Chapter 8 Conclusions

8.1 Introduction

The main aim of the work presented in this thesis has been to study the way industry currently perform risk management and to find ways of improving certain aspects of that process. This aim has been carried out through a questionnaire, identifying the most common and successful ways of executing a risk management process. The information comprising the questionnaire was gathered from an extensive survey of the most up to date literature on the subject. The subsequent results identified an aspect of the process, the quantitative risk analysis stage, which required urgent attention. The improvement of this stage, which was presented in the case study supplied by AHL, introduced the @RISK package, which provided the tool for the ensuing simulations. It was the input data that was deemed imprecise, which ultimately expressed the resultant output probabilities with an unspecified amount of uncertainty. To remedy this condition, probability distributions were implemented into the QRA in replace of the present single point values. Normal distributions were selected for the exercise, classified by their mean and standard deviation. The resulting output distributions provided a spread of results with respective probabilities. A number of statistical parameters were also usable depending on the analyst's partialities. From this additional information better decisions concerning the risk could be made.

This chapter presents a list of definitive conclusions which have been ascertained from the work described above. The observations are sub-divided into sections based on the general areas of research investigated and are presented together to allow an overall appreciation of the findings. All conclusions are highly relevant to industry.

8.2 Conclusions from the Literature Survey

1. A comprehensive risk management process should consist of 5 steps. These 5 steps include identification, estimation (identification and estimation are collectively called 'analysis'), evaluation, response and monitoring.

2. The risk analysis (estimation) techniques are divided into two broad categories, namely qualitative and quantitative. Qualitative techniques are used to distinguish the possibility of the risk occurring and its consequence in a linguistic manner. Quantitative techniques apply numerical probabilities and frequencies to the likelihood and consequence of identified risks.

3. There are 4 different ways of responding to risks. These 4 are risk avoidance, transfer, retention and reduction.

8.3 Conclusions based from Risk Management Questionnaire

1. The questionnaire was formulated, designed, posted, and successfully received from 139 respondents. This equates to a response of 21.65%. However, because six copies were sent to each company, not all six were able to be completed. The response from the companies the questionnaire was sent to reached 48.60%, which is regarded by any survey to be a success.

2. The proportions of the job responsibilities of the respondents from both industries, apart from two, were relatively comparable. The two differences were the safety/risk and finance departments. The oil and gas industry were predominantly from the former department (41%) with little representation from the latter (2%), whereas the construction industry had a higher response from the finance department (22%) and less from the safety/risk (14%), implying the oil industry views risk from a more technical perspective, whilst construction perceives risk as financial.

3. Certainly at the present moment, as risk management is still relatively a new area, the process of managing risks is required to be performed in the existing schedule for a project, and hence there are time boundaries on the assessment. This subject needs continual assessment throughout the life-time of any projects and in the future, the project durations and schedules will need to be extended to allow thorough and comprehensive risk analyses to be undertaken.

4. Extensive lists of both qualitative and quantitative risk analysis techniques were given. The preponderance of respondents (72.1% from construction and 97.6% from oil) believed their company uses a combination of both techniques for analysing risk. The most successfully used techniques to date under the two categories are as follows, in Table 8.1:

Qualitative		Quantitative
Personal and Corporate experience	*Decreasing success*	Scenario analysis
Engineering Judgement		EMV
Brainstorming		ENPV
%age contingency from historical data		Break-even analysis
Interviewing		Decision tree
Fuzzy set analysis		Decision matrix
		Simulation
		Algorithms
		Risk adjusted discount rate
		Stochastic decision tree
		Bayesian theory
		Portfolio theory
		EMV using a Delphi peer group
		Stochastic dominance

Table 8.1 *Ordered list of the most successful techniques*

However, there were some interesting developments and results under the quantitative techniques, which suggested that the top five methods will continue to be used but the next three, with particular focus on simulation, could be more frequently applied with enhanced success.

5. The risks that these methods are endeavouring to analyse are listed in Table 2.2 and were attained from the final section of the questionnaire. The replies from this section ascertained the importance given by the respondents to a number of risk types. The two industries, construction and oil, differed on the importance of risk types, shown in Table 8.2:

Construction Industry		*Oil Industry*
Financial	*Decreasing*	Financial
Technical	*importance*	Technical
Time	↓	Operational
Operational		Environmental
Environmental		Time
Political		Political

Table 8.2 *Ordered lists of risk importance*

6. When the companies, through their safety officers, risk analysts etc., are faced with risks, there are a number of response methods available to them. The order of popularity from both industries is headed by risk reduction, followed by risk transfer with risk retention being least used. There are also a few other methods coming under the broad title of risk elimination. The construction companies regard risk elimination as being approximately equally utilised as risk retention, whereas the oil industry lists this response method below the other three.

7. Such risk reducing methods most prevalent, and successful, in todays companies are prevention by educating employees and to improve working conditions. A bonus system for improved safety standards has been proven to produce some success, but lies a distant third. The method of risk sharing is also determined to be a successful technique, with 'excess or deductible' being the most often form practised.

8. When transferring risk, the construction industry prefers to use both specialists and through financial transferral. Conversely, the oil industry prefer to transfer the risks financially. Insurance and exclusion or indemnity clauses in contracts

are the most popular way of financially transferring risks. Again, risk sharing is frequently used. Companies who have ever used captives, are still using one with 82% of them believing that it is the best way of insuring ones risks. This is a situation that may prove useful to the construction industry in the future. The oil industry has to effectively manage all projects until their decommissioning date. If a risk is transferred to a third party, control over that risk is to some extent lost. Construction companies that are involved in privately financed and owned projects cannot afford to lose control of such aspects and must either retain or reduce the risk, or transfer them financially.

9. Eighty five percent of respondents replying to this method, actively retain their risks. The main reason for retaining these risks is because the required insurance premium is judged to be too high. Internal funding and absorbing losses as part of current operating are currently favoured for financing retained risks.

10. The money spent (as a percentage of the total project cost) on risk analysis does not compare with the money spent on the management of the project. The average percentage of the total cost for the management of the project is 6.62%. Conversely the equivalent figure for risk management is 1.25%. Whether these values will increase over the next ten to twenty years is unknown. Certainly for the risk analysis percentage, there are signs suggesting that it will (see Figure 4.24 and section 4.7.1). The losses through unforeseen risks is presently regarded as above ideal. The majority of respondents feel that these values could be decreased by performing a more thorough risk analysis.

8.4 Conclusion based from the Case Study

1. When one examines the techniques used to analyse risks, the results from AHL employees, when compared against the oil industry and one other leading oil company, named 'Y', identify that the frequency and success of the qualitative techniques are comparable amongst the three divisions. Conversely, the

quantitative techniques present a different picture. The percentage values for the success of the used techniques are relatively poor in comparison to the industry and company Y. It was from the results to the latter two divisions that led the author to identify simulation as one of the techniques that could be improved. Others methods could have been pursued, but simulation had much literature explaining that it could be the future of risk analysis.

2. The main problem with the QRA was the imprecise nature of the input data, see also conclusion 3 in this section. The input data, concerning the technical risks examined in this thesis, is never going to be 100% accurate for a number of reasons. The main reasons being that the sample sizes of similar accidents are extremely limited and no one installation and all its associated components is identical to the next. So, the objective of this thesis was to identify the best possible estimates for all the branches of a specific event tree (Event I/21 (100mm)), which evidently would give the most accurate answer. However, because of the uncertain nature of this data, normal probability distributions were attached to each single point value and a simulation was duly performed, whereby random probabilities would be selected for each branch, under the envelope of its specified input distribution. Each run of this simulation resulted in one iteration and 10,000 were executed. The resulting outputs graphs improved the analyst's decision making process, as well as accumulating a multitude of advantages over the single point value technique currently adopted, see section 7.8.

3. The traceability of the initial frequency and probability values requires urgent attention. Most of the main risk analysis documents, like the FRA (WS Atkins, 1992d) or the integration QRA (AHL, 1996b), are originally attained from data references, such as OREDA (DNV Technica, 1992b) or WOAD (Veritec, 1988) etc, and are very hard to trace as to their origin from these sources. The author understands that no two situations or scenarios are never exactly alike and therefore the figures must be used with caution. However, it would be extremely

useful and good business sense for the figures to be explicitly derived by identifying which page or table or figure they were attained from. If the values are not contained within these historical databanks then equations and macros are used. These are contained within highly descriptive and informative spreadsheets, some are confidential and others are not, which are cumbersome to say the least. Understanding them and producing results from them and understanding how probabilities were updated or attained originally is almost impossible. Assuming the writer of the spreadsheet were to pass it on to another person for usage then the system does not seem to be user friendly. This entire problem would be prevented if the method proposed in Chapter 7 were to be implemented, as the adjoining cells in Excel to the data could be used to describe the data's origin. This technique generally leads to better business all round.

4. Finally, there seems to be some confusion over which numbers to use for the event trees. Whichever values are selected there should be a clear statement, as to its origin and how they were calculated, in the document where the trees are present. There are unspecific paragraphs explaining these, but these are not sufficient for any person to read and calculate the probabilities. This could account for the lack of confidence in AHL success of their QRA techniques.