

## *Managing Industrial and Environmental Crises*

*The Role of Heterogeneous Top Management Teams*

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This study examines firms that have experienced an industrial and/or environmental crisis and proposes that top management team (TMT) characteristics will affect a firm's ability to minimize the severity of these crisis events. Specifically, heterogeneity in the TMT will exhibit a curvilinear (U-shaped) relationship with the severity of firm crises. Our results suggest that a moderate level of age and tenure heterogeneity are positively related to a firm's ability to successfully minimize the severity of crises. Variance in educational backgrounds was unrelated to crisis severity. Functional background heterogeneity exhibited a curvilinear relationship with crisis severity but was not U-shaped as hypothesized.

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The potential damage from industrial and environmental accidents, disasters, and catastrophes has increased over the past few decades due to the emergence of highly interactive, tightly coupled, complex, high-risk technologies (Pauchant and Mitroff, 1992; Perrow, 1984). One need only to recall the Challenger explosion, Chernobyl, Exxon's *Valdez* incident, the Jalisco cheese poisonings, Three Mile Island, and Union Carbide's Bhopal tragedy to illustrate the destruction from these organizational crises. The damage from these crises affects key stakeholders and constituents, often resulting in lost sales, profits, productivity, image, and prestige, as well as damaged internal and external relations and drained energies (Barton, 1993; Mitroff and Pearson, 1993; Shrivastava, 1993).

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Although the centralization of authority is the most common response to crisis situations (Staw, Sandelands, and Dutton, 1981), very little research has investigated the impact that different kinds of top management teams (TMTs) may have on the resulting decisions that mollify or exacerbate these deleterious events. We assert, however, that it makes sense to investigate the impact that various TMTs and their associated characteristics may have in the decisions to respond to these crises. This research attempts to understand the variability in the severity of human-induced crises that companies experience by examining differences in the characteristics of TMTs, and more specifically, the role that heterogeneous TMTs and their associated information processing, communication, social cohesion, and cognitive structures play in a firm's ability to respond to industrial and environmental crises.

Many people consider crises and disasters to be part of the increasingly industrialized world with more hazardous products, technologies, manufacturing processes, and tightly coupled systems<sup>1</sup> (Perrow, 1984). However, many crises are a function of errors in human judgment (Sethi, 1987), equipment failures, rigid responses to threats, poor information processing and environmental scanning (D'Aveni and MacMillan, 1990), or a failure of top managers to install appropriate organizational rewards, structures and designs, and cultures to minimize potential disasters (Gephart, 1987). Clearly, research has shown that some companies tend to be more accident prone than others, and some are clearly less prepared to respond to crises than others (Greening and Johnson, 1996; Meyer, 1982).

This study adopts a systems perspective following Perrow's (1984) work, which emphasizes the highly interactive, tightly coupled interactive nature of such systems and the perception of organizations as interrelated sets of elements, following classic open systems theorists such as Bertalanffy (1956) and Boulding (1956). Within this systems framework, this study hypothesizes relationships between heterogeneous TMT characteristics and the severity of organizational crises. It should be emphasized that we do *not* suggest that top managers can avoid *natural disasters* such as earthquakes, floods, or hurricanes. Conversely, we believe that top managers can proactively help their companies minimize more human-induced industrial and environmental<sup>2</sup> crises such as oil spills, gas leaks, and chemical spills by keeping them from becoming major crises and disasters. Support for studying the roles played by top management can be seen by the development of computer simulations designed specifically for top managers to train them to cope with disasters. *The Times* ("Bosses Learn," 1992: 23) reported that in talking about oil spill disasters,

A company's senior executives need to be very well prepared. If they are not, the situation can rapidly deteriorate and, in the worst instances, the whole future of a company could be endangered.

and

Companies handling high-risk substances, mainly in the petrochemical industry, are putting their directors and top management through regular training programs to teach them how to cope if the worst should suddenly happen.

In accordance with the important role that top managers play in responding to industrial and environmental crises, we combine the TMT organization theory literature (Hambrick and Mason, 1984) with the crisis management literature to empirically investigate the relationships between these two areas in minimizing the potential damage from crises. In addition to the TMT literature, we draw on a specific area of crisis management research that represents part of the underlying theory for our investigation. This includes the important roles of information processing and communication during crisis events (Dutton, 1986; Staw et al., 1981). After defining a crisis, we briefly review these crisis management areas of research as they represent the underlying associations with heterogeneous TMTs' ability to either minimize crises or exacerbate their impact.

### *RELEVANT CRISIS MANAGEMENT RESEARCH*

Organizational crises are events characterized by threat, surprise, magnitude, and need for a quick response constituting high-priority items with high potential costs if an organization does not resolve them efficiently and effectively (Dutton, 1986). The implication is that crises are decisive moments that if handled one way, could make things worse, but if handled another way, could make things better (Carroll, 1993). This managerial discretion (Wood, 1991) and latitude that top managers have to initiate a response to a developing crisis underlies the rationale for our analysis.

The crisis management area relevant to our study involves the critical role of information processing and communication both previous to and during a crisis event. This area specifically involves the crisis management literature that addresses the development of threat/rigidities, group cohesiveness, constriction in control, attentional processes, internal and external communication, and environmental scanning behavior that affect organizational decision making during crises. Under a stress situation,

information processing and decision-making groups may reduce their flexibility, seal off new information, and control deviant responses or suggestions (Janis, 1972; Kiesler and Sproull, 1982). The crisis management information-processing research further reveals that some firms tend to respond rigidly to crises, narrowing the field of attention, restricting and simplifying information channels, and constricting control, which often only intensifies the threat (Staw et al., 1981). The associated stress, anxiety, and arousal organizational decision makers experience under high-threat conditions may interfere with their ability to accurately discriminate between visual stimuli and to learn and solve problems leading to behavioral rigidities and habituated responses. However, other TMTs appear to be able to process information more effectively and to respond to developing crisis events in a thoughtful, proactive, and timely manner to mollify the potential damage from such crises before it reaches catastrophic levels (Greenberg, 1993; Kirkpatrick, 1994). The above research areas relevant to our study suggest that firms have different repertoires of processing modes to address threatening strategic issues (Dutton, 1986; Greening and Gray, 1994), they process information and communicate differently, and they pay attention to different aspects of the environment during crisis situations.

In the following section, we briefly review research from the TMT perspective and the crisis management literature. We then develop a series of hypotheses to test relationships between TMT heterogeneity characteristics and the severity of industrial and environmental firm crises. In our study, we emphasize the role of human agency in addressing crisis situations by suggesting that heterogeneity in the TMT will be related to differences in the above processes and, hence, different abilities to effectively minimize the severity of tightly coupled, interactive, complex crisis events.

### *TOP MANAGEMENT TEAM HETEROGENEITY AND CRISES*

TMT theorists envision top managers as the principal decision makers of the firm (Hambrick and Mason, 1984; Szilagy and Schweiger, 1984). The strategic importance of the TMT in corporations has been acknowledged in organization theory (Child, 1972; March and Simon, 1958), the strategic management/business policy literature (Andrews, 1971; Hambrick and Mason, 1984), and the business and society literature (Greening and Johnson, 1996; Thomas and Simerly, 1995). In fact, this strategic choice

view argues that top management fills a critical role in determining how the firm adapts to changes in external and internal contingencies (Meyer, 1982). Furthermore, the characteristics of the TMT may influence its power, motivation to be involved, and/or ability to take effective action toward strategic issues.

TMT researchers consider the homogeneity/heterogeneity of top management characteristics to be important proxies for underlying group processes (Bantel and Jackson, 1989; Greening and Johnson, 1996; Murray, 1989). Previous research has generally assumed that heterogeneous characteristics are beneficial in most decision-making instances, especially in changing, uncertain, turbulent environments (Eisenhardt, 1989; Murray, 1989). This would seem to suggest that increasing heterogeneity in the TMT would be associated with a firm's ability to successfully address or minimize crisis severity. However, crisis situations are unlike most strategic decisions in that both a quality decision and a very quick decision must be made to minimize a rapidly escalating, potentially catastrophic event (Barton, 1993; Fink, 1986).

In addition, organization theorists have recently emphasized the potential costs associated with TMT heterogeneity (Ancona and Caldwell, 1992; Wiersema and Bantel, 1992). Heterogeneity in terms of cohort membership is likely to lead to heterogeneity with respect to attitudes, values, and potentially to greater interpersonal conflict (McCain, O'Reilly, and Pfeffer, 1983). If this conflict is left unchecked, it could hinder the group's ability to function and make effective decisions (Ancona and Caldwell, 1992). For example, O'Reilly, Snyder, and Boothe (1993) and Smith et al. (1994) report tenure and experience (organization tenure) heterogeneity to be negatively related to informal communication and positively related to poor team dynamics. Functional background heterogeneity in the TMT also has been found to increase conflict within the group and to decrease the amount of internal communication. In addition, although high levels of TMT diversity have been associated with an increased quality of strategic decision making, Ancona and Caldwell (1992) found that it also tends to hinder the implementation of these strategies. The critical need for a timely response to quickly escalating harmful crisis events indicates that high levels of heterogeneity may be problematic. The above research suggests that the associated costs of heterogeneity may start to outweigh the benefits at high levels (i.e., similar to many stress and anxiety studies) and that the relationship between heterogeneity characteristics and performance outcomes may not be linear.

The discussion of the costs of heterogeneous TMTs is consistent with research on the homogeneous characteristics of TMTs. Homogeneous teams have been shown to be associated with inertia, threat-rigidities, and poor quality decisions (Janis, 1972; Staw et al., 1981). Specifically, low levels of functional background heterogeneity have found to lead to the social cohesion of team members as they develop a similar mental schemata for decision making (Murray, 1989). Homogeneity and social cohesion have been shown to be associated with a failure to realistically appraise alternative courses of action and with a decline in appraising reality, ethical judgment, and decision-making quality (Janis, 1972; Whyte, 1989). Homogeneous teams may be more inert and inactive in the face of needed change or uncertainty (Kiesler and Sproull, 1982; Miller, 1991) and as a result, make lower quality decisions with an increased probability of experiencing the negative effects of a crisis.

The above-stated costs associated with low and high levels of TMT heterogeneity suggests that heterogeneity in top managers' characteristics may exhibit a curvilinear, U-shaped relationship with respect to crisis severity.

## *HYPOTHESES*

Several TMT characteristics have been offered as proxies for underlying human processes affecting a series of subsequent group decisions. These characteristics have traditionally included TMT occupation, age, organization and team tenure, education, and education specialty, as well as others (Hambrick and Mason, 1984). Our focus on the "heterogeneity" of these characteristics is consistent with the literature that has emphasized that certain kinds of heterogeneity in TMTs have been posited to be associated with the group's ability to cope well with change and to be more responsive and adaptable to turbulent external environments (Bantel and Jackson, 1989), but that high levels of heterogeneity also have been found to be dysfunctional. The crisis management literature strongly emphasizes that to effectively address environmental and organizational crises, firms need to be creative, flexible, and adaptable but that TMTs also need to respond efficiently to these quickly escalating events in a timely manner to minimize their potential devastating impact (Pauchant and Mitroff, 1992; Shrivastava, 1993). Therefore, we suggest that certain kinds and levels of heterogeneity and homogeneity may be related to effective and ineffective crisis management behavior and that TMT heterogeneity will demonstrate a U-shaped relationship with crisis severity.

*Functional Background Heterogeneity*

The rationale for the importance of TMT functional background heterogeneity relates to the hypothesized increased stakeholder representation with such heterogeneity and its potential impact on the information processing and external communication of top managers during crisis situations. Research investigating the functional specialty of top management generally has supported the notion that the dominant coalition brings an orientation to decision analysis and problem solving that has developed from its functional departmental experience (Hambrick and Mason, 1984; Dearborn and Simon, 1958). This notion supports a view that organizations reflect the backgrounds of their most powerful top managers, determining the definition given to problems and affecting the range of strategies companies pursue to resolve problems (Chaganti and Sambharya, 1987). Managers with different functional experience are likely to differ in their knowledge, attitudes, and perspectives, as they represent constituents who potentially can be harmed by industrial and environmental crises. This shaping of cognitive and attitudinal perspectives affects the behaviors of top managers, the problems they identify, and the types of solutions they choose and implement (Meyer, 1982).

Because crisis situations affect organizations across multiple departmental areas, that is, marketing, public affairs, production, and engineering, we suggest that firms with TMTs having more heterogeneous functional backgrounds are more likely to engage in discussions with multiple points of view, be less socially cohesive, and be less entrenched as these heterogeneous managers represent constituents associated with their functional departmental area. Whereas these diverse teams would logically represent their associated functionally related constituents, these more heterogeneous background teams may engage in more environmental scanning, process information more effectively, be more flexible in developing responses to complex crisis situations, and be better able to develop high-quality decisions and responses to minimize the severity and extent of damage during a crisis.

However, high levels of functional background heterogeneity have been found to produce a number of processes that hinder group performance. Ancona and Caldwell (1992) found that although functional background heterogeneity does bring more creativity to problem solving (a requirement for successful response development to crises), it impedes implementation because there is considered to be less capability for teamwork than there would be with a more homogenous group. Functional background heterogeneity also was found to increase conflict within the

group and to decrease the amount of internal communication and overall, was associated with decreased performance (Ancona and Caldwell, 1992). We suggest that a moderate amount of functional background heterogeneity among TMT members will be associated with lower levels of crisis severity than either very high or low levels of functional background heterogeneity. Thus, the following hypothesis is proposed:

*Hypothesis 1: Top management team functional background heterogeneity will exhibit a U-shaped curvilinear relationship with crisis severity.*

#### *Education Specialty Heterogeneity*

The rationale for the importance of heterogeneity in educational specialization is that this diversity will be associated with a group's increased ability to evaluate decisions from multiple points of view and to generate a greater variety and number of creative alternatives to crisis events. We also suggest that heterogeneity in educational backgrounds will be associated with a group's increased ability to assess the complex connections and interactions and tight sequencing evident in crisis events (i.e., effective information processing) and also will be associated with a flexibility in decision making and communication with outside groups that have been shown to be related to the ability to minimize the likelihood of crisis events (Greening and Johnson, 1996).

Research has indicated that one's education specialty tends to affect one's cognitive style and personality and to shape one's perspective and outlook (Hitt and Tyler, 1991). Managers with different educational backgrounds are considered to differ in their knowledge and attitudes, which affect their evaluations and assessments of strategic decision making (Murray, 1989). We suggest that heterogeneity in top managers' educational backgrounds will be associated with a broader perspective to decision making and an ability to understand potential environmental and industrial crises from several viewpoints. A TMT with diverse educational backgrounds may have a better ability to discriminate among a variety of stimuli and may be better able to generate a variety of alternatives and creative solutions to potential maladies. Teams with diverse educational backgrounds may also be able to understand environmental and industrial crises from several different perspectives (Wiersema and Bantel, 1992) and may be able to assess the complex connections among problems and crisis events that Perrow (1984) indicated is fundamental to recent crisis situations (i.e., interactive, tight coupling).



Murray (1989) suggested that the diversity in outlook of heterogeneous groups can increase a group's adaptability. Because the primary characteristic of organizational "information processing" and decision making to effectively reduce the severity of organizational crises is flexible, adaptable, innovative decision making, we suggest that top management groups with diverse educational backgrounds will be more effective at minimizing crisis severity than teams with more homogeneous educational experiences. However, similar to functional background heterogeneity, at very high levels of educational specialty heterogeneity, there may occur a number of group processes (i.e., a multitude of options and different perspectives and prolonged discussion) that would be dysfunctional to minimizing the severity of crisis events. For example, although high levels of TMT diversity have been associated with an increased quality of strategic decision making, it has been shown also to hinder the "implementation" of these strategies (Ancona and Caldwell, 1992). The critical need for a timely response to quickly escalating harmful events indicates that high levels of educational background heterogeneity may be problematic. Therefore, we expect lower and higher levels of educational heterogeneity to be associated with more severe crises.

*Hypothesis 2:* Top management team educational specialty heterogeneity will exhibit a U-shaped, curvilinear relationship with crisis severity.

#### *Age Heterogeneity*

Previous research suggests that similar to skill-based heterogeneous characteristics (i.e., functional and educational diversity), age heterogeneity (temporal-based diversity) may be more beneficial at a moderate level than when either very low or very high levels are present. Research on age heterogeneity emphasizes that individuals derive their values from the society in which they grow up (Ireland, Hitt, Bettis, and dePorras, 1987). They are also affected by historic events that take place during their formative years (Wagner, Pfeffer, and O'Reilly, 1984). Thus, individuals of similar age are molded by a similar environment and tend to have similar values. In addition, perspectives change as a function of the process of aging (Elder, 1975).

Low levels of TMT age heterogeneity (high homogeneity) have been found to lead to certain group processes that are considered to be most effective under conditions of environmental stability. TMTs with high levels of age homogeneity tend to socialize and exert influence on team members to increase cohesiveness and conformity (Hambrick and Mason,

1984; Murray, 1989). This increase in cohesiveness and conformity tends to lead to quicker decisions and is considered to be most effective in routine problem-solving situations associated with stable environments. Because decisions need to be made quickly under crisis situations, it may appear that high levels of age homogeneity may be beneficial. However, these responses may be of lower quality due to the "groupthink" syndrome (Janis, 1972) and high level of consensus-seeking in response to a rapidly escalating external threat (Staw et al., 1981) and may even exacerbate its harm.

Diversity of age is expected to increase the variety of perspectives relating to escalating strategic issues such as firm crises (Greening and Johnson, 1996). Although differences in values and attitudes may result in greater conflict, some conflict is seen as beneficial in developing responses to strategic issues because it stimulates discussion of alternative solutions and results in qualitatively better solutions. However, it appears that an extreme diversity of opinion may lead to chaotic conditions, which reduces TMT effectiveness (Pfeffer, 1983). This reduction in effectiveness may be translated into increased time to arrive at a decision as well as decisions of poorer quality due to the level of conflict. Wiersema and Bantel (1992: 97) suggest that the benefits of increased age heterogeneity will be greater at moderate levels and will taper off the more heterogeneous in age a TMT becomes. The previous discussion suggests that crisis severity is more likely to be minimized when age heterogeneity is present at moderate levels. Low and high levels of TMT age heterogeneity may extend decision making due to conflict (thereby rendering the process less effective) and/or result in less effective decisions due to pressures to conform and maintain cohesiveness. We therefore suggest that low as well as high levels of age heterogeneity will be associated with more severe crises.

*Hypothesis 3:* Top management team age heterogeneity will exhibit a U-shaped, curvilinear relationship with crisis severity.

#### *Tenure Heterogeneity*

Like cohort groups defined by age, cohort groups defined by tenure are likely to differ with respect to their experiences and perspectives as well as attitudes and values. Homogeneity with respect to tenure may result in a reduced search for information and alternative solutions as well as threat-rigidities such as inertia, cohesiveness, socialization, and conformity (Ancona and Caldwell, 1992; Keck, 1997). When TMTs have greater

tenure heterogeneity, they tend to be less socially cohesive (Wiersema and Bantel, 1992). The presence of individuals with differing points of view ensures consideration of a larger set of problems as well as a larger set of alternative potential solutions. Tenure heterogeneity may lead to more dialectical inquiry, multiple points of view in strategic decisions, and less likelihood that management will overlook the conditions producing ineffective responses to crises.

High levels of tenure heterogeneity do carry a cost, however (Smith et al., 1994). Individuals joining the TMT more recently will have been less thoroughly socialized into adopting group norms. TMT members from different cohort groups have different organizational experiences and may find it difficult to communicate effectively (Roberts and O'Reilly, 1979). These newcomers may introduce different, nonadaptive values that may increase the likelihood of misunderstandings and mistrust (Murray, 1989).

For example, both Bantel and Jackson (1989) and Wiersema and Bantel (1992) suggest that tenure heterogeneity may either add cognitive diversity and increase discussion or may interfere with the communication process and cause dysfunctional conflict. Their conclusions suggest that tenure heterogeneity may be more beneficial at moderate levels. Low levels of tenure heterogeneity may lead to poor responses to rapidly escalating serious events and excessive conflict and dissensus at high levels. These responses to a crisis may lead to an increase in crisis severity because of the failure to take either efficient or effective action. Therefore, we propose that crisis severity will be greater when tenure heterogeneity is at low or high extremes and that a moderate level of tenure heterogeneity will be associated with a TMT's ability to respond both effectively and efficiently to escalating threatening events.

*Hypothesis 4:* Top management team tenure heterogeneity will exhibit a U-shaped, curvilinear relationship with crisis severity.

## METHODS

### *Sample*

We drew our sample from the population of firms operating in the following industries: petroleum and gas, utility, food, and chemical industries. We selected these particular industries because they have been characterized as crisis-prone (Barton, 1993; Greening and Johnson, 1996).

A total of 311 firms from these industries were listed on the COMPUSTAT data tapes during the study period (1985-1992).

*Survey data.* Because what actually constitutes a crisis for a firm has often been debated (e.g., Billings, Milburn, and Schaalman, 1980), we surveyed vice presidents to identify what they felt were examples of crises in their industry, whether their firm experienced a crisis, and the severity of the crisis. Crises were broadly defined for respondents as accidents, scandals, or catastrophes that resulted in lost profits, injuries, loss of life, damage, or loss of reputation and image (see Appendix A for a list of crises by industry).

The overall response rate to this questionnaire was 30.9% or 96 out of 311. Of the 96 responding firms, 44 experienced a crisis during the study period. Because there were only 44 responding firms that experienced a crisis, we opted to use an archival measure of crisis severity to increase sample size. Crisis severity data from survey responses were used to help validate the archival measure discussed below.

*Archival data.* Articles relating to these firms in the Lexis database were searched to determine if a firm had experienced a crisis during the sample period (1985-1992) using the list of crises generated by industry practitioners. These databases include public relations announcements (PR Newswire) as well as abstracts from newspapers from all geographic regions and major cities in the United States. Two judges decided whether the articles indicated that a crisis had occurred and the year in which it had occurred. The Spearman rank correlation between judges' determinations was ( $r = .90, p < .001$ ). The seven discrepant cases were resolved by raters jointly reviewing the cases to reach consensus. The judges coded the total number of crisis-related articles for the most recent crisis (6 firms experienced two crises during the study period). Of the 311 companies listed on the COMPUSTAT tapes, 112 were found to have experienced a crisis during the sample period.

### *Measures*

*Dependent variable.* The dependent variable used in this study was the number of articles written about a firm's most recent crisis from the Lexis database divided by firm total assets. We tracked firms for 1 year after the crisis to determine crisis severity (the use of a 2-year, 6-month window did not change results appreciably). We divided the number of articles by

total assets to adjust for the fact that larger firms may receive greater attention from the media and the public (Elsbach and Sutton, 1992; Hill, Kelley, Agle, Hitt, and Hoskisson, 1992). We termed the resulting variable *crisis severity*.

*Independent variables.* Data used to operationalize the independent variables were collected for the year immediately preceding the crisis. We collected demographic characteristics for members of the TMT listed in Dun and Bradstreet's *Reference Book of Corporate Managements* and *Who's Who in Finance and Industry*. Consistent with Wiersema and Bantel (1992) and Murray (1989), we defined TMT members as the chairman, chief executive officer, president, chief financial officer, and the next highest tier of managers. Top management functional background heterogeneity was operationalized using a variation of the Herfindahl-Hirschman index [ $1 - \sum S_i^2$ ] where  $S$  is the proportion of group members in a category and  $I$  is the number of different categories represented in the team (cf. Michel and Hambrick, 1992). Similar to the procedure used by Michel and Hambrick (1992), I took on the values 1 to 6, representing the following functional tracks: general management, finance/accounting, production-operations, research and development, marketing and sales, and law.

TMT educational specialty heterogeneity was operationalized using the same procedure outlined above. Consistent with Wiersema and Bantel (1992), we classified individuals into one of five categories: arts, sciences, engineering, business and economics, and law. We operationalized heterogeneity in mean TMT tenure and age as the coefficient of variation (i.e., standard deviation divided by the mean; Allison, 1978). Each of the four independent variables was entered as both a linear term as described above and a quadratic (squared) term to test the hypothesized curvilinear relationship.

*Control variables.* TMT size was used as a statistical control because previous research on TMTs has indicated that larger groups have a greater potential for dissimilarity (Bantel and Jackson, 1989). Firm size was also used as a control because previous research reported that firm size was positively related to illegal behavior and citations by the Environmental Protection Agency (Baucus and Near, 1991; Hill et al., 1992). We averaged the log of total assets (from COMPUSTAT) for the 2 years prior to the year of the crisis to control for firm size. To control for potential industry effects, we included dummy variables for three of the four industries in the regression models.

### *Dependent Variable Validity*

To examine the validity of the archival dependent variable, we compared the severity score reported by survey respondents for firms that experienced a crisis ( $n = 44$ ) with the number of articles for that crisis divided by firm size (the archival dependent variable). The Pearson correlation between the survey-based measure and the archival dependent variable was positive and significant ( $r = .72, p < .001$ ).

In addition to the above comparison, we conducted an external validity check on the archival dependent variable. Fatalities, injuries, and fines associated with firm crises should be positively related to our archival measure of crisis severity as well as to the survey-based measure of crisis severity reported by respondents (Pauchant and Mitroff, 1992; Shrivastava, 1993). Data regarding fatalities, injuries, and fines were collected from Lexis for 1 year after the crisis occurred. The presence of fatalities, injuries, and fines (each operationalized as a 0,1 variable) associated with a specific crisis was compared to both survey and archival measures of crisis severity. The Spearman rank correlations between fatalities, injuries, and fines and the archival measure of crisis severity were .48, .45, and .57, respectively (all  $p < .001$ ). For purposes of comparison, the Spearman rank correlations between fatalities, injuries, and fines and the survey-based measure of severity were .50, .47, and .54, respectively (all  $p < .001$ ). These results provide strong evidence that the archival dependent variable represents a valid proxy for crisis severity.

### *Statistical Analysis*

Hierarchical regression was used to test the hypothesized relationships. To test for a curvilinear effect, we regressed the linear term of the variable and the squared term (in that order) on the dependent variable. If the squared term enters the model significantly (as indicated by the change in the  $F$ -statistic between models) above and beyond the linear term, a curvilinear relationship would be indicated (Cohen, 1978).

## **RESULTS**

Table 1 presents means, standard deviations, and correlations for the dependent, independent, and control variables. To test for the presence of multicollinearity, we followed procedures outlined by Neter, Wasserman, and Kutner (1983). Variance inflation factors (VIF) and a linear depen-

Table 1  
Means, Standard Deviations, and Intercorrelations for Variables Used in the Study

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Crisis severity	7.04	25.84										
2. Top management team size	5.75	2.55	-.18*									
3. Firm size	8.35	1.33	-.23*	.25*								
4. Petroleum industry <sup>a</sup>	0.36	0.48	-.26*	.01	.41*							
5. Utility industry <sup>a</sup>	0.27	0.45	.01	-.22*	-.18*	-.46*						
6. Food industry <sup>a</sup>	0.12	0.33	-.03	.11	-.04	-.28*	-.23*					
7. Chemical industry <sup>a</sup>	0.25	0.43	.30*	.14	-.24*	-.43*	-.35*	-.21*				
8. Functional background heterogeneity	0.68	0.25	-.26*	.18*	.28*	.14	.12	.07	-.08			
9. Educational background heterogeneity	0.67	0.21	.07	.25*	.32*	.30*	-.14	-.15	.07	.29*		
10. Top management team age variance	0.11	0.05	.21*	.22*	-.10	.05	-.06	.09	-.06	.21*	.20*	
11. Top management team tenure variance	0.52	0.26	.18*	.27*	-.01	.04	-.06	.08	-.04	-.03	.09	.26*

Note:  $N = 112$ .

a. Spearman rank correlations are reported where ordinal data are used.

\* $p < .05$ .

gency test were used to test for collinearity. With the exception of the obvious collinearity between the linear and quadratic terms for each independent variable, results suggest that multicollinearity is not a concern in this sample.

The results of the study are presented in Table 2. Five regression models were tested: (a) the base model (Model 1), which included control variables and the linear components of the independent variables; (b) Model 2, which included Model 1 plus functional background heterogeneity squared; (c) Model 3, which included Model 2 plus educational background heterogeneity squared; (d) Model 4, which tested Model 3 plus TMT age variance squared; and (e) Model 5 (Model 4 plus TMT tenure variance squared). Evaluation of significant curvilinear terms to determine whether the relationships are nonmonotonic and U-shaped is presented in Appendix B.

Model 1 tested the effects of the control variables and linear components of the independent variables on crisis severity. The  $R^2$  for the model was .27.

Functional background heterogeneity squared (Hypothesis 1) was entered in Model 2. Functional background heterogeneity squared was positively and significantly related to crisis severity. The change in  $R^2$  from Model 1 (the comparison model) to Model 2 was .03 and significant ( $F = 6.05, p < .05$ ). Because  $\beta_1 < 0$  and the absolute value of  $\beta_1$  is greater than  $2\beta_2$ , the relationship is monotonic, decreasingly negative (i.e., the greater the amount of functional background heterogeneity, the smaller the negative effect of functional background heterogeneity on crisis severity [see Appendix B]). Thus, Hypothesis 1 was not supported.

Educational background heterogeneity squared (Hypothesis 2) was introduced in Model 3. Educational background heterogeneity squared was not significantly related to crisis severity. In addition, the change in  $R^2$  from Model 2 (the comparison model) to Model 3 was .004 and nonsignificant ( $F = 0.59$ ). Therefore, Hypothesis 2 did not receive support.

TMT age heterogeneity squared (Hypothesis 3) was introduced in Model 4. TMT age heterogeneity squared was positively and significantly related to crisis severity. The change in  $R^2$  from Model 3 (the comparison model) to Model 4 was .18 and significant ( $F = 34.29, p < .001$ ). The calculated inflection point, .108, is within the range of TMT age heterogeneity values (0.011 to 0.267), whereas  $\beta_1 < 0$  and  $2\beta_2 > 0$ , further suggesting a U-shaped, curvilinear relationship. Hypothesis 3 was therefore supported (see Appendix B for a depiction of the relationship).

TMT tenure heterogeneity squared (Hypothesis 4), was entered in Model 5. TMT tenure variance squared was positively and significantly



Table 2

Results of the Hierarchical Regression Analysis<sup>a</sup>

Control variable	Dependent Variable: Crisis Severity				
	Model 1: Base Model	Model 2: TMT Functional Background Heterogeneity Squared	Model 3: TMT Educational Background Heterogeneity Squared	Model 4: TMT Age Heterogeneity Squared	Model 5: TMT Tenure Heterogeneity Squared
	$\beta$ Estimate	$\beta$ Estimate	$\beta$ Estimate	$\beta$ Estimate	$\beta$ Estimate
Top management team size	-0.32***	-0.33***	-0.33***	-0.21**	-0.24***
Firm size	-0.07	-0.07	-0.06	-0.01	-0.02
Petroleum industry	-0.04	-0.05	-0.02	-0.05	-0.06
Utility industry	-0.04	-0.05	-0.07	-0.09	-0.07
Chemical industry	0.24*	0.24*	0.23*	0.15	0.17
Independent variable					
Functional background heterogeneity	-0.24***	-1.20**	-1.19**	-1.18**	-1.14**
Educational background heterogeneity	-0.14	-0.15	-0.07	-0.21	-0.20
Top management team age heterogeneity	0.27***	0.27***	0.26***	-1.26***	-1.28***
Top management team tenure heterogeneity	0.21**	0.21**	0.21**	0.16**	-0.51*
Functional background heterogeneity squared		0.49**	0.48**	0.44**	0.42**
Educational background heterogeneity squared			0.13	0.05	0.04
TMT age heterogeneity squared				1.56***	1.58***
TMT tenure heterogeneity squared					0.55*
Overall Model $R^2$	.27	.30	.30	.48	.50
Overall $F$ statistic	4.90***	4.39***	4.03***	7.77***	7.36***
Change in $R^2$		.03	.00	.18	.02
$F$ statistic for change		6.05*	0.59	34.29***	2.79*

NOTE:  $N = 112$ .a.  $\beta$  estimates are standardized regression coefficients.\* $p < .10$ . \*\* $p < .05$ . \*\*\* $p < .01$ . \*\*\*\* $p < .001$ .

(at the .10 level) related to crisis severity. The change in  $R^2$  from Model 4 (the comparison model) to Model 5 was .02 and marginally significant ( $F = 2.79, p < .10$ ). The inflection point is 0.915 and is within the range of TMT tenure heterogeneity values (0.03 to 1.393) while  $\beta_1 < 0$  and  $2\beta_2 > 0$ . Results suggest that the curvilinear relationship is nonmonotonic and U-shaped as hypothesized (see Appendix B). Therefore, Hypothesis 4 received support.

## DISCUSSION

This research makes important contributions to organization theory. Within an open systems framework, it emphasizes the role that TMT characteristics can play in organizational responses to potential and actual crisis events. Although demographic characteristics have been shown to be related to certain strategic and performance outcomes as well as to strategic change, they have not been studied in relation to a firm's propensity to effectively manage crisis situations. The potential damage and destruction from industrial and environmental crises have intensified in recent decades, and as a result, crises are obviously critically important events for firms and affected stakeholders. This research attempts to link this important area of study to organization theory, specifically to heterogeneous TMT characteristics, and offers prescriptions for organization designs.

Another important contribution of this study is that it presents theory and results indicating that characteristics of top managers exhibit a curvilinear relationship with crisis severity. Previous TMT research has tended to focus on simple linear relationships. One of the reasons why TMT research yields mixed results may be due to the fact that top management characteristics exhibit curvilinear relationships with many dependent variables. Examination of linear relationships without testing for curvilinear ones may lead to oversimplification, incorrect results, and erroneous interpretations.

The findings from this study supported two of the four hypothesized relationships. Firms appear to be better able to prevent, or minimize, the damage from crisis events if they have TMT configurations with diverse functional backgrounds and moderate levels of tenure and age heterogeneity.

Results suggest that functional background heterogeneity does not exhibit a U-shaped relationship with crisis severity (see Appendix B). Although the relationship is curvilinear, it appears that higher levels of functional background heterogeneity are not associated with crisis sever-

ity. Admittedly, our sample does not range from perfect homogeneity (all managers with the same functional background) to perfect heterogeneity (all managers from different backgrounds). Our sample of 112 teams ranges from 0.00 (perfect homogeneity) to 0.94 on the heterogeneity scale (perfect heterogeneity = 1.00). Although it is possible that an inflection point may exist beyond 0.94 such that functional background heterogeneity increases crisis severity, it is unlikely.

The above result suggests that functional background heterogeneity does not impede teamwork, reduce communication, or increase conflict as found by Ancona and Caldwell (1992), at least with regard to top management's ability to minimize damage due to crises. Rather, it appears that firms with TMTs with increased functional heterogeneity have individuals who will differ in their knowledge, attitudes, and perspectives and, as a result, the problems they identify, the definitions they give to problems, and the range of strategic alternatives they present to problems. Teams with heterogeneous functional backgrounds are more likely to represent multiple stakeholder interests during crises, possibly minimizing the harmful effects on constituents other than shareholders. This is consistent with research by Mitroff and Pearson (1993) who emphasize that during a crisis, key stakeholders need to be contacted or involved personally (i.e., regulatory agencies, competitors, suppliers, key customers, media, others).

Results suggest that educational background heterogeneity is unrelated to crisis severity. It appears that having a diverse group in terms of educational background does not significantly contribute to (or inhibit) effective (or efficient) decision making in terms of generating solutions to crisis situations. It appears that firms with TMT members with many different educational backgrounds that may introduce more diversity in thinking relationships does not provide the "type" of diversity that helps top managers generate effective solutions to escalating negative events.

Both tenure heterogeneity and age heterogeneity demonstrated a U-shaped, curvilinear relationship with crisis severity (see Appendix B). In regard to age heterogeneity, this suggests that at low levels of age heterogeneity, similarity in values, perspectives, and attitudes, as well as the increased pressure for cohesiveness and conformity, may prevent the development of high-quality decisions to address the inherent complexity associated with crises. Conversely, at extreme levels of age heterogeneity, the difference in values and attitudes may lead to excessive conflict that precludes the implementation of successful solutions in a timely manner. It is interesting to note that the inflection point for TMT age heterogeneity

is fairly low. This suggests that the negative effects associated with age heterogeneity take effect at relatively low levels of diversity.

The finding for tenure heterogeneity and crisis severity suggests that similarity in the time spent with an organization results in a shared set of attitudes, values, and perspectives that is associated with inertia and threat rigidities. Extreme levels of tenure heterogeneity appear to be associated with a level of chaos and conflict due to diverse amounts of socialization that may delay responses to crises or possibly interfere with effective communication to develop quality responses to potentially disastrous events. Interestingly, results suggest that the inflection point for tenure heterogeneity is considerably higher than the inflection point associated with age heterogeneity. Extreme levels of tenure heterogeneity are required before crisis severity increases dramatically. In fact, 91.9% of the firms in the sample are plotted below the inflection point (0.92), whereas 8.1% of teams exhibit tenure heterogeneity that exceeds the inflection point (see Appendix B). These results suggest that the negative effects associated with age heterogeneity are more serious than those associated with tenure heterogeneity.

Our findings suggest that we cannot expect all forms of heterogeneity to have the same effect on performance outcomes and that certain kinds of heterogeneity may be more/less effective in responding to different kinds of strategic decisions. Our findings suggest that age and tenure heterogeneity can be viewed as a "temporal" diversity (i.e., length of time) as opposed to functional background heterogeneity, which may be more logically viewed as a "skill-based" diversity. Skill-based diversity may not provide the same type of dissensus or conflict at high levels that might interfere with the implementation of activities to respond to escalating events in the same way that temporal-based diversity may.

There are some possible limitations to our investigation. The use of COMPUSTAT restricts the sample to publicly traded firms with at least \$30 million in sales. Although we controlled for firm size in the analysis, future studies may wish to investigate whether findings generalize to privately held and very small firms less concerned with shareholders. Another possible limitation is the use of the newspaper articles as a proxy for crisis severity. One might question if the articles reflect a firm's ability to control the press more than effective responses to the crisis event. However, we externally validated this measure with crisis severity scores from company practitioners as well as to indications of fatalities, injuries, and fines. In addition, crisis management scholars indicate that a critically important step in effective crisis situations is to work proactively with the

press to minimize external speculations and rumors that would only generate greater media coverage (Fink, 1986; Lerbinger, 1986; Mitroff and Pearson, 1993; Pinsdorf, 1986).

Another possible limitation of this research is that we used the most advanced degree an individual attained to compute educational specialty heterogeneity. The argument could be made that this operationalization ignores any undergraduate degrees that are in areas different from the more advanced degree (such as an MBA). Although the convention in TMT research is to use the most advanced degree (Wiersema and Bantel, 1992), the MBA represents an advanced degree that does not necessarily reflect a specialization. In fact, the MBA degree may be rather transparent in that it serves more as a filtering device to match individuals and jobs as opposed to having an effect on firm outcomes (Pfeffer, 1983). Thirty percent of managers in our sample held an MBA degree. Future research might examine the effects of using undergraduate degrees to assess educational specialty, especially when managers hold an MBA.

## CONCLUSION

Given that the centralization of control is the most dominant organizational response to crises, a major goal of this project was to conduct an empirical study to examine if a certain configuration of TMT characteristics may lead to better crisis management and less severity of crises. In addition to linking the crisis management literature to TMT research, we likewise sought to extend TMT research beyond the traditionally studied performance measures by linking this area of research to crisis management, in keeping with recent studies investigating relationships between TMT characteristics and illegal behaviors (Kesner, Victor, and Lamont, 1986), corporate philanthropy (Wang and Coffey, 1992), green-mail decisions (Kosnik, 1990), and golden parachutes (Cochran, Wood, and Jones, 1985).

This research has several implications. It suggests that the incidence and severity of organization crises can be more fully explained by an examination of TMT characteristics and that these characteristics serve as proxies for effective (or ineffective) information processing, conflict resolution, social cohesion, entrenchment, threat/rigidities, and environmental scanning during crisis situations. Our findings indicate that other related areas of study may prove worthy of examination.

For example, future research could provide more in-depth investigations of the relationship between TMT characteristics (and possibly board composition), potential incentive systems for top management, and the prevalence of corporate crises. Future research could examine if characteristics of the board of directors such as outside director representation, occupation, and experience in the industries in which the firm operates affect the likelihood and severity of crises. Given that the board of directors can serve as a liaison to multiple constituencies (Pfeffer, 1973), they may play an active role in minimizing the damage caused by crisis events.

Other research (possibly through case studies) could investigate what actions firms might take that result in human judgment errors (Sethi, 1987) that cause specific industrial or environmental problems and what part TMT characteristics played in producing those errors. Similarly, examinations of proactive and resistive responses to crises could be examined to assess if TMT factors tend to be associated with variance in firm responses to adversity.

Additional studies could fully investigate possible relationships between top management characteristics and impression-management techniques that firms use in interacting with the media, as Elsbach and Sutton (1992) suggest. One might examine the CEO's style (Alderfer, 1986) and the impact that an authoritarian or participative style may have on enhancing or delaying a firm's response to impending crises. It is hoped that future research will continue linking these areas of study that organizational researchers have not investigated previously.

*APPENDIX A*  
*Crisis Identified by Respondents*

*Petroleum and Gas Industry*

Cargo fire (refinery fire)  
Refinery explosion  
Oil spills  
Groundwater contamination  
Crude oil fire  
Pipeline failure  
Ship sank  
Gas leaks

*Utility Industry*

Nuclear accidents (defects)  
Contamination (radiation leaks)  
Major electric outage  
Nuclear plant shutdown  
Explosions  
Oil spill

*(continued)*

## APPENDIX A Continued

<i>Food Processing Industry</i>	<i>Chemical Industry</i>
Product recall	Explosions, blasts
Plant fire	Chemical fires
Chemical spill	Chemical poisonings
Product tampering	Chemical spills
Explosion	Dioxin exposure deaths
Labor strike	Agent orange
	Toxic waste discharges
	Gas leaks

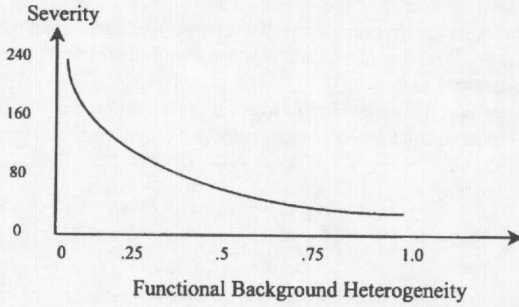
## APPENDIX B

*Evaluation of Curvilinear Relationships*

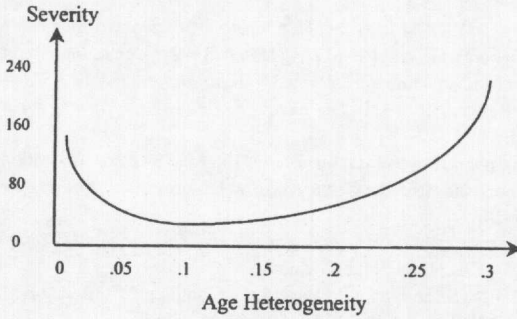
A positive significant squared (quadratic) term does not necessarily indicate a U-shaped relationship. To determine whether the relationship was nonmonotonic and U-shaped, we took the first order derivative of the regression equation (Cohen and Cohen, 1983: 233). The first order derivative determines the slope of the straight line tangent to the  $\text{Severity} = \alpha + \beta_1 X + \beta_2 X^2$  curve at each point through the entire range of X (the independent variable in question). Thus, we obtain  $\partial \text{Severity} / \partial X = \beta_1 + 2\beta_2 X$ . Three possible patterns can be found for different combinations of  $\beta_1 + 2\beta_2 X$  (only one of which represents a nonmonotonic U-shaped relationship). An inflection point determining the minimum of the curve was calculated using the following formula:  $I = -\beta_1 / 2\beta_2$ , where  $\beta_1$  = unstandardized regression coefficient of the linear term and  $2\beta_2$  = unstandardized regression coefficient of the quadratic term (Cohen and Cohen, 1983: 233).

If  $\beta_1 < 0$ ,  $2\beta_2 > 0$ , and there is an inflection point within the range of X in the sample, then the effect of X on Severity is nonmonotonic and U-shaped. If, however,  $\beta_1 < 0$  and the absolute value of  $\beta_1$  is larger than  $2\beta_2$ , then  $\partial \text{Severity} / \partial X$  is always negative. This indicates a monotonic, decreasingly negative effect of X on crisis severity. Last, if  $\beta_1 > 0$ , and  $2\beta_2 > 0$ , then  $\partial \text{Severity} / \partial X$  is always positive. This indicates a monotonic, increasingly positive effect of X on crisis severity.

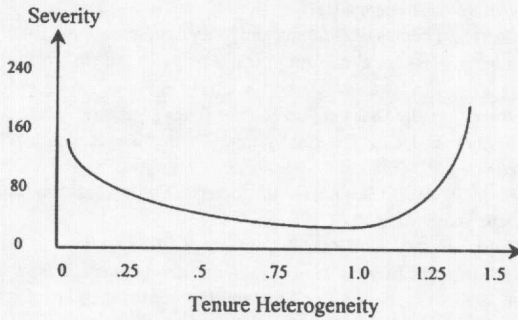
A. Crisis Severity by Functional Background Heterogeneity



B. Crisis Severity by Age Heterogeneity



C. Crisis Severity by Tenure Heterogeneity



Depiction of curvilinear relationships found.



## NOTES

1. Tight coupling refers to systems that are highly interdependent with tight sequencing, little buffers or slack, time-dependent processes, unifinal methods of operations, and little time for recovery (Perrow, 1984).

2. "Environmental" here refers to an organization's impact on the natural environment and not to environmental disasters such as floods, earthquakes, and so on, over which firms have little control.

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