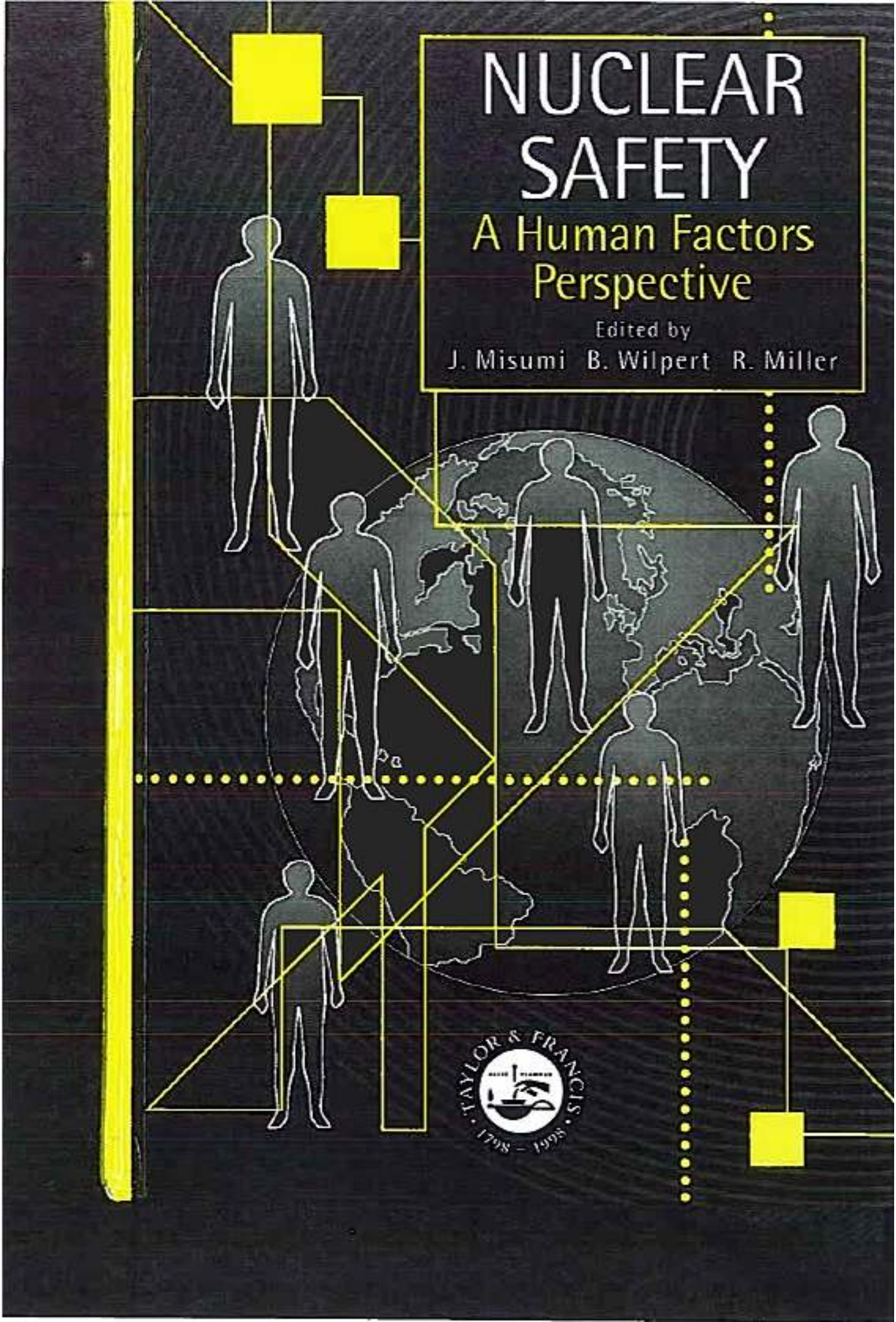
NUCLEAR SAFETY

A Human Factors Perspective

Edited by

J. Misumi B. Wilpert R. Miller



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For many years, as a direct result of international governmental concern, the nuclear power industry has been at the forefront of industrial safety. This book represents a cross-disciplinary state-of-the-art look at the latest human factors developments in this industry, with their wider applications for the entire industrial sector. Technical, psychological and social aspects of industrial safety come under the rigorous scrutiny of scientists and engineers from a vast array of different backgrounds. The contributors are all internationally renowned safety scientists from the U.S.A., Japan and Europe, and their chapters cover the gamut of nuclear safety from theoretical aspects of applicable cultural models, all the way to reviews of actual safety performance in specific plants.

Nuclear Safety: a Human Factors Perspective will be essential reading for academics and professionals in the applied human sciences – management and organisation, human factors, industrial engineering, work psychologists, risk analysts and safety technologists.

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Nuclear Safety: A Human Factors Perspective

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CHAPTER FOUR

The cultural context of nuclear safety culture: a conceptual model and field study

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The two general components of safety culture are 'the necessary framework within an organisation and the attitude of staff at all different levels in responding to and benefiting from the framework.' Also, the requirements from individual employees for achieving safety culture at installations are 'a questioning attitude, a rigorous and prudent approach, and necessary communication.' Recent studies have highlighted the critical role of cultural factors in the safety of nuclear power plants. This chapter contends that an organisation's safety culture, as a system composed of behaviours, practices, policies, and structural components, cannot flourish or succeed without interactions and harmony with its environment – the societal or national culture. In other words, safety culture should be considered in the context of national culture. It is concluded that the necessary conditions for creating and nourishing safety culture in a technological system include (but are not limited to):

- an understanding of systems-related factors affecting human performance;
- determination of the extent to which systems-related factors interact with factors of organisational culture and the national culture;
- promotion of a questioning attitude and openness in the organisation;
- development of conducive regulations and a supportive regulatory environment.

Human and organisational factors play a vital role in the safety of large-scale technological systems (Meshkati, 1988; 1989a, b, c; 1991a, b). Fortunately, this fact has been almost universally recognised by the nuclear industry around the

world. Nevertheless, it was the accident at the Chernobyl nuclear power plant that formally introduced the concept of *safety culture* to the vocabulary of nuclear safety. According to the International Atomic Energy Agency (IAEA), 'the term "safety culture" came into use after the Chernobyl accident' (*Nuclear Safety Review 1992*, p. D24). The expression is used nowadays quite extensively in the safety-related context, particularly in the field of nuclear energy. For instance, the former chairman of the US NRC, Ivan Selin, has referred to safety culture as one of four major sources of concern about the safety of the former Soviet-designed reactors (*Nuclear Engineering International*, July 1994). The concept of safety culture has also been embraced by other industries (Geller, 1994), such as chemical processing (Miner, 1991) and commercial aviation (Rodney, 1991; Lauber, 1993).

This chapter contends that an organisation's safety culture, as a system composed of behaviours, practices, policies, and structural components, cannot flourish or succeed without interaction and harmony with its environment – the societal or national culture. In other words, safety culture should be considered in the context of national culture.

The objectives of this chapter are threefold:

- to identify the element of a safety culture;
- to delineate a conceptual model of the interactions of dimensions of national culture with those of the safety culture, and to report on an experimental study on how the safety and productivity of US-owned manufacturing plants in other countries are affected by both the national culture of the host country and the organisational culture of the subsidiary plant;
- to identify important, culturally based parameters affecting nuclear safety.

4.1 CULTURAL CONTEXT AND NUCLEAR SAFETY

According to Fujita (1992), who compared Japanese with US nuclear power plants, cultural differences play a significant role in determining the performance of operators. A recent seminal study of nuclear power operations in the United States, Germany, France, Switzerland, and Sweden by Rochlin and von Meier (1994) has highlighted the *critical* role of cultural factors in the safety of nuclear power plants. Their findings were that 'cultural differences were central and functional to operational safety and reliability' (p. 160) and that 'regulators almost always insist that their actions are meant to encourage or nourish the safety culture, but [that] many of the operators we interviewed pointed out that awkward or clumsy regulation can also interfere with the safety culture' (p. 181). Rochlin and von Meier stated that 'care must be given to the group dynamics when designing computer-based control rooms; and because the dynamics of the control room differ from country to country (and possibly from plant to plant), the design must take cultural differences into account' (p. 175). The authors also noted that regulations should be sensitive to cultural norms and they cautioned the blind 'transfer of US or other regulatory

approaches developed in a radically different technical and cultural context' (p. 181). In conclusion, they raised an important warning flag for the nuclear industry around the world:

> To tinker with staff and departmental organisation, assignments of responsibility, delegation of authority, operator discretion, or even control-room design and integration without understanding the role of culture is to perform a real-time experiment with possibly irreversible consequences. (p. 182)

4.2 SAFETY CULTURE AND ORGANISATIONAL CULTURE

Since the Chernobyl accident, several studies of safety culture have emerged from the nuclear industry around the world (e.g. General Accounting Office [GAO], 1990; Saji, 1991; Ostrom, Wilhelmsen, and Kaplan, 1993; Joksimovich, 1992; Dien, Llory, and Montmayeul, 1992). According to the International Atomic Energy Agency (IAEA),

> the [Chernobyl] accident can be said to have flowed from deficient safety culture, not only at the Chernobyl plant, but throughout the Soviet design, operating, and regulatory organisations for nuclear power that existed at the time. Safety culture requires total dedication, which at nuclear power plants is primarily generated by the attitudes of managers of organisations involved in their development and operation. (INSAG, 1992, p. 24)

In a report by the International Nuclear Safety Advisory Group (INSAG) of the IAEA, safety culture is defined as 'that assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance' (INSAG, 1991, p. 4).

According to the US NRC, nuclear safety culture is a prevailing condition in which each employee is always focused on improving safety, is aware of what can go wrong, feels personally accountable for safe operation, and takes pride and 'ownership' in the plant. Safety culture is a disciplined, crisp approach to operations by highly trained staff, who are confident but not complacent, follow sound procedures, and practice effective teamwork and effective communication. Safety culture is an insistence on a sound technical basis for actions and a rigorous self-assessment of problems (GAO, 1990).

According to Pidgeon (1991), safety culture can be characterised as the set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimising the exposure of employees, managers, customers, and members of the public to conditions considered dangerous or injurious. Also, the principal cultural unit within which a safety culture is assumed to be located is that of the organisation (Pidgeon and O'Leary, 1994). In other terms, safety culture is a product of a larger concept of organisational culture (Joksimovich, 1992), an assertion verified by a study supported by the NRC (Orvis, Moieni and Joksimovich, 1993).

Organisational culture through its operative norms, significantly affects system safety and reliability (Weick, 1987). Furthermore, many factors, such as the 'shared experience' of the organisational members, are formed and nurtured by the organisational culture. According to Rochlin, La Porte, and Roberts (1987), this factor contributes to organisational adaptability, 'self-designing', and self-adjusting and eventually results in higher organisational reliability. Therefore, the organisational culture is a key determinant in the formation of the safety culture of a technological system.

According to Schein (1985), organisational culture is 'a pattern of basic assumptions – invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration – that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems' (p. 9). Kotter and Heskett (1992) contend that organisational culture has two levels that differ in terms of their visibility and their resistance to change.

> At the deeper and less visible level, culture refers to values that are shared by the people in a group and that tend to persist over time even when group membership changes. . . . At the more visible level, culture represents the behaviour patterns or style of an organisation that new employees are automatically encouraged to follow by their fellow employees. Each level of culture has a natural tendency to influence the other. (p. 4)

Operationally, organisational culture is defined as a set of shared philosophies, ideologies, values, beliefs, expectations, attitudes, assumptions, and norms (Mitroff and Kilmann, 1984). Cultural norms refer to the set of unwritten rules that guide behaviour (Jackson, 1960). Use of this concept allows the capturing of those dimensions of organisational life that may not be visible in the more rational and mechanical aspects of the organisation.

4.3 DEFINITION AND DIMENSIONS OF NATIONAL CULTURES

Culture, according to anthropologists, is the way of life of a people – the sum of their learned behaviour patterns, attitudes, customs, and material goods. According to Azimi (1991), the culture of a society consists of a set of ideas and beliefs. These ideas and beliefs should have two principal characteristics or conditions. First, they should be accepted and admitted by the majority of the population. Secondly, the acceptance of these beliefs and ideas should not necessarily depend upon a scientific analysis, discussion, or convincing argument. In the context of technology transfer and utilisation, culture could also be defined operationally as the 'collective mental programming of peoples' minds' (Hofstede, 1980).

This view might be anathema to many scholars of 'hard' sciences and other engineering-dominated fields, but according to Stephen Jay Gould, the renowned Harvard University professor of geology, biology, and the history of science, even *scientific* theories are strongly culturally based (Gould, 1981, p. 22):

> Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.

4.3.1 Dimensions of national culture

Culture, defined earlier as the collective mental programming of the people who work in technological systems, affects not only the safety but also the success and survival of any technology. National cultures differ in at least four basic dimensions: power distance; uncertainty avoidance; individualism–collectivism; and masculinity–femininity (Hofstede, 1980). *Power distance* refers to the extent to which a society accepts the fact that power in institutions and organisations is distributed unequally. It is an indication of the interpersonal power or influence between two entities, as perceived by the least powerful of the two (Boeing Commercial Aircraft Group [BCAG], 1993). *Uncertainty avoidance* refers to the extent to which a society feels threatened by uncertain and ambiguous situations. It also refers to attempts to avoid these situations by providing greater career stability, establishing more formal rules, not tolerating deviant ideas and behaviours, and believing in absolute truths and the attainment of expertise. *Individualism* refers to a 'loosely knit' social framework in which people are supposed to take care of themselves and their immediate families only, whereas *collectivism* is characterised by a tight social framework in which people distinguish between in-group and out-group. They expect their in-group members (e.g. relatives, clan, organisation) to look after them and, in exchange, they owe absolute loyalty to the group. The *masculinity* dimension expresses the extent to which the dominant values in a society are 'masculine,' as evidenced by decisiveness, interpersonal directness, and machismo (Johnston, 1993). Other characteristics of masculine cultures include assertiveness, the acquisition of money and material goods, a relative lack of empathy, and a lower perception of the importance of quality-of-life issues. This dimension can also be described as a measure of the need for ostentatious manliness in the society (BCAG, 1993). *Femininity*, the opposite pole on this continuum, represents lower assertiveness and greater empathy and concern for issues regarding the quality of life.

The four cultural dimensions discussed above also have significant implications for nuclear safety and control-room operations. For instance, according to Helmreich (1994a) and Helmreich and Sherman (1994), there is evidence that operators with high power distance and high uncertainty avoidance prefer and place a 'very high importance' on automation. Furthermore, it is known that the primary purpose of regulations is to standardise, systematise, and impersonalise operations. This is done, to a large extent, by ensuring adherence to (standard and emergency) operating procedures. On many occasions it requires replacing operators' habits with more desirable ones that are prescribed in procedures or enforced by regulations. However, according to several studies, an operator's culturally driven habit is a more potent predictor of behaviour than his or her intentions, and there could be

occasions on which intentions cease to have an effect on operators' behaviour (Landis, Triandis, and Adamopoulos, 1978). This places in doubt the effectiveness of those regulations and procedures that are incompatible with operators' culturally driven habits.

4.4 FIELD STUDY AND ITS IMPLICATIONS FOR THE SAFETY CULTURE IN NUCLEAR INSTALLATIONS

A major, though subtle, factor affecting the safety and performance of a technological system is the degree of compatibility between its organisational culture and the national culture of the host country. It is an inevitable reality that groups and organisations within a society also develop cultures that significantly affect how the members think and perform (Schein, 1985). Demel and Meshkati (1989) and Demel (1991) conducted an extensive field study to explore how the performance of US-owned manufacturing plants in other countries is affected both by the national culture of the host country and the organisational culture of the subsidiary plant. A manufacturing plant division of a large American multinational corporation was examined in three countries: Puerto Rico, the United States, and Mexico. Hofstede's (1980) *Values Survey Module* for national culture and Reynolds' (1986) *Survey of Organisational Culture* were administered. Performance measures (i.e. production, safety, and quality) were collected through the use of secondary research.

The purpose of this investigation was threefold:

- to determine if there were any differences between the national cultures of Puerto Rico, the United States, and Mexico;
- to find out if there were any differences between the organisational cultures of the three manufacturing plants;
- to establish whether there was any compatibility between the organisational culture of the plants and the national culture of the three countries, and to examine if the compatibility or incompatibility affected their performance in terms of production yields, quality, safety, and cycle time.

This study's aim was to examine the relationship, if any, between the compatibility of national and organisational cultures on the one hand, and performance on the other. The results of this study indicated that there were differences between the national culture dimensions of Puerto Rico, the United States, and Mexico. However, no significant differences were found between the organisational cultures of the three plants, perhaps because of selection criteria, according to which candidates may have been carefully screened for behavioural styles, beliefs, and values that 'fit in' to the existing organisational culture. Additionally, socialisation may have been another factor. For example, the company may have had in-house programmes and intense interaction during training, which could have created a shared experience, an informal network, and a company language. These training events often include songs, picnics, and sporting events that provoke feelings of togetherness. Also, the company may have had artifacts (the first level of organisational

culture) such as posters, cards, and pens that remind the employees of the visions, values, corporate goals of the organisation, and that help to promote its culture.

Therefore, it seems that a 'total transfer' has been realised by this multinational corporation. These manufacturing plants produce similar products, so they must achieve uniform quality in their production centres. To do so, this company has transferred both its technical installations and machines as well as its organisation. Moreover, to fulfill its purpose, the company chooses its employees according to highly selective criteria.

These results notwithstanding, Hofstede's (1980) research demonstrated that even within a large multinational corporation famous for its strong culture and socialisation efforts, national culture continued to play a major role in differentiating work values. Differences were found between the national cultures of Puerto Rico, the United States, and Mexico.

There are concepts in the dimensions of organisational culture that may correspond to the same concepts of the dimensions of national culture. The 'power distance' dimension of national culture addresses the same issues as the perceived oligarchy dimension of organisational culture, in that they both refer to the nature of decision-making. In countries where power distance is large, only a few individuals from the top make the decisions; uncertainty avoidance and perceived change address the concepts of stability, change, and risk-taking. One extreme is the tendency to be cautious and conservative (e.g. to avoid risk and change when possible) in adopting different programmes or procedures. The other extreme is the predisposition to change products or procedures, especially when confronted with new challenges and opportunities – in other words, to take risks and make decisions. Uncertainty avoidance may be related to perceived tradition in the sense that, if the employees have a clear perception of 'how things are to be done' in the organisation, their fear of uncertainties and ambiguities will be reduced. Agreement on a perceived tradition in the organisation goes well with a country with high uncertainty avoidance. Individualism–collectivism and perceived cooperation address the concepts of cooperation between employees and of trusting and assisting colleagues at work. In a collectivist country cooperation and trust among employees is keenly pursued; in an individualist country, less so.

One could say that perceived tradition (of the organisational culture) may also be related to individualism–collectivism in the sense that, if members of an organisation have shared values, know what their company stands for and what standards they are to uphold, they are more likely to feel as if they are an important part of the organisation. They are motivated, because life in the organisation has meaning for them. Ceremonies (of the organisational culture) and rewards to honour top performance are very important to employees in any organisation. However, the types of ceremony or reward that will motivate employees may vary across cultures. In other words, rewards and ceremonies should vary depending on whether the country has a masculine orientation (where money and promotion are important), or a feminine orientation (where relationships and working conditions are important). If given properly, they may keep the values, beliefs, and goals uppermost in the employees' minds and hearts.

Because cultural differences may play significant roles in achieving the success of corporate performance, the findings of this study may have important managerial implications. First, an organisational culture that fits one society might not be readily transferable to other societies. In other words, the organisational culture of the company should be compatible with the culture of the society to which the company is transferring. There needs to be a comfortable match between the internal variety of the organisation and the external variety (coming from the host country). When the cultural differences are understood, the law of requisite can then be applied as a concept for systematic investigation of the influence that culture has on the performance of the multinational corporation's manufacturing plants. This law may be useful when examining environmental variety in the new cultural settings. Secondly, the findings of the present study have confirmed that cultural compatibility between organisational cultures of the multinational corporations and the cultures of the countries they are operating in play a significant role in the performance of their manufacturing plants.

It can be suggested, therefore, that the decision about which management system to promote should be based on specific human, cultural, social, and deeply rooted local behaviour patterns. For the success of their operations it is critical for multinational corporations operating in cultures different from their own to ensure and enhance cultural compatibility. As a consequence, it can be recommended that no organisational culture should be transferred without prior analysis and recommendations for adjustment and adaptation to the foreign country's cultures and conditions. This research has given a clear view of the current potential for supervising and evaluating cultural and behavioural aspects of organisations as affected by their external environment and their relation to the performance of the organisations. Culture, both national and organisational, will become an increasingly important concept for technology transfer.

Results of this study showed that, whereas there were differences between the national cultures of the three countries, there were no significant differences between the organisational cultures of the three manufacturing plants. It is noteworthy that the rank order of the performance indicators for these plants was in exact concordance with the rank order of the compatibility between the organisational culture and the national culture of the host country: Mexico had the highest overall cultural compatibility and the highest performance, Puerto Rico had high overall compatibility and the next highest overall performance, and the United States had the lowest cultural compatibility and the lowest overall performance.

4.5 NATIONAL CULTURE: ATTENUATOR OR AMPLIFIER OF THE SAFETY CULTURE?

The following issues and examples are an attempt to demonstrate some important culturally based attitudes affecting organisational functioning, technology utilisation, and, in particular, safety culture in nuclear power plants (discussed in detail in Meshkati, 1994):

- Risk perception.
- Attitude toward work.
- Work group dynamics.
- Attitude toward technology.
- Attitude toward organisation, hierarchy, procedure, and working habits.
- Attitude toward time and time of the day.
- Religious duties and their effects on work.
- Achievement motivation and orientation.
- Population stereotype (e.g. colour association).
- The 'If-it-ain't-broke, don't-fix-it' attitude.

For instance, according to Otway and von Winterfeldt (1982), people's perceptions of technologies and of risk depend upon the information to which they have been exposed, the information they have chosen to believe, the values they hold (including religious and ideological beliefs), the social experiences to which they have had access, the dynamics of stakeholder groups, the vagaries of their political process, and the historical context within which all of the aforementioned have taken place. The perception of the risk posed by a given technology is also influenced positively by, among other things, whether the technology increases the standard of living, creates new jobs, enhances national prestige, and/or creates greater independence from foreign suppliers. According to Douglas and Wildavsky (1982), risk perception is influenced or moderated in society by a 'cultural bias' that 'elevates some risks to a high peak and depresses others below sight' (p. 9).

The response of nuclear reactor operators to nuclear power plant disturbances is shown in Figure 4.1. The operators are constantly receiving data from the displays in the control room and looking for change or deviation from standards or routines in the plant. It is contended that their responses during transition from the rule-based to the knowledge-based level of cognitive control, especially at the knowledge-based level, are affected by the safety culture of the plant, and are also moderated or influenced by their cultural background. Their responses could start a vicious circle which, in turn, could lead to inaction, which wastes valuable time and control room resources. Breaking this vicious circle requires boldness to make or take over decisions, so that the search for possible answers to the unfamiliar situation does not continue unnecessarily and indefinitely. It is contended that the boldness is culturally driven to a high degree, and that it is a function of the plant's organisational culture, reward system, and regulatory environment. Boldness, of course, is also influenced by operators' personality traits, aptitude for risk-taking, and perception (as mentioned before), which are also strongly cultural. Other important aspects of the national culture include *hierarchical power distance* and *rule orientation* (Lammers and Hickson, 1979), which govern acceptable behaviour and could determine the upper boundary of operators' boldness.

According to INSAG (1991), 'two general components of the safety culture are the necessary framework within an organisation [whose development and

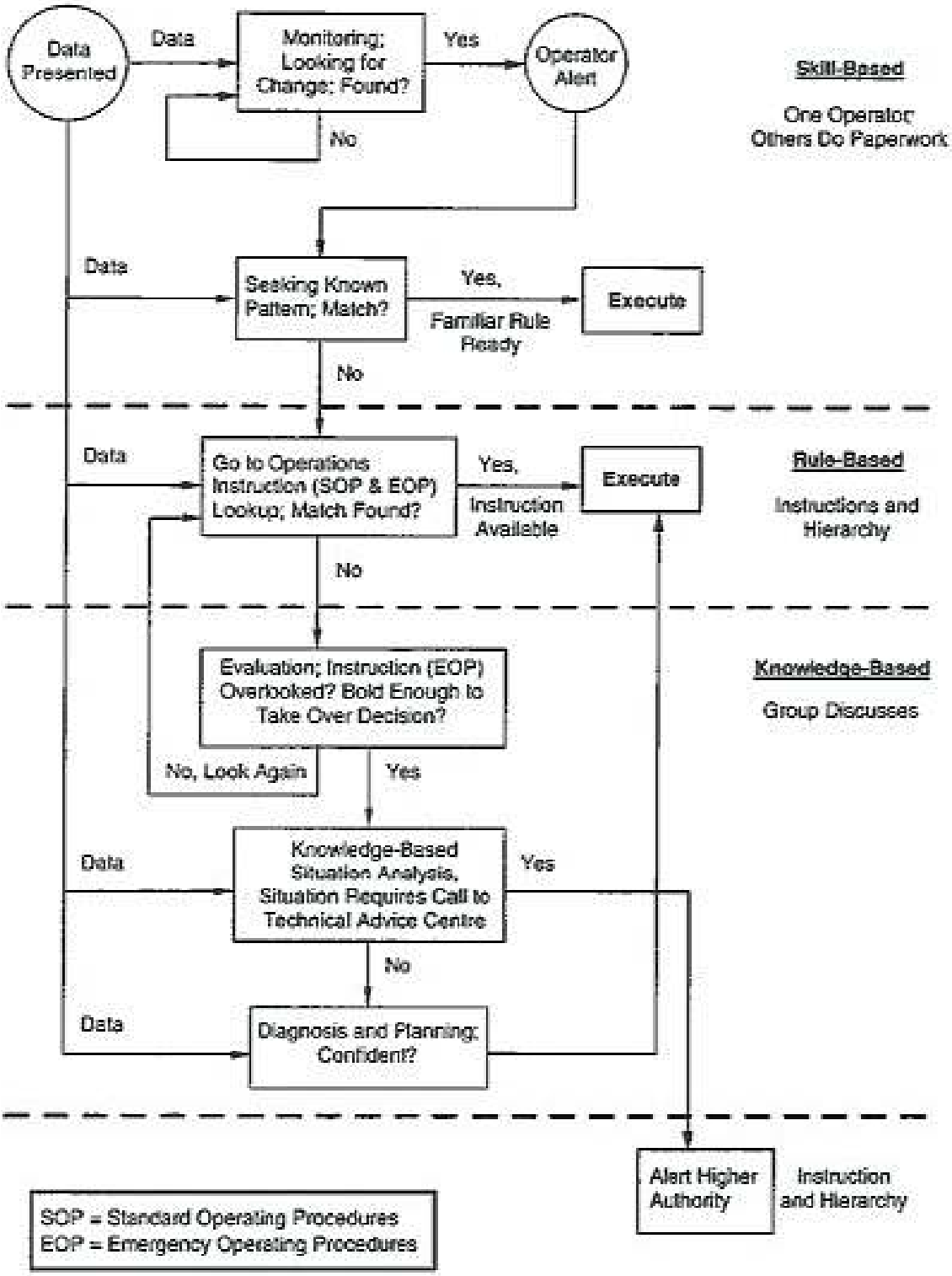

Figure 4.1 Model for nuclear power plant operators' responses to disturbances.

From: *Integration of workstation, job, and team structure design in the control rooms of nuclear power plants: Experimental and simulation studies of operators' decision styles and crew composition while using ecological and traditional user interfaces* (p. 42), N. Meshkati, B. J. Buller, and M. A. Azadeh, August 1994, Grant Report, prepared for the US Nuclear Regulatory Commission (Grant No. NRC-04-91-102), Los Angeles: University of Southern California. Reprinted with permission. Adopted from J. Rasmussen, March 1992.

maintenance is the responsibility of management hierarchy] and the attitude of staff at all different levels in responding to and benefiting from the framework.' Also, the requirements of individual employees for achieving safety culture at the installation are 'a questioning attitude, a rigorous and prudent approach, and necessary communication' (pp. 13–14). However, other dimensions of national culture – uncertainty avoidance, individualism-collectivism, and masculinity–femininity – could either resonate with and strengthen or attenuate safety culture, while interacting with these general components and requirements. For instance, a questioning attitude (on the part of operators) is greatly influenced by the power distance, rule orientation, and uncertainty avoidance of the societal environment and the openness in the organisational culture of the plant. A rigorous and prudent approach, which involves understanding the work procedures, complying with procedure, being alert for the unexpected, and so forth, is moderated by power distance and uncertainty avoidance in the culture. It is also moderated by the sacredness of procedures, the critical nature of step-by-step compliance, and a definite organisational system at the plant. Communication, which involves obtaining information from others, transmitting information to others, and so on, is a function of all the dimensions of national culture as well as the steepness and rigidity of the hierarchical organisation of the plant.

The nuclear industry shares many safety-related issues and concerns with the aviation industry, and there is a continuous transfer of information between them (e.g. Electronic Power Research Institute [EPRI], 1984). Cultural and other human factors are considerations affecting the performance of a cockpit crew and are, to a large extent, similar to those affecting nuclear plant control-room operators. It is worth, therefore, recalling the crash of a passenger aircraft, an accident to which cultural factors within the cockpit and between it and the air-traffic control tower were found to have contributed significantly (National Transportation Safety Board [NTSB], 1991). Flight 052 (AV052), a Boeing 707 of the Airline of Columbia, crashed in Cove Neck, New York, on 25 January 1990, fatally injuring 73 of the 158 persons aboard. According to Helmreich (1994b):

> In a culture where group harmony is valued above individual needs, there was probably a tendency to remain silent while hoping that the captain would 'save the day.' There have been reported instances in other collectivist, high power distance cultures where *crews have chosen to die in a crash rather than disrupt group harmony and authority* and bring accompanying shame upon their family and in-group.
>
> (emphasis added, p. 17)

> High Uncertainty Avoidance may have played a role (in this accident) by locking the crew into a course of action and preventing discussion of alternatives and review of the implications of the current course of action. High Uncertainty Avoidance is associated with a tendency to be inflexible once a decision has been made as a means of avoiding the discomfort associated with uncertainty. (p. 17)

Moreover, the importance of the cultural factors *vis-à-vis* automation in the aviation industry has been further highlighted by two recently published studies. Sherman and Helmreich (in press), in their study of national culture and flightdeck automation, surveyed 5,705 pilots across 11 nations and have reported that 'the lack of

consensus in automation attitudes, both within and between nations, is disturbing'. They have concluded that there is a need for clear explication of the philosophy governing the design of automation. Most recently, the US Federal Aviation Administration Human Factors Study Team (FFA, 1996) issued a report entitled *The Interfaces Between Flightcrews and Modern Flight Deck Systems*. This team identified several 'vulnerabilities' in flightcrew management of automation and situation awareness that are caused by a number of interrelated deficiencies in the current aviation system, such as 'insufficient understanding and consideration of cultural differences in design, training, operations, and evaluation' (p. 4). They have recommended a host of further studies under the heading of Cultural and Language Differences. They included pilots' understanding of automation capabilities and limitations, differences in pilot decision regarding when and whether to use different automation capabilities, the effects of training, and the influence of organisational and national cultural background on decisions to use automation.

4.6 CONCLUSION

Safety culture in a nuclear installation should be considered in the context of its local national culture. Necessary conditions for creating and nourishing safety culture in a nuclear installation include (but are not limited to):

1 a thorough understanding of the dimensions of local national culture;
2 a determination of the extent of their match with those of the organisational culture of the installation;
3 their compatibility with the prescribed requirements for safety culture;
4 a further understanding of the effects of cultural variables on the interactions between human operators and automation in control rooms.

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