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**“The Need to Teach an Integrated Approach to
Process Safety Management to
Undergraduate Engineering Students”**

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Introduction:

The topic of safety and loss management (S&LM) is not an easy one to understand. It requires a commitment by a company to do the right thing and a belief that by acting in a proactive manner a company can effectively manage the risk(s) they have chosen to accept. That commitment starts from the top and becomes part of the way of doing business. If every company were to look at their processes for getting work done, each process should have an analysis of what the potential risks are. Are the risks acceptable, and what needs to be done to ensure the potential incident does not happen? But, as well, an on going process is needed to identify changes, which may have impact on that risk or introduce more risk to the company.

One such change (risk) that cannot be overlooked is the new employee and for this paper specifically the new engineer. How do we bring their knowledge of risk up to a level that would make them an acceptable risk to a company? Understanding the fundamentals around determining risk and managing risk is a complex topic. Can a company, regardless of size, ignore providing these fundamentals to a new engineer as they embark on their career? As S&LM is a very complex topic it could be argued that a company is unable to provide the necessary training and understanding of these fundamentals. This is why it is important to provide these fundamentals as part of the development of an engineer.

My early experience in the chemical industry showed me that from a safety and loss management view I was not well prepared and in fact the company I joined took a chance (a risk) on me. Wiser employees and supervision guided me through much of the S&LM issues but it was not until several years later (I estimate 7 years), where I really felt I had a good grasp of all the safety and loss management elements that were appropriate for the times. Today we now, of course, use the more complex and detailed

elements recognized in the “globally accepted concept” of Process Safety Management (PSM). Because, the company I worked for did not have a specific program to teach these elements to new engineers, what we learned were from shared experiences of those around us. Now this was back in the late 60’s and early 70’s before Integrated S & LM was used but none the less equally important.

I was making decisions, then, that had a potential impact on the safety and health of workers, on the safety of the public, on the environment and that could affect the protection of company assets and its business. In fact I probably do not realize some of the impacts I did have and just how close I came to having unacceptable incidents. I was making these decisions very early. Within 6 months of starting I was on-call making many decisions over the phone late at night not thoroughly analyzing the situations for all possible consequences. And feeling the pressures of cost and production schedules influencing the decision making process when they should be considered in a balanced view.

Today, the same approach is not acceptable. The changes in society make it a very important issue for companies (small or large) to solve. Society expects companies to perform in an acceptable fashion. The public in general is more outraged than they ever have been at industry making this topic more of a priority to be addressed. But the new engineer is still put in a position of making decisions with potential negative impact.

We as an industry have come a long way since the 60’s and early 70’s when it comes to PSM. The concepts have been developed and tested in the workplace. Many governments in legislation now accept these same concepts. Professional ethics requires it and the public knows and expects it from us. The challenge for companies to provide this knowledge is a very large one. It is often not done in a formal comprehensive way leaving many important elements left out. The overall concepts of S&LM require an understanding of all the elements in order to be the most effective. So, how do companies do it? With great difficulty.

In Alberta this concern was felt in the late 1980's when a program jointly funded by industry and government in conjunction with the Faculty of Engineering at the University of Alberta decided to teach the fundamentals of safety and loss management to undergraduate engineering students. It was clear from the beginning that all disciplines of engineering (not just chemical) needed to learn these basics. Some have made it a compulsory subject. The program consists of two full term credited courses; the first is a general approach to the concepts of how to manage safety and loss in the workplace. The second course focuses on risk determination and management. The content is built on the fundamentals as mentioned above and discussed later in this paper. There is enough content available to easily fill both courses which are given full credit towards a student's engineering degree.

We are finding our students do learn the basics of an overall program. They are prepared to walk into a company where a program exists and immediately become an active participant contributing to the overall success of that company's business. They will provide an immediate resource for companies where programs are weak or do not exist. In both cases lowering the risk of hiring a new engineer to an acceptable level. We have seen this from the feedback received by students as they interview for jobs and from companies expressing a desire for students with this knowledge.

Hence the need to effectively prepare our new engineering graduates with these complex skills which are becoming more complex as more is learned around the topics. In fact industry has carried the weight of developing the safety & loss management (PSM) concepts so far but to develop them further is becoming more and more difficult. It is time for academia to become more involved.

Looking at the topic from different points of view serves to confirm the need for having engineers understand the fundamentals. Here are a few thoughts:

The Company

Why should a company be concerned? RISK. More than ever, the responsibility for incidents lands in the lap of management. Management is being held accountable and the new engineer is probably one person who can put management at greater risk.

The impact of an incident can have major repercussions. Those outcomes can mean injury to people, damage to the environment or affect assets and business. An incident could also lead to loss of business, loss of company prestige or even the failure of the business.

The larger companies are better off than the medium and smaller ones simply because they have the resources to do an effective job. Although this is not the case for all companies it is generally true. But the point is all have the potential to be impacted negatively. It is interesting to note that most engineers will find their way into the small and medium sized companies where resources to perform good safety and loss management are often not there. Here the new engineer is put on the spot even more.

Profession

Being a profession requires managing the activities of members in a way to ensure proper attention be given to doing the “right thing”. The various “professions acts” where requiring the safety of the public and protection of the environment be incorporated in all we do, among other things, delegates a significant responsibility onto the shoulders of its members. Increasingly professional members are being challenged around their activities in this regard. They are being challenged through the courts too. Due Diligence is a prime topic of training these days.

Public

The public is deeply concerned with the industry. Government, as the arm of the public, has paid much more notice and will continue to do so. Our responsibility to the public needs to be paramount in our minds as we design, construct and operate processing facilities. As a matter of fact, we have not responded well to this concern in past years.

Evidenced by the regulations now in place to govern PSM in the workplace and to communicate hazardous scenarios to the affected public.

Academia

The development of safety and loss management and risk management has largely been done by industry either individually or through associations. But academia has not been much of an active partner. The tools used today have evolved to be more sophisticated. The new knowledge gained from experiences around the world is readily available but needs to be effectively incorporated into the existing structures used today. This expansion of knowledge is where academia needs to step in. There is an opportunity to expand this topic and move into the field of research.

What is Integrated S & LM?

An integrated Safety and Loss Management program is:

“The integrated approach to the management of the continuous reduction of risk to people, the environment, company assets and ability to do business in an industrial setting. Those who benefit from this risk reduction are company employees, associated contractors and the public at large. “

In the chemical processing industry the elements of an integrated program are presented in terms of PSM (Process Safety Management). When these PSM elements are looked at individually they do not have a particularly strong impact. And, in some cases do not become important on the list of activities a manager needs to be paying attention to. But, when they are associated together with the topic of PSM they take on new and more significant meaning. Providing a large enough topic to not be lost in the priorities of management.

Understanding the significance is best done in a program drawing all the elements together into one and to study the way each element contributes to a successful program. And, of course, how each element complements other elements. This is what we teach. Each student will have a clear understanding of these elements and will look for them when they embark on their careers. When they begin their careers they

will have expectations that the company they work for will have such a program in place to manage these risks effectively and they will fit in. If not they will have a valuable resource for the company to use to improve on their program.

In the second term course we focus more heavily on the process of doing a risk assessment which is one of the elements of a safety and loss management program. This too provides the student in the chemical processing industry in particular, a cursory understanding of the tools available to do the assessment. They learn that there are many tools from the easy to do field audits to the most complicated QRA (Quantitative Risk Assessment). The selection of the most appropriate tool or tools to use to analyse a hazard for risk and the how to conduct a risk review are all highlighted in the course.

The method of teaching includes a balance of in class lectures, seminars, industrial field trips, use of outside guest lecturers from industry and government, looking at case studies, and applying the gained course knowledge to an actual incident in history in the form of a team project.

The elements as described in OSHA-PSM are:

1. Accountability; objectives and goals
2. Process knowledge and documentation
3. Capital project review and design procedures (for new or existing plants, expansions and acquisitions).
4. Process risk management
5. Management of change
6. Process and equipment integrity
7. Human factors
8. Training and performance
9. Incident investigation
10. Standards, codes and laws
11. Audits and corrective actions
12. Enhancement of process safety knowledge

These elements describe what is expected in an industrial operation. However, in order to teach the elements effectively we have chosen to focus more on the ILC-DNV elements as a clearer way to present the elements. These are shown below and are the ones taught in

the Industrial Safety and Loss Management Program at the University of Alberta. These elements are:

1. Management leadership, commitment and accountability
2. Risk assessment, analysis and management
3. Design, construction and start up
4. Operations and maintenance
5. Employee competency and training
6. Contractor competency and integration
7. Management of change
8. Incident reporting, investigation, analysis and documentation
9. Operation and facility information and documentation
10. Community awareness and emergency preparedness
11. Program evaluation and continuous improvement

For example if one talks about training in the context of Safety and Loss Management it becomes apparent that good training including refresher training are key to a successful S&LM program. The impact of poor training can be easily visualized in terms of consequences. Similarly, doing project reviews or auditing existing facilities for hazards and potential risks have clear benefits from the effort put forward towards looking for potential problems.

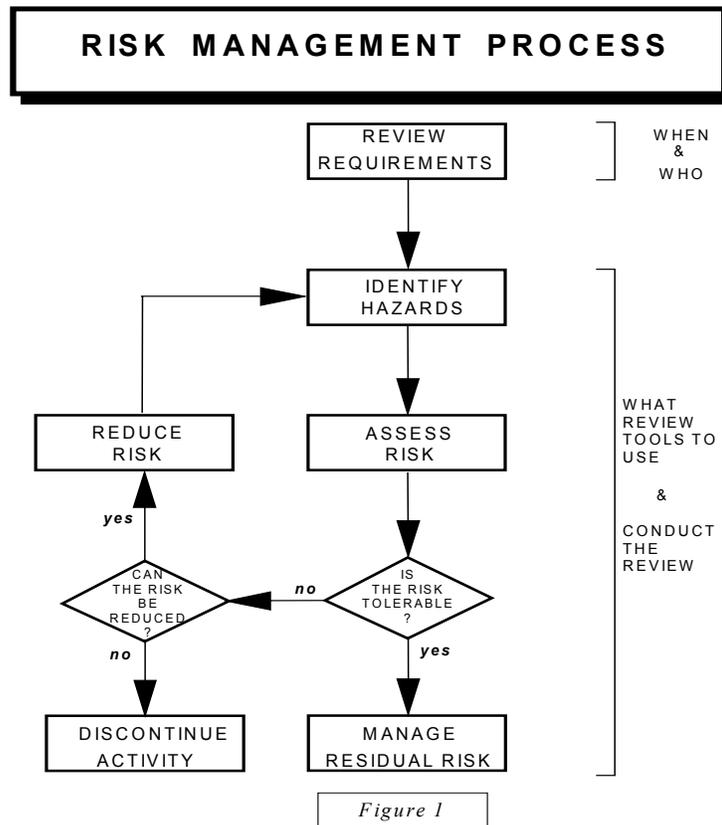
Some topics included in the lectures:

- programs such as Responsible Care are included in the lectures.
- the workings of the Workers Compensation Boards,
- how the government regulates and monitors industrial activities,
- how labour views safety and loss management,
- how senior management views it,
- concepts around occupational health and industrial hygiene,
- the troublesome environmental risk arena where it is hard to determine what risks are most important,
- impact of human factors in the workplace
- risk communications,
- consequence modeling,
- working in a team atmosphere,
- producing an incident analysis with recommendations to a management team of real managers.

The courses use the following “Risk Management Process” flowchart (figure 1) to clearly describe the overall risk management process. Here the students will understand that

being proactive and actively looking for hazards is where it all starts. They will learn the need for management support in order to complete the risk analysis, as these reviews will consume resources without the typical ROI (return on investment) analysis. They learn that the prevention of an incident easily justifies the expenditure of time to analyse for risk.

They will learn the concept of “acceptable level of risk” as everything we do has some level of risk associated with it. What is acceptable is looked at using the risk matrix approach common in industry today (shown below in figure 2). The importance’s of ensuring all employees understand what is acceptable and what is not. The fact that some things will be unacceptable no matter what is done to reduce the risk and that management needs to discontinue the activity in that case. And finally, the residual risk left over. This being the biggest box and the one where all the integrated S&LM elements are used to manage the risk.



Levels of Risk:

- Acceptable = L (Low)
- Acceptable with additional controls = M (Medium)
- Unacceptable = H (High)

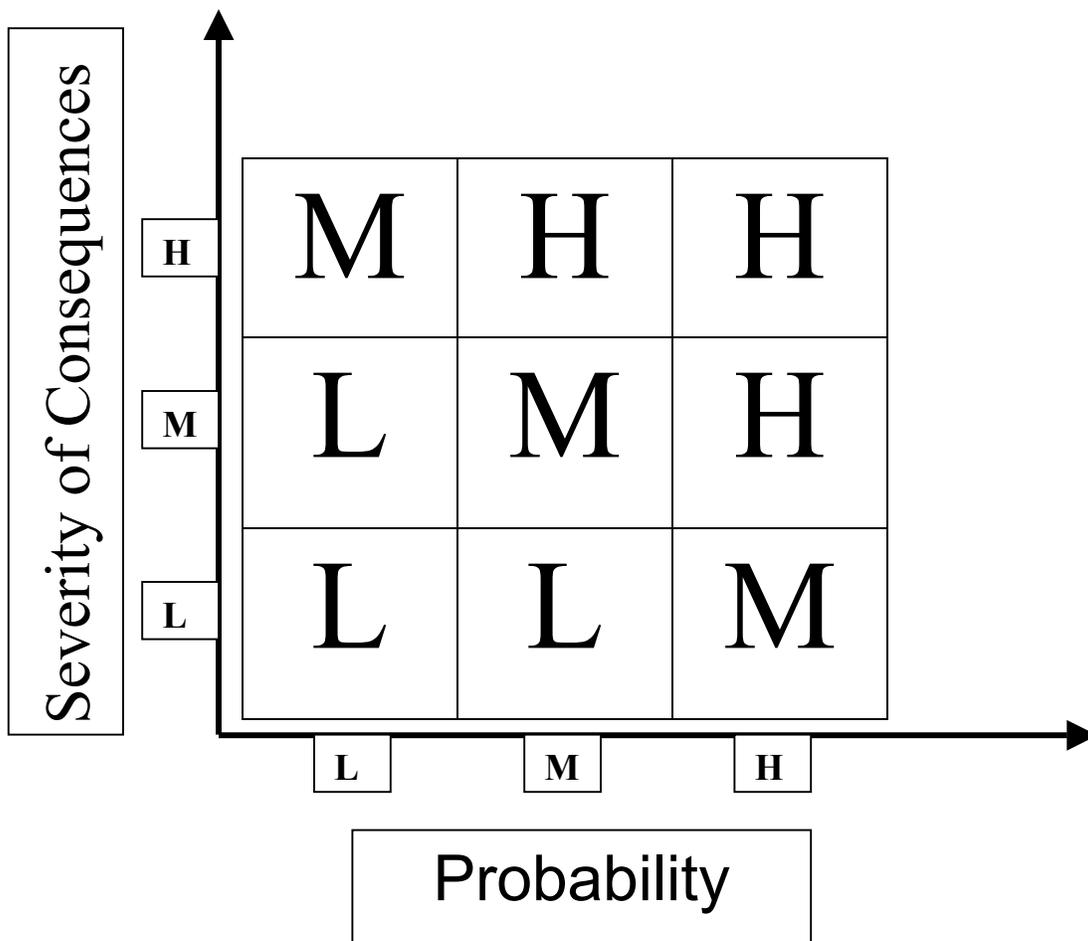


Figure 2

Summary:

The newly graduated engineer has an immediate effect on the level of risk a company is accepting. In today's complex world engineering companies must recognize their responsibilities to ensure the new employee is prepared properly to understand the risks, understand how the company manages the risk, and to be able to contribute towards reducing risk further.

The field of safety and loss management is a complicated one growing more technical and complex daily. The concepts are important and companies do not have the ability to teach them. University engineering programs therefore should be teaching this topic as a fundamental part of any engineering program.

By including this training in the engineering curriculum, the new engineer will contribute beginning at the entry level of their careers. This will be part of their way of getting work done. And, as their careers progress the company will benefit. All people they are in contact with will feel they're understanding of the topic around safety and loss management and risk management in their daily activities. The result will be an influence on the company's culture in a positive way.

However, remember most newly graduated engineers are still impressionable (as all graduates are). Whatever the company's practices are around safety and loss management will impact how they see that company. By hiring engineers with a sound basis in this field and by creating an atmosphere where they are challenged to use that knowledge will set the stage for a strong organization in the future. Be careful not to discourage their ideas.

It has been a pleasure to address this conference. Thank you for your consideration.

I welcome comments and further discussion on the topic. Please contact me at your convenience at:

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