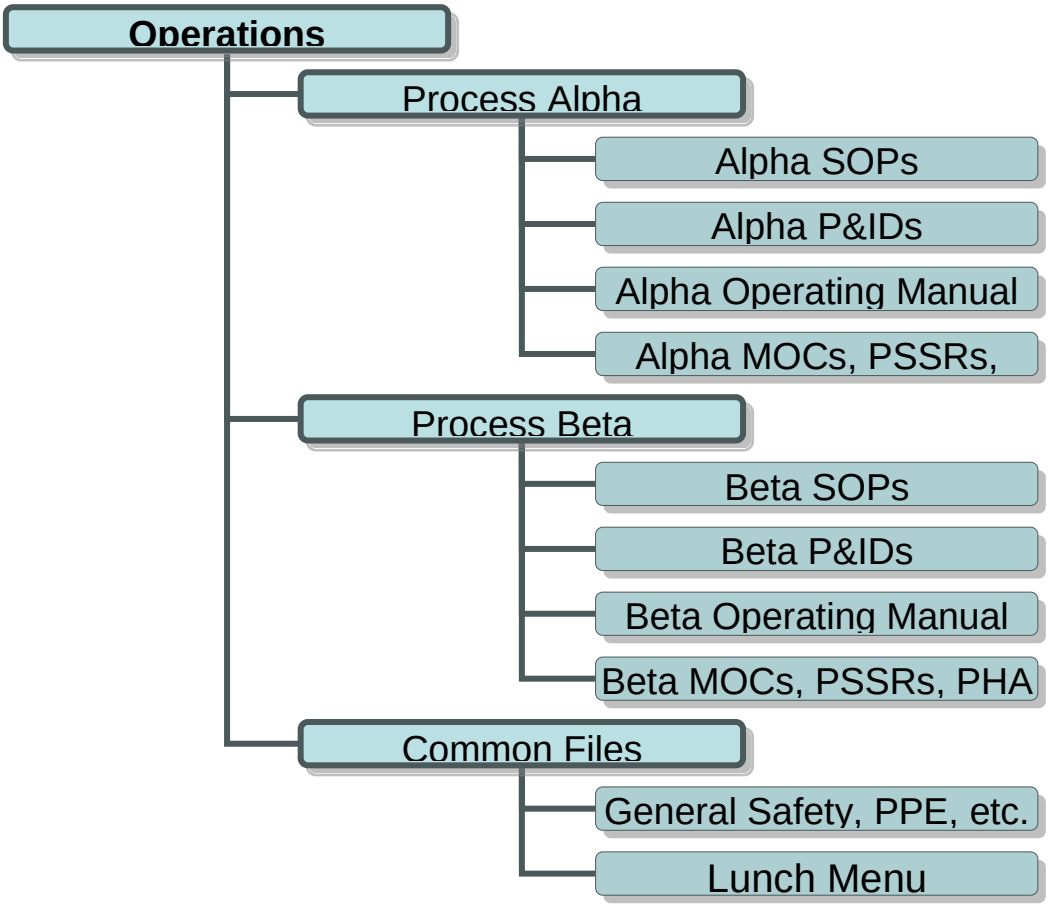

Figure 2. Operations Document Structure

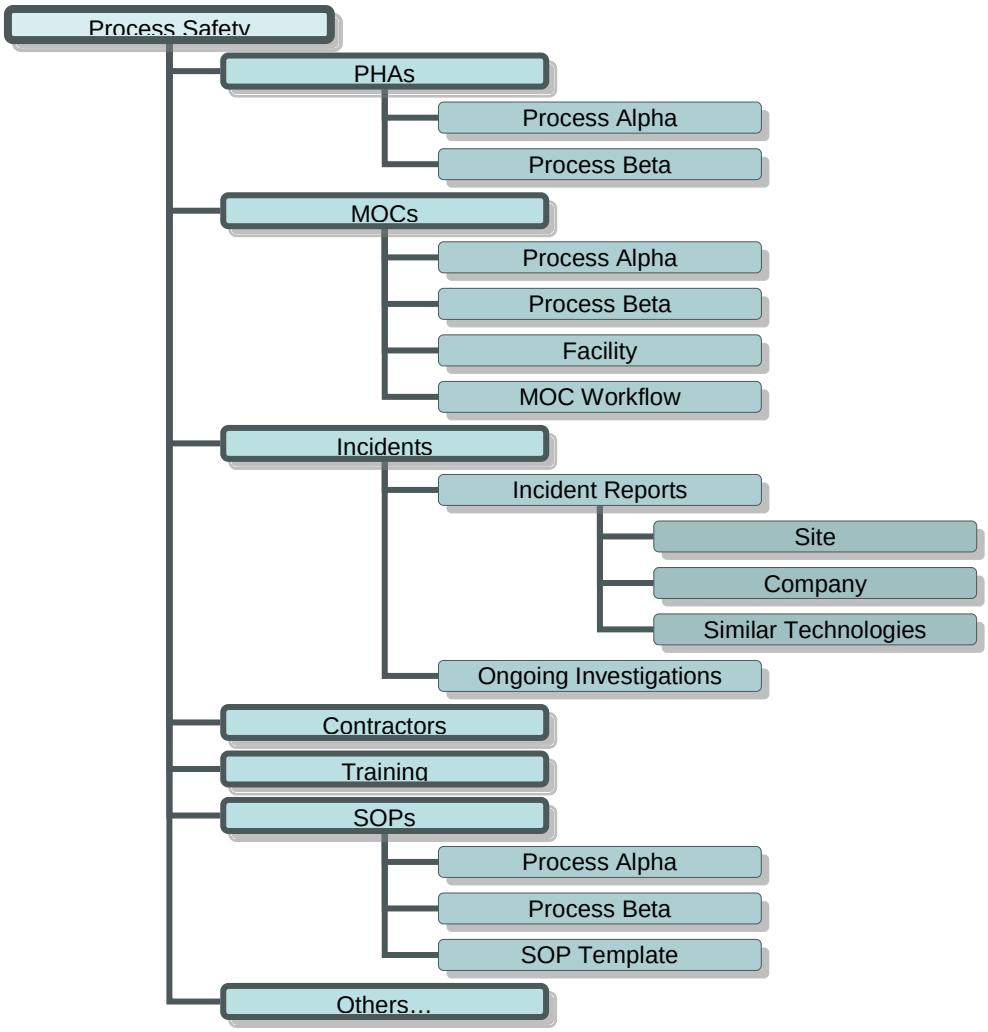

Figure 3. Process Safety File Structure

As can be seen from Figures 2 and 3, there are common documents in both file trees such as SOPs, PHAs and MOCs. These are the documents shown but there could be another category under PSM that could be called Plant Information, and in it would appear the P&IDs, Maintenance Procedures, Equipment and Instrument Files, etc. Obviously the same files would appear in another classification under Project Engineering for P&IDs and under Mechanical Integrity for the Maintenance Procedures and Equipment Files. How? Again, by using virtual copies which means that it is exactly the same document that appears to the different viewers in different file folders.

Each department would have a folder structure based on the needs of the group. The Operations group can be divided into the various process technologies or process areas existing in the plant (in this example only two, Alpha and Beta) plus a common folder where forms, general safety information, a bulletin board and any other document of special interest to Operations would appear. In

reality at least an additional folder would be useful: a management or administration folder. This folder would be more secure and contain for example, production plans, resource estimates, work schedules, and Operations personnel performance evaluations.

Document Control and Security

In order for our library to work the ownership of every document and every folder needs to be defined. Most of the ownership will be by groups, although individual document ownership (and/or authorship) is easily recognized by the system. The Operations group will be the owner of the SOPs and if necessary, that ownership can be split among the operating areas. Depending on the desired security of the documents, e.g. to protect trade secrets, viewing the documents may be restricted and outsiders may not be able to open and read the documents even though they could have access to the folder where the documents reside.

Typically, ownership will fall to the document creator(s) or maintainers who are the subject matter experts. Ownership may change during the life cycle of a document, for example, an SOP that gets written initially by a process engineer will be modified and become the property of operators or trainers until the SOP is approved, when the ownership passes to the area superintendent or Operations manager. After approval when the SOP becomes official, the ownership will be restricted. The owner can then only decide who can view the document but not change it anymore. If an SOP is to be modified (through the MOC process) a copy of the official SOP will be generated and worked on. Once the new SOP is approved it will replace the old one as a new version. The old version will still be available but controlled—it cannot be changed. The system will keep the new version on top, that is, if the SOP is requested, only the new version will be shown. The DMS will keep tabs on all the changes.

By having this type of security each department or group can keep control of the documents it is responsible for. It can decide when these documents will be 'published' (made available to others) and what is the best way of sharing them. Of course these decisions cannot be made arbitrarily but have to take into consideration the needs of the organization. This process eliminates duplication of documents (and duplication of effort).

Creating and Maintaining the Knowledge Repository

In creating this new library of knowledge existing data collections should be replaced only when it makes sense. For example, the existing P&ID database should be kept if it is already tied to a workflow and permissions and is readily accessible to all that need the drawings. Although each P&ID could become a document in the DMS, chances are that duplicating the functionality of a CAD system will not be practical. Therefore the best way is to use a pointer or link to this database as the "document" that would appear in a specific folder. In the

DMS this will be an icon that looks like a document labeled ‘P&IDs’ that when clicking on it will open the database. By the same token an incident database can reside side-by-side with incident investigation reports in the DMS. The incident database would have data such as date of the incident, chemicals involved, type of incident, process, etc, which facilitates manipulation and development of statistics or metrics. The reports would have the detailed investigation, analysis and root causes.

Maintenance of the library will be shared by the various groups and each will have its own workflow of document creation, development, review, approval and internal publication. The process becomes easier in many ways since the DMS will keep track of the versions and security and the author doesn’t need to e-mail his drafts to the reviewer/approver but just indicate the location of the document (one way to do it is by e-mailing the link to the document). Thus, unnecessary duplication of uncontrolled versions is avoided.

Security is best handled by assigning the desired security to a folder rather than a document. A document moved into a folder inherits the folder’s security. This also facilitates the workflow since if there is a folder named Incident Reports and one named Ongoing Investigations as shown in Figure 3, the former may be information that is ready to be shared outside the PSM group, and the latter information that still needs completion and approval before it can be shared and therefore its access is restricted. When the report is finished and approved it only takes dragging it from the Ongoing Investigations folder to the Incident Reports folder to make it available to everybody.

Improved Process Safety

In conclusion, by being able to accumulate knowledge as we go along with the assurance that the knowledge is correct and appropriate, and by being able to easily share that knowledge we minimize human error and thus improve safety. Using the tools (the DMS) and the methodology described above we haven’t just improved the existing Process Safety Information (PSI) but we have created a mechanism to continually maintain it, and most important, to make it readily available to those that need to use it.

Of course the concept of a knowledge repository is not limited to the PSI. If this concept is taken beyond it and applied to all the organization’s documents we can see that a leap in efficiency would be obtained.