

## POST-BHOPAL BEHAVIOUR AT A CHEMICAL COMPANY

EDWARD BOWMAN

HOWARD KUNREUTHER<sup>[1]</sup>

*Wharton School University of Pennsylvania, USA*

### INTRODUCTION

The Bhopal disaster where Methyl Isocyanate gas escaped from a Union Carbide plant led to more than 2000 deaths and caused illness in countless others. Chemical industry officials are particularly disturbed that an accident such as Bhopal could occur in what is reported to be the safest manufacturing industry in the United States. The tragedy stimulated moves in the United States that will change the handling and production of toxic chemicals as well as the dissemination of information on potential hazards and safety precautions for toxic and hazardous substances to the public.

This article examines some of these changes by looking at the behaviour of a large chemical company not directly involved in Bhopal (which we have given the pseudonym Chemco) following the Bhopal disaster. Our interest is in determining what type of actions Chemco has taken in response to this type of low-probability-high-consequence event. In particular, we are interested in analysing the firm's behaviour using a conceptual framework grounded in organizational theory and behavioural decision theory. Data on Chemco's response to Bhopal were collected through more than 20 hour-long interviews with different executives in the company. This article should thus be viewed as a field study that illustrates a set of conceptual ideas. It is in the spirit of studies advocated by Campbell (1975). One must be cautious in over-generalizing from single-case naturalistic observations but these empirical studies may be necessary ingredients for developing more general theories of behaviour. Our intention is to stimulate further research in the area of decision-making for low-probability events where firms feel compelled to respond to specific crises that may affect not only their future but that of the industry.

Our motivation for conducting interviews at Chemco was to determine whether managers in an organization exhibited a set of heuristics and biases which have been found empirically in studies of individuals. Charles Schwenk (1984) has argued that the same cognitive simplification strategies that have been found by cognitive psychologists and behavioural decision theorists may affect strategic decision-making in an organization. We were very sympathetic to this view before beginning the interviewing process but were careful not to inject this bias when interfacing with the Chemco executives. For this reason the ideas and the theory found in the received literature will be presented after the story line rather than preceding it.

The plan of the article is as follows: the next section briefly summarizes key events in the United States which have sensitized the public to chemical and environmental hazards, setting the stage for chemical firms' reactions to Bhopal. In the following section we describe the nature of Chemco and its activities prior to Bhopal. The next section characterizes the Bhopal disaster as it was perceived by Chemco officials and details the actions taken by the company during the aftermath of this disaster. We then develop a conceptual framework in the penultimate section illustrating its different components based on our observations at Chemco and a set of hypotheses regarding organizational behaviour following a low-probability disaster. The concluding section explores policy questions stimulated by Bhopal and outlines directions for future research.

#### THE PROBLEM CONTEXT

Chemical hazards of both a chronic and catastrophic nature set the stage for Chemco's reaction to Bhopal. The general public was first made aware of the potential negative impact of chemicals on the environment in Rachel Carson's 1962 book, *Silent Spring*. Carson, a biologist who worked at the Fish and Wildlife Service, felt that man-made chemicals were threats to life by making the air, water, and soil toxic. Her book, which was read by millions, presented a scenario to the public of the sudden eerie disappearance of living creatures on earth due to man's poisoning of the environment.<sup>[2]</sup>

In 1976, partly in response to *Silent Spring*, Congress passed the Toxic Substances Control Act which was designed to protect citizens and the environment from industrial chemicals posing an unreasonable risk to humans. As part of the legislation, the Environmental Protection Agency required the chemical industry to test chemicals for toxicity and the agency had the power to ban new chemicals which they felt were unsafe to the public.

#### *Love Canal*

Salient hazards often trigger specific legislation. The disclosure that there was a leakage of 82 chemicals at a burial site in Love Canal, 11 of which were carcinogens (including dioxin) led to national coverage in the press. Many of the families in this small community near Niagara Falls had to be relocated because some scientists claimed that the exposure to leakage from this abandoned dump might cause cancer. Interestingly enough, Hooker Chemical, which had previously utilized this landfill, warned the school board and community upon their purchase of this site that it was potentially dangerous. They had written letters to this effect, but once the health threat came to the media's attention the chemical company was portrayed as a villain.<sup>[3]</sup>

Love Canal triggered the passage of Congressional legislation in the form of Superfund in December 1980. This bill imposed a tax on the chemical and oil industries which would generate \$1.6 billion for clean-up of wastes. This legislation which was re-authorized in November, 1986 and expanded to provide over \$9 billion in clean-up funds, is primarily responsible for chemical companies today considering alternative ways of producing and storing chemicals so as to avoid the use of landfills.

*Seveso, Italy*

Prior to the Love Canal publicity, an explosion at a Hoffman-La Roche subsidiary in 1976 exposed the town of Seveso, Italy to a toxic cloud of dioxin causing severe illnesses to animals and serious concerns that individuals' lives would also be affected. The accident at Seveso resulted in a document, known as the Seveso Doctrine, which specifies a set of rules to be followed by chemical plants in the European Economic Community for improving the health and safety of their workers and residents near the plants. As we shall see later in our discussion of Chemco's reaction to Bhopal, there was an interest by the company in developing new rules and regulations modelled after the Seveso Doctrine.

*Three Mile Island*

The Three Mile Island nuclear power plant accident in 1979 made the public aware of the limitations of scientific expertise in anticipating the potential dangers and risks associated with new technologies. More than one newspaper article has compared the accident at Bhopal to the TMI disaster, noting that Bhopal is to the chemical industry what TMI is to the nuclear power industry. In both cases there has been increasing concern by the general public in minimizing the possibility of severe disasters in the future.

## NATURE OF CHEMCO

Chemco is a profitable multinational chemical firm in the top Fortune 500 with plants around the world. Prior to Bhopal its principal health and safety concerns were with employees and with chemical hazards causing chronic illnesses, notably cancer. For many years Chemco, along with other chemical companies, had also been concerned with acute risks to employees and the surrounding community associated with the production and storage of chemicals. Formal techniques of risk assessment such as Haz-Op analysis are used to reduce the risks for operating a plant. Other analytical methods, including fault tree analysis, draw on the generic concept of decision trees.<sup>[4]</sup> Such calculations were part of Chemco's decision process for evaluating the impact of low-probability-high-consequence events associated with alternative technologies and plant location proposals.

In the early 1970s one particular chemical was associated with causing an abnormal number of cancers in one of its plants. In addition to the real grief about the deaths, the company was sufficiently concerned about the adverse impact of court suits related to this chemical, that the top executives spent considerable time exploring future courses of action for improving health and safety regulations. The company was a strong initiator and supporter of the Toxic Substances Control Act (TOSCA) of 1976, which required the testing of all potentially toxic chemicals.

One of the Chemco plants was located in the vicinity of a landfill which they utilized for disposing of some of their waste. Community residents expressed considerable concern that chemical contamination from the landfill was responsible for polluting a nearby river. The firm commissioned a study which, upon completion, revealed in six volumes that the landfill posed practically no threat

to the community. This behaviour by Chemco reflected their concern with community relations, an area which received even higher priority following the Bhopal disaster.

The Love Canal publicity coupled with Superfund legislation were additional reasons why Chemco and other companies began to investigate major changes in their policy for storing waste. Specifically, there was a concerted effort to move away from landfills and investigate incineration of waste either through specialized middlemen or by constructing their own incinerator. In the case of Chemco a report outlining steps that could be taken in this direction was presented to the Board of Directors in 1983, one year prior to Bhopal. The Company adopted a solid waste management policy to reduce landfills to the minimal practical level and eventually to build their own incinerator for use by some of their plants.

In addition to a concern with direct damage awards following accidents, Chemco and other companies recognized that the general public exhibited 'chemophobia', a term used by US Representative John Dingle. Due to these fears, Dingle asserted that if the chemical industry didn't regulate itself in the near future, then Congress would. It is thus understandable that when Bhopal occurred, Chemco and other firms viewed it as essential to take immediate steps, even if they had no direct involvement in the accident.

In fact, Chemco had reacted to all these issues one month prior to Bhopal by setting up an Environmental Affairs Council (EAC) consisting of two members of its Board of Directors and two outside experts. The EAC was designed to provide a broad and objective perspective on some of Chemco's problems associated with chronic illness as well as its landfill problems. However, following Bhopal, the EAC turned its attention toward catastrophic disasters and the strategies that should be adopted to reduce both the chances of these accidents occurring in the future and their potential impact.

#### THE INTERVIEWS AND EMERGING STORYLINE

For several months prior to Bhopal we had been interviewing executives at Chemco about how their company was dealing with potential hazardous waste problems. The Indian disaster presented us with an opportunity to focus on how corporate behaviour was influenced by a low-probability catastrophic event that occurred at another company's plant. Within one week of the Bhopal disaster we began a systematic series of interviews extending over a year with over 20 Chemco executives whose jobs were impacted by Bhopal. We let each person tell his own story as to how Bhopal affected Chemco's activities.

No attempt was made to structure the interview except by asking several broad questions related to the impact of Bhopal on their jobs, their group or division and the company itself. In other words, we tried to intervene as little as possible in the interviewing process. In this sense we followed the approach advocated by Michael Piore (1979) whereby one abstracts from these stories a view of the world reflecting both individual concerns and corporate culture. Through this process one may then be able to interpret specific programmes and advocate new policies in ways that seem plausible to the people who will actually implement them.

Although most of the individuals did not find that their job had changed radically because of Bhopal, there were a few notable exceptions. For example, both the process hazard and the safety managers considered Bhopal an add-on to their current jobs, so that their work week suddenly expanded to seven days. A safety team, established to investigate potential dangerous chemicals in Chemco plants, clearly had additional responsibilities which took them away from their normal work. As a result, plant safety activities and other risk studies such as Haz-Op analyses temporarily received lower priority by corporate officials. A district general manager was given a new assignment to work with communities over the next two or three years by focusing on risk identification, risk assessment, and risk management.

On the firm's direction, Chemco executives took a number of systematic steps following Bhopal to reduce substantially the potential for catastrophic accidents in the future.

#### *Step 1: Questionnaire Development*

Within a day of the disaster, it was apparent to Chemco that this was a crisis of major importance which would affect the entire chemical industry. The company viewed the accident as a signal to the public about the potential for future accidents of this type within the United States and elsewhere.

A questionnaire was prepared two days after Bhopal and telexed to all plant managers around the world requesting the following information:

- (1) What is the nature of the volatile toxic and flammable chemicals in the plant that might cause catastrophes?
- (2) What are the potential population exposures within various distances if an event occurs?
- (3) Are there any specific evacuation plans that have been prepared for the community and for the plant for dealing with Bhopal-type vapour cloud events?

#### *Step 2: Formula for Chemicals with Vapour Cloud Potential*

Immediately after Bhopal Chemco established a team of three people from the corporate safety and engineering divisions to examine responses to the questionnaire. One of the team members developed two empirical formulae which provided measures of the relative toxic and explosive risk from different chemicals produced by Chemco or utilized in their plants around the world. These formulae were designed to rank the potential impact on the population within one mile of the plant based on such data as potential spill weight in tons of material, vapour pressure, heat release, gas density, and a lethality measure. Calculations were made for chemicals at each of the plants with lethal potential ranging from a low of 1 to a high of 300. These values were relatively low compared to the hazardous chemical methyl isocyanate (MIC) at Bhopal which was rated at 2400 by the formula. An initial value of 10 was arbitrarily chosen as a cut-off for determining whether a chemical should be examined further by the study team. The result: 20 per cent of the chemicals were actually inspected on site because their relative potential risk was greater than 10. In early 1986 the *cut-off* was reduced to 2 so that additional chemicals have now been inspected.

*Step 3: Plant Inspections*

In early February after Bhopal specific plans were made to actually visit the relevant plants producing or storing these potentially dangerous chemicals. A training/learning session was held at the plant which had the highest number of chemicals with potential exposures. All inspection teams participated in this session in order to standardize their procedures for use at the other plants. Each plant so selected was normally visited by a team of three people. They talked to several levels of management at the plant and they physically inspected much of the equipment, especially the safety features, such as relief valves, and overflow vessels.

*Step 4: Recommended Changes*

Following these visits the review team provided each plant with a set of recommendations on ways in which they could reduce the future risk of catastrophic accidents. Before a final report was issued, plant managers had an opportunity to react to these recommendations, and provide their own view as to their appropriateness. In making these recommendations the review team did not estimate the cost of implementation, but rather focused on how risks of an accident would be reduced. Their principal objective was to avoid *worst-case scenarios* in the future.

These recommendations emphasized ways of making the community safer, sometimes at the expense of the plant. For example, if there were a potential danger associated with a derailment of freight cars carrying toxic chemicals, then the preliminary safety team report recommended that derailment be towards the plant rather than a nearby river because of fear of chemical contamination. There was some resistance to this proposal by plant managers concerned with worker safety and the recommendation was changed. Trade-offs such as these are bound to emerge when discussing changes in operations.

The most significant recommendation was to reduce inventory of specific chemicals which might be stored at the plant, such as chlorine and ammonia. Consideration of costs after the fact revealed that such a policy would not necessarily be much more expensive than the current practice.

All the plants had disaster evacuation plans for their employees, which were outlined in company manuals. However, only one-quarter of the plants had evacuation plans for the community. A recommendation was made to develop these plans more fully with assistance from community leaders.

*Step 5: Implementation*

Additional phases of the Bhopal activities involved the implementation of policy guidelines by different plants. There was a feeling by general management that the costs associated with most of these changes were relatively small so that they could be undertaken without much difficulty. One major change involved the implementation of new methods for processing raw materials to reduce inventories. For example, there had been a production process developed by a foreign subsidiary which eliminated the storage of certain raw materials through a chemical conversion process. This technological innovation was proposed for other plants.

Other suppliers to Chemco were also reducing their inventory or eliminating production of potentially dangerous raw materials. The Chemco purchasing

department had its own concerns with respect to future stocks of these goods. In one case they ordered a three-year supply of a potentially hazardous chemical due to its discontinuation by a supplier. The plant manager was most surprised to learn one day that a convoy would be arriving in several hours with a large supply of this chemical. The town fire marshall was immediately contacted and temporary refrigeration facilities were utilized to store the material. A consulting firm is now looking at the risks associated with this product before final action is taken.

There was some disagreement among executives about the affect of Bhopal on one potential company acquisition. Substantial consideration had been given to acquiring an available chemical company. The product line which would be added to Chemco's portfolio now seemed physically risky after the Bhopal accident. Chemco withdrew its proposal. In our discussions with executives it was not clear how strongly the final decision was based on a 'Bhopal effect'.

Prior to Bhopal there had been considerable interest by Chemco in interacting with the community on risk-related problems but there was only marginal interest by the town residents in pursuing preventive activities. Following Bhopal there was a spill in one of Chemco's plants and the police had to close down a nearby highway for a short period. This incident triggered many meetings with community officials to determine ways in which evacuation could proceed in the future should another accident occur. Several of the individuals we interviewed felt that Bhopal was a catalyst for this type of reaction.

On the other hand, it was still difficult to get people in the community excited about the possibility of an accident occurring in their backyard. For example, in one of the neighbouring plants Chemco announced an evacuation drill that would affect 15,000 people in the area. Despite efforts by Boy Scouts and others on a door-to-door basis to inform people about this trial only 500 of the residents showed up at the appointed time.

### CONCEPTUAL CONSTRUCTS

We are especially interested in explaining what happened in a particular circumstance – in an interesting and readable form, not a labouring of theoretical constructs *per se*. We do not want to 'pick a clear theoretical perspective, stick to it, and use Chemco data to make the case'. We are not making a case *a priori* for a particular theoretical school, but in the spirit of *The Discovery of Grounded Theory*, (Glaser and Strauss, 1967) our exploration is not for 'theory verification' but more in the spirit of 'theory generation' from the data. In particular, we are not 'examplimg', (anecdotes to support a theory), in the form which Glaser and Strauss condemn. (Glaser and Strauss, 1967, p. 5). Our theoretical constructs, some of which are borrowed from others' previous work, are being developed from the data set – mainly from the interviews but also from the reading of available internal documents.

Our interviews were all jointly conducted, with one exception. We both took interview notes separately and wrote them up independently. We then jointly cross checked them, and allowed the critical input from a third person. While we hoped for a real comparative analysis between organizations as recommended

by Glaser and Strauss (p. 21), we were able to get some comparison with post-Bhopal from individuals representing different parts of the organization, e.g. safety department and government relations department. We extend the Glaser and Strauss argument for comparative analysis, by our longitudinal analysis. We have been able to utilize perceptions and behaviour shortly before the Bhopal crisis, immediately following the crisis, and as much as a year later.

Our principal interest in undertaking this field study was to gain a better appreciation of the relationship between the decision processes in an organization and the firm's actual choices. It is our view that the rules and procedures guiding a firm's day-to-day activities will strongly influence outcomes. There is a long tradition in organization behaviour stemming from the work of Cyert and March (1963) and Simon (1976) which highlights the importance of understanding processes in order to interpret outcomes.

Much of the debate in recent years on the nature of organizational choice under uncertainty has revolved around different definitions of rationality. Simon (1978) in his Richard T. Ely lecture at the American Economics Association annual meeting explored this issue in some detail, distinguishing between two types of rationality in organizations: procedural and substantive rationality.

*Procedural rationality* refers to the decision processes utilized by individuals and groups given inherent human limitations in collecting and processing information. *Substantive rationality* refers to the nature of the outcomes or decisions taken from a set of alternatives facing an individual or a firm. Do the choices made satisfy certain criteria such as maximizing expected profits or minimizing expected costs?

We have included concepts of procedural and substantive rationality to interpret the interview data from Chemco executives. It has helped us to understand better the basis for Chemco's actions in response to the Bhopal disaster.

#### *Procedural Rationality Concepts*

The decision process by Chemco illustrates a set of heuristics or rules of thumb which are easy to implement and require limited information. They illustrate concepts of procedural rationality since they economize on information and reflect human limitations in processing data.

Prior to Bhopal, Chemco had utilized a number of risk assessment procedures which enabled them to reduce the chances of specific events occurring. Their standard procedure was to design production processes so that the risk of their activities met acceptable standards as indicated by fault tree or Haz-Op analyses. Bhopal changed all this. Now, in addition to focusing on the probability of an accident and its consequences affecting workers, added emphasis was placed on *worst-case scenarios* affecting the public, and making sure they did not occur.

In a Bayesian sense it could be argued that the subjective probability of a vapour cloud explosion had increased substantially, thus justifying certain actions without having actually to undertake cost-benefit trade-off calculations. If this were the case then Chemco behaviour would fall in the domain of substantive rather than procedural rationality.

From a procedural level it appears that Chemco's actions following Bhopal fit into a typical pattern of corporate behaviour with respect to low-probability-high-consequence events.<sup>[5]</sup> Once the perceived probability of a specific event is below a predetermined threshold then the firm assumes 'it cannot happen to me'.

It thus does not consider any risk reducing measures for events within this range. Following a crisis the normal reaction is 'it can happen to me'. As cognitive psychologists have recently demonstrated, individuals utilize a set of heuristics which emphasize the importance of memorable events such as severe disasters (Kahneman, Slovic and Tversky, 1982). For example, the availability heuristic is one where individuals estimate the probability of a future event by the ease with which they can imagine it happening. Once a tragedy like Bhopal occurs it is considerably easier for Chemco and other firms to imagine how this could happen again.

Our interviews suggest that the thinking at Chemco after Bhopal focused on avoiding any situation that resembled such a disaster in the future. Worst-case scenarios of potential accidents were constructed and policies were put in place to avoid their future occurrence. This behaviour is consistent with the concept of uncertainty avoidance formulated by Cyert and March (1963).

One reason for mobilizing a number of individuals in the company for investigating chemicals at different plants is that the Bhopal disaster was viewed as a *signal* of future troubles for the chemical industry (Slovic, Lichtenstein and Fischhoff, 1984). The fact that it was unexpected created considerable uncertainty in the minds of the public as to whether or not they would be subject to similar disasters in the future.

The process followed at Chemco was a *sequential* one that tried to avoid conflicts among different groups. For example, plant managers were asked to submit reports on their chemicals which were then evaluated using the specific formula developed by the study team. This provided legitimation for classifying chemicals as potentially hazardous or non-threatening. The preliminary reports first prepared after consulting plant managers were then revised based on feedback from the plant managers themselves. Top management only saw the final versions after any disagreements had been worked out to the satisfaction of both parties.

Finally, the work of Cohen, March, and Olsen (1972) on the garbage can model of choice suggests that firms look for opportunities to utilize existing solutions for dealing with specific issues. In the case of Chemco, the company had been concerned for many years about a particular chemical that had been classified as a carcinogen and which might have caused an unacceptable number of cancers in their firm. Once it was pointed out that the same chemical also had catastrophic potential, the chief executive officer perceived an immediate need to reduce inventory at plants producing it. There had been concern with high inventories in previous years but the post-Bhopal investigation of acute toxic and/or explosive chemicals and the discovery that this chemical fitted into that category caused immediate action to be taken.

#### *Substantive Rationality Concepts*

Turning to concepts of substantive rationality, Barry Staw has categorized two types that characterize organization behaviour: prospective rationality and retrospective rationality (Staw, 1980). Prospective rationality refers to behaviour that attempts to maximize some criteria (such as expected utility or profits). It requires the decision-maker to identify the most favourable response to a given situation and act accordingly (Tetlock, 1985). Retrospective rationality refers

to the process of re-evaluating alternatives and outcomes to make it appear that the organization has acted in a competent manner.

In a crisis situation it is extraordinarily difficult for organizations to be prospectively rational. Rather than considering a number of different alternatives, there is a tendency to search for a satisfactory course of action for coping with the given situation. In this spirit, Herbert Simon has used the example of the difference between finding a needle in the haystack that is sharp enough to sew (satisficing) and finding the sharpest needle in the haystack (optimizing). Our interviews with Chemco officials reinforced this point.

There is considerable evidence that Chemco exhibited behaviour that conformed to the concepts of retrospective rationality. Their actions signalled to the outside world that the organization had acted in an intelligent manner with respect to the disaster. Specifically, two concepts, accountability and justification, are closely related to retrospective forms of rationality exhibited by Chemco. *Accountability* is the social, psychological link between the individual decision-maker on the one hand and the social systems to which they belong on the other (Tetlock, 1985). An organization like Chemco has to be accountable to its board of directors who are concerned with public reaction to any event such as Bhopal. This was perhaps a key reason why Chemco decided to focus on a worst-case scenario and 'eliminate' any risk of a future accident.

The concept of *justification*, developed in Staw (1980), characterizes actions by the individual and the organization. When organizations experience failure, such as direct or indirect losses from an accident or low profits, they will increase their own drive towards internal justification through internal trappings of rationality. In the case of Bhopal the formula created by the new safety committee justified actions with respect to classifying chemicals as potentially hazardous or non-threatening. From an external point of view Chemco utilized its recently formed Environmental Advisory Council to justify certain management actions.

### *Propositions*

We now turn to a set of propositions that follow from the discussion of procedural and substantive rationality. Following Glaser and Strauss' recommendation (1967, pp. 32 and 79) of turning substantive theory into formal theory (particular field situations into general and more abstract coverage) more studies of crisis-related organizational behaviour will be required. The 'testing' of our propositions – only some of which may be original here – will require a series of field studies in the aftermath of particular low-probability-high-consequence events.

*Proposition 1.* Following a catastrophic accident there is a tendency for decision-makers to ignore objective data for specifying probabilities and rather to focus on ways of dealing with the direct impact of the event, such as preventing another Bhopal.

To illustrate, Chemco dealt only with acute toxic and explosive events following the accident and did not take any new actions with respect to chronic illnesses. The firm interpreted the accident as a signal to the public of problems in the operation of chemical plants and hence there was a need to reassure everyone that specific actions were being taken. Rather than examining a spectrum of

potential disasters with different probabilities, Chemco focused on worst-case scenarios. This behaviour is consistent with the availability heuristic discussed above.

*Proposition 2.* There is a linkage of activities undertaken prior to Bhopal (*i.e. ex ante* activities) with solutions following Bhopal (*i.e. ex post* solutions).

This proposition follows from both the garbage can model of choice which postulates that 'solutions are looking for problems' (Cohen, March and Olsen, 1972) and the behavioural theory of the firm which postulates that 'search activity is initiated by exogenous events'. Cyert and March provide an example of management's reaction to a fatal accident caused by the unexpected movement of a crane which pinned a worker against the wall. Although the fatal accident did not depend upon the crane itself, the crisis led to the formation of a special committee for investigating ways of improving plant safety. The committee recommended replacing old crane controllers with new ones even though the accident had nothing to do with the type of crane utilized by the firm. Interestingly enough, costs of the new cranes were not even considered in the recommendation, just as the costs of new procedures at Chemco were not of concern to the study team. Only when the actual implementation of these recommendations was studied were costs explicitly raised both at Chemco and at the manufacturing company studied by Cyert and March.

Bhopal offered similar opportunities to Chemco management. Their decision to reduce inventory of potentially toxic materials was stimulated by the Indian disaster. The firm recognized that this action had potential long-run benefits and took advantage of Bhopal to implement new policies regarding the maximum amount of raw materials to be stored at different plants. Another example of this *ex ante-ex post* linkage is the opportunity that Bhopal provided for cementing relations with nearby communities.

A third example of the linkage of *ex ante* activities with *ex post* needs was the importance Chemco gave to two activities that the Chemical Manufacturers' Association had initiated: (1) The Community Awareness Emergency Response (CAER) programme which provided linkages between the chemical companies, residents, local officials, and emergency response agencies of surrounding areas should an emergency arise, and (2) Chemtrec which provided information to the chemical companies on the characteristics of different products with respect to toxicity.

*Proposition 3.* Crises enable the organization to exert tighter hierarchical control to take rapid action.

The activities associated with the newly formed safety committee and the rapid responses of plants around the world clearly illustrate the importance of a crisis in obtaining rapid responses. Out of the review of individual plant investigations a series of safety principles was generated. Once the principles emerged from the safety evaluation team it was possible for management to utilize them to exert pressure on plants to improve their behaviour.

Several of our interviews indicated that management was much better informed about external events than they were prior to Bhopal. Whenever there was an accident or specific incident which involved a chemical company, phone calls

were made to top management to keep them abreast of the situation. Whether this was translated into specific actions from the top is not explicitly clear.

*Proposition 4.* There is a confounding between chronic and catastrophic risks following a low-probability-high-consequence accident.

Prior to Bhopal, Chemco had been dealing with critical chronic risk problems, especially landfill contamination and carcinogenic plant process conditions. Lawsuits had been brought and community action groups had raised questions. Following Bhopal one can observe crossover behaviour between the different risk perceptions, potential effects, and corporate and societal behaviour.

The Environmental Affairs Council had been established to deal primarily with chronic environmental risks on a quarterly basis. Now it was meeting on a monthly basis and most of the agenda was taken up with potential catastrophic risks. The CEO had not been committed to meeting with the committee regularly. Now he virtually always attends.

The carcinogenic chronic problem chemical with its lawsuits involved much legal work and investigation. Now for the first time, in the light of its being also a potential vapour cloud catastrophic risk, the inventory has been immediately cut in half at the direct intervention of the CEO.

A large toxic waste incinerator had been planned to alleviate the corporation's landfill problem. The site had been chosen after much analysis, and some discussion with the Environmental Protection Agency (EPA). Because of the latent toxic chronic risk problem – though judged to be minimal – some forethought had been given to public relations efforts with the local community. Before Bhopal the probability was estimated at between 0.66 and 0.75 of successfully passing all the staged licensing and tasks, for approval of the incinerator. Immediately after Bhopal an informed executive reduced this success probability by half. While there was virtually a zero probability of a catastrophic event such as Bhopal, the latent chronic effects of a chemical industry incinerator might now be looked at differently by the community. As in escalation (see Barry Staw) the firm now plans to put more effort (and costs) and potential *quid pro quo* arrangements with the different stakeholders involved with this project.<sup>[6]</sup>

While the company in some of its locations had been attempting to obtain close interaction with community officials (such as a mayor) to deal with potential chronic problems, their success had been limited. After a small vapour cloud in one of Chemco's own locations, after Bhopal, the interaction with community officials was much closer and more active.

*Proposition 5.* There is a tendency to ignore costs when crisis situations appear.

None of the reports analysing plants with the designated chemical exposure problems discussed costs of implementing each recommended course of action. For example the recommendation to cut inventories in plants was made without regard to cost effects. Subsequent discussions revealed that these were often not substantial in any case.

In retrospect the concepts which seem most fruitful from this study are related to procedural rationality with the firm relying on the threshold and availability heuristics for dealing with post-Bhopal activity. As pointed out above, ignoring or down-playing costs can be made consistent with concepts of substantive rationality

if the subjective probability of a future disaster is treated as sufficiently high due to the use of the availability heuristic. In such situations the expected benefits now appear to outweigh expected costs so that any formal calculations appear unnecessary.

*Proposition 6.* With salient events there is a form of organization learning which turns tacit knowledge into organization policy.

As the individual plant visit reports by the inspection teams were drafted and then criticized by the plant management personnel, general principles of safety began to be codified. Here we had central office safety people exchanging ideas with plant management people all over the world. Many ideas had been latent in both of these groups but had not been explicitly stated. This is a form of tacit skills as explored by Nelson and Winter (1982).

With the final versions of the plant reports made available to the top management of the company, a new view of general principles and their advantage became evident. Ultimately a set of 24 principles for safety operations at the plants was developed through this process of crisis, analysis, discussion and decision. These have now become company policy. Future plant visits by home office personnel, both safety people and general executives, will be able to use these principles for reviews in less traumatic times.

One could argue an omniscient rationality as an alternative case for the purposes of comparison – either Lindblom's (1959) straw man or Simon's (1976) straw man – but it is too artificial to be useful. Our generation of theory looks to previous work for resolution. From the evidence, and all things considered, we chose the garbage can model augmented by a set of heuristics and concepts such as availability, accountability and justification. This resolution follows Charles Perrow's judgement in *Complex Organizations: A Critical Essay* (1986), p. 219: 'Fortunately, over time theorists are forced to include bits and pieces of alternative theories compromising simplicity and limiting generality, and in this way we seem to make progress'.

#### POLICY QUESTIONS STIMULATED BY BHOPAL

The Bhopal disaster has had an extraordinary impact on Chemco's behaviour as well as on societal attitude toward low-probability-high-consequence events. In this section we will review briefly some areas where there are relevant policy questions that need to be considered.

(1) Chemco has established new monitoring and control procedures modelled on the Seveso doctrine. Specifically, there was a regulation produced in the UK after the Seveso explosion which specified different procedures which firms should follow to control major hazards affecting the public. This regulation was used as a basis for the design of procedures at Chemco. The 25 general principles for safety operation which were developed as a natural consequence of the plant investigations have now been circulated for discussion purposes and they are being considered as policy doctrine for both US operations and those elsewhere.

(2) Concomitant with Bhopal there was a drying up of environmental liability insurance due to potentially severe losses and the inability to estimate future

losses from these types of risk. This crisis in insurance has induced firms in the chemical industry, including Chemco, to set up some type of self-insurance programmes and to explore other types to mutual insurance programmes within the industry (Kunreuther, 1987).

(3) As indicated above there was concern by the public on their right to know about chemical hazards. One rival chemical company announced the availability of its material safety data sheets (MSDS) to the local community almost immediately following Bhopal, thus applying related public pressure for other firms to do the same. It is still unclear whether the public will actually avail itself of this information.

The feeling that the public has the right to know and should be able to obtain these data has established a different relationship between chemical companies and the outside world. CMA has also been concerned with improving community relations, hence the establishment of the CAER programme. Clearly Chemco's own actions reflect a continued concern with relations between itself and the community.

(4) The presence of 'chemophobia' as reflected in Representative John Dingle's speech has stressed the importance of improving risk communication to the general public so they understand the nature of the risks they are facing. This is particularly true with respect to the location of new technological facilities near communities. Chemco had been discussing the location of a new incinerator prior to Bhopal and has been aware that the public's attitude toward this facility may have changed after the disaster.

It is not clear what alternative actions Chemco will take to deal with the public perception problem for these types of facilities. The company was committed to this course of action prior to Bhopal and may not be willing to change their strategy afterwards, hoping for the best. Added jobs and investments are one attraction. One policy tool which had been of interest to them is some type of benefit-sharing or compensation. This might take the form of various payments prior to the siting of the facility or guaranteed payments should there be problems while the incinerator is in place (*e.g.* reimbursing individuals for decreased property values should they try to sell their house) and compensation after an accident (*i.e.* victim's compensation), (Kunreuther, 1987).

(5) One can design systems that are less complex and less tightly coupled than prior to Bhopal. Charles Perrow (1984) in his stimulating book, *Normal Accidents*, makes the point that organizational systems today are so tightly coupled, certain accidents may be unavoidable once a problem emerges in the firm. Chemco has taken two types of action which may reduce their potential problems: they have reduced inventory of raw materials in the plant thus lowering the chance of a catastrophic accident and they have explored alternative processes for producing goods which eliminate intermediate stages. The issue of tightly coupled systems also relates to organizational design issues which are beyond the scope of this article.

#### CONCLUSION

The Bhopal disaster epitomizes a crisis of catastrophic proportion that has galvanized Chemco and other chemical companies into action. The nature of their decision process can be captured by broadening the concepts of rationality

to include procedural as well as substantive elements. Chemco's actions also illustrate biases that individuals and organizations follow when dealing with low-probability events.

Perhaps most importantly, the reaction to the disaster exemplifies the tremendous concern that organizations have with their social context. Many of the decisions taken by Chemco can be viewed as ways of justifying, accounting, and legitimizing their operation to their board of directors and the outside world. The public wants to feel that they are safe and that everything is being done to minimize the risks associated with new technology. Chemco has responded to this concern: they recognize full well that if they do not, then there may be legislation passed which will force them into actions that they prefer not to take. In other words, they have concluded that the best defence is a good offence, in the most positive sense of the world. Only time will tell how well these actions have changed the basic structure of chemical firm behaviour for dealing with low-probability-high-consequence events.

#### NOTES

- [1] We would like to express our deep appreciation to all of the Chemco executives who generously gave of their time to be interviewed by us and to Donna Klees for her research assistance. Our paper has benefited from comments by Kathleen Conner, Jack Guttentag, Richard Herring, James March, Barry Staw, students in the Wharton Behavioral Decision Theory seminar and two referees. We also received useful suggestions from participants in the Management Department workshop and Public Policy and Management Brown Bag lunch. Support for this project project was provided by the Reginald H. Jones Center and the Wharton Risk and Decision Processes Center.
- [2] For more details see Edith Efron (1984).
- [3] A similar situation occurred in Bhopal where Union Carbide had warned the community that it might not be wise for people to reside close to the plant. However, there were no regulations imposed and hence a large residential settlement sprang up in the vicinity of the plant. For more details see Shrivastava (1987).
- [4] HAZ-OP techniques were originally developed in Britain by ICI Chemical and had been instituted in US firms for the past ten years. Fault tree analysis was pioneered by Bell Laboratories.
- [5] For an interesting set of examples regarding corporate decision-making with respect to these events see Mitroff and Kilmann (1984).
- [6] In the late autumn of 1986 Chemco executives officially announced the decision on the incinerator to the community officials and the general public. Having spent considerable time with the city on the potential benefits of the incinerator to the area (*e.g.* more jobs, lower taxes) the plan was greeted with enthusiasm.

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