

WORLD VIEW AND IMPLICATIONS FOR PRACTICE: OCCUPATIONAL HEALTH AND SAFETY (OHS) AS A MODEL

Susanne J Tepe PhD.

RMIT University School of Applied Science OHS Unit
Melbourne Victoria Australia
susanne.tepe@rmit.edu.au

John Barton PhD.

Business Strategy Dynamics
Melbourne Victoria Australia
bartcons@bigpond.net.au

ABSTRACT

In many countries, particularly Australia, there has been a steady decline in the number of workplace injuries, but the number never seems to reduce below a certain level, approximately 10 compensable injuries per 1000 employees.

A mantra of systems dynamics states that the structure of a system is ascertained by understanding the pattern of observable events that result from that system. However, one's understanding of the pattern of events is influenced by the world view that underpins one's view of the pattern. Pepper's four world views or hypotheses offer a framework for discerning a system's patterns: If one views the world through a Formism lens, one sees categories of similar and different events. A Mechanistic world view causes one to see controllable machines with inputs, outputs, processes and feedback. An Organicism world view sees the world as an organism evolving in response to the environment while a Contextual world view sees operators in the world who influence the environment and are influenced by it in a continuous cycle.

The events of significance to occupational health and safety (OHS) are workplace injuries. The pattern of events is used to determine the causes of injuries and to elucidate the structure of the system that caused the injury. The causes of the injuries determine how you structure your control systems to prevent further injuries, how you establish your management system, even what risk equation is needed to calculate the risk associated with the injury events. Yet how, or whether, you recognise the pattern is determined by your world view.

This paper describes how the various world views influence the practice of OHS and suggest a framework for a pluralist approach to the control, management, research of, and learning about OHS issues.

Key words: occupational health and safety; risk; systems thinking; experiential learning; action research

INTRODUCTION

For decades governments around the world have been focusing on reducing injuries and disease in workplaces, and with some success.

Figures 1 and 2 describe compare trends in compensated injuries from 2000 to 2006 for Australia, the United Kingdom, and Canada (ILO, 2009). While these data raises many questions about the relative performance of each country, we wish to concentrate on the trends indicated in the data. For each country the aggregate data shows some degree of improvement but for individual industries the data shows more dramatic improvements in manufacturing, particularly in Australia but a tendency to level out in other industries. While it may be the case that the community accepts these injury rates as some sort of balance between exposure to risk and the cost of safety, this will not be the case for any individual who suffers an injury at work. The question arises: how can we reduce injury rates to even lower benchmarks for industries where the current approaches have levelled out? This situation is the focus of discussion in this paper. The general argument presented is that injury levels can only be reduced by using more insightful ways of framing our approaches to OHS which in turn provides new ways of developing interventions and forming policy.

This paper aims to develop an approach to identifying relevant underlying structural frameworks for the management of OHS and to integrate these with an experiential learning approach.

To achieve this aim the rest of the paper develops as follows:

Firstly, to establish some criteria for developing new approaches to OHS, sociological risk frameworks described by Luhmann and Perri are considered. These approaches recognise that an essential criterion for selecting any particular framework is the extent to which the framework facilitates dialectical learning.

Secondly, a framework based on Pepper's "World Hypotheses" (Pepper, 1942) is introduced. While Luhmann and Perri apply *sociological* frameworks, Pepper's framework has its roots in *philosophy* and pluralism and this is further articulated in terms of approaches to systems thinking (Barton and Haslett, 2007).

Thirdly, some basics of the design of experiential learning and approaches to adult learning are described. Four inter-related aspects of learning are discussed: the nature of experiential learning; the importance of dialectics to adult learning; the evolutionary nature of learning and knowledge creation; and finally, the nature of action research as a process for policy implementation and change management.

Fourthly, and in conclusion, an approach to OHS management using systemic frames based on Pepper's World Hypotheses and an experiential learning approach is described.

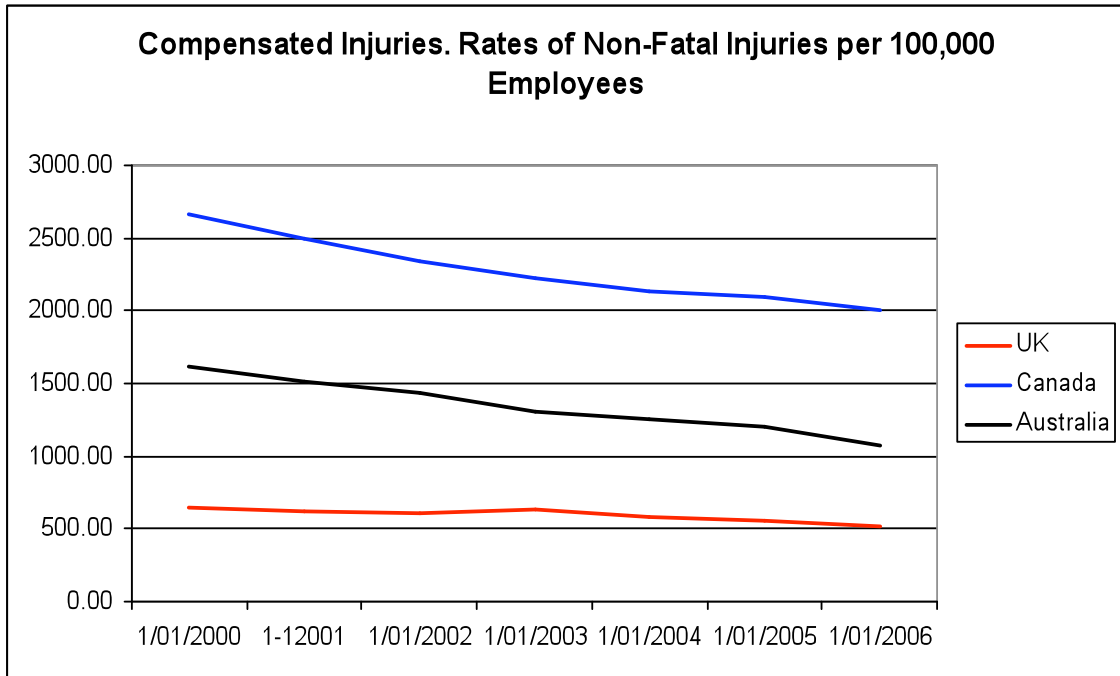


Figure 1. International Comparison of OHS Data (ILO, 2009)

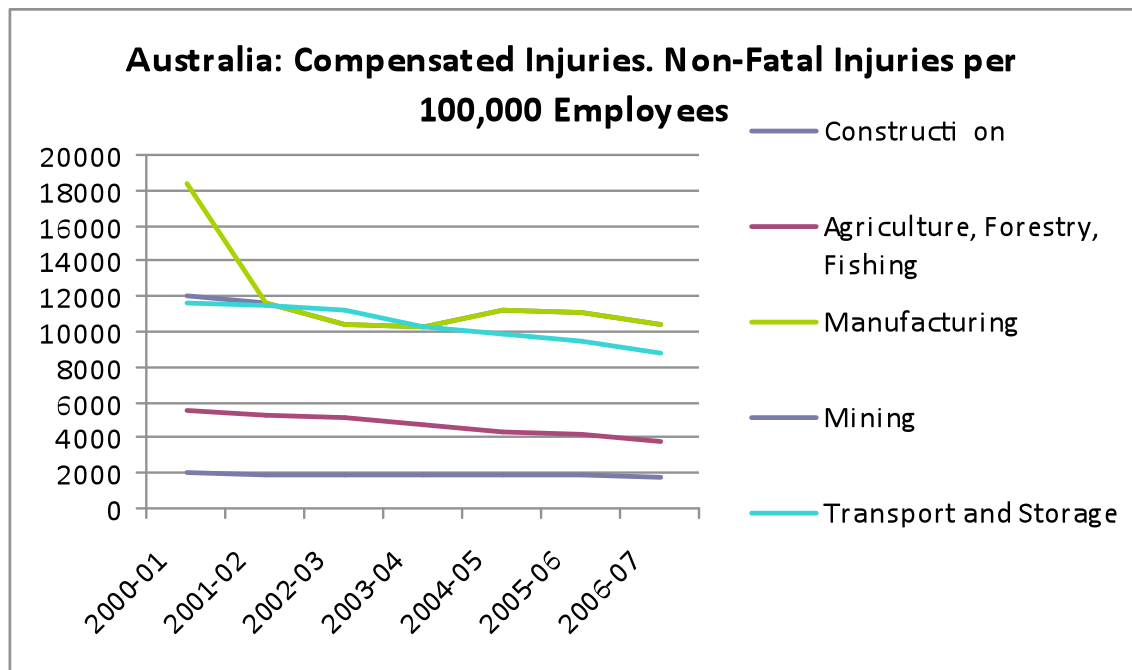


Figure 2. OHS Industry Trends: Australia (ILO, 2009)

DATA and STRUCTURAL EXPLANATIONS

When the OHS statistics from a given country are examined in more detail, the data are usually classified by the severity of the injury (eg was it a fatality, compensable according to the jurisdiction's criteria, a disease, etc), the sex of the injured person, the 'agent' which was the immediate cause of the injury (fall, manual handling, stress, etc) and the industry in which the injured person worked. Statistics are usually derived from calculating the number of these events and the rate of events per number of workers or per hours worked (ILO 2009).

While injury statistics describe the events of an injury, they do not tell you what caused the injury; they can describe a collection of individual events, but not the cause. However causation can be inferred by examining the pattern of events (eg many fatal events in the construction industry result from falls from roofs).

Examining causality can be difficult if several causal agents are involved. If there were another worker awkwardly carrying an unstable load on the roof who came in contact with the worker who fell, this would never be known from the statistics of workers killed falling off roofs. If there were management or regulatory reasons for the other worker being on the roof, these latent causes (see Reason's (1990) Swiss cheese model) would be lost completely.

A widely accepted approach to understanding patterns of behaviour and the development of causal models is to research perceived structures that underpin particular behaviours. The quality expert, Deming (1982), building on Walter Shewhart's (1939) concept of a "control chart" in which data variations are shown around a trend line, argued that system performance needs to be considered in two parts: the underlying trend in the level of performance of the system, and the variability around this level. While approaches can be developed that minimize variability (Wheeler, 1993), Deming argued that changing the trend behaviour required fundamental changes to the underlying system.

While most fields of science can assist in interpreting statistical data, in 1969, Jay Forrester put forward what has become an iconic diagram (Figure 3). Forrester suggests that events, which are observable, ultimately become statistics. When these events are examined for frequency, correlations, and /or trends over time, they form patterns of events over time. These patterns assist us in understanding the causes of the trends, the underlying connections and structures that influence the outcomes that have been observed. These patterns help us understand the reasons why, for example, the construction industry has fatalities from falling off roofs.

This approach has been further operationalised in the field of systems thinking where the underlying system is interpreted through structural lenses, whose conceptual bases are metaphorical in nature (Lakoff, 2004). For example, practitioners of System Dynamics (Forrester, 1961; Sterman, 2000), represent their systems as socio-technical structures with feed-back controls; from this paradigm simulation models can be constructed. Of particular significance is the way System Dynamics uses the relationship between events and patterns of

events to guide the search for the minimal underlying structure that explains observed or perceived dynamic behaviour.

OHS professionals are very good at recognising patterns from the event data related to injuries. Trend over time graphs are standard ways of analysing injury data and assessing performance against corporate or national goals. Reason (1990) has had considerable influence on the ability to recognise the structure of the system that underlies OHS injury. In a similar vein, drawing on System Dynamics techniques, McLucas (2003) demonstrates the way causal maps of underlying structure can be used to understand the systemic basis of accidents such as the Black Hawk accident (2003).

In much of what follows, the Forrester approach (see Figure 3) will be broadened by admitting a wider number of metaphors that are used to describe the structure of the system in addition to the feedback structure that helps define System Dynamics.

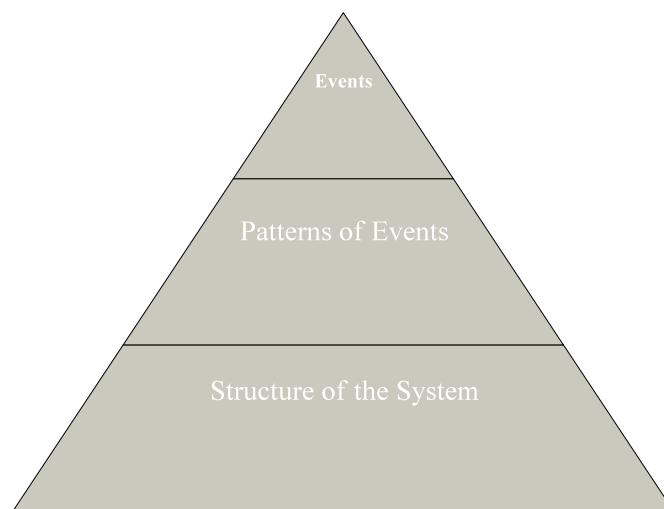


Figure 3. Forrester's triangle of events / patterns / structures (1961)

On this basis, if current approaches to OHS have resulted in a plateau in performance, then perhaps we need to look at the fundamental way OHS interventions and policy are framed. This needs to be done at two levels; at the macro level of how we understand risk and policy systems, and at the micro level of how we interpret risk, decide on interventions and learn from experience.

Jens Rasmussen (1997, p183) describes the challenge we face in the following terms:

In spite of all efforts to design safer systems, we still witness severe, large-scale accidents. A basic question is: Do we actually have adequate models of accident causation in the present dynamic society? The socio-technical system involved in risk management includes several levels ranging from legislators over managers and work planners, to system operators. The system is presently stressed by a fast pace of technological change, by an

increasingly aggressive, competitive environment, and by changing regulatory practices and public pressure.

Traditionally, each level of this is studied separately by a particular academic discipline, and modeling is done by generalizing across systems and their particular hazard sources. It is argued that risk management must be modeled by cross-disciplinary studies, considering risk management to be a control problem and striving to represent the control structure involving all levels of society for each particular hazard category. Jens Rasmussen (1997, p183)

Tepe and Haslett (2002) go part of the way proposed by Rasmussen by outlining how Beer's cybernetics-based theory of viable systems can be used to structure and review the management of OHS across the several organizational levels. This control-structure approach defines the same structure at each level. Like "Russian Dolls", each structure sits recursively within a higher level structure but with provision for by-passing levels in cases of extreme emergency (the "algedonic" process). While this approach describes system structure and information flow, does not explicitly address the way in which risk is framed and implemented within the policy structures across these organisational levels. Fortunately this is an area which has attracted considerable theoretical attention (Nelkin, 1985; Shrader-Frechette, 1991; Luhmann, 1993/2005; Lewens, 2007; Perri, 2005; Rescher, 2007).

FRAMING RISK FROM SOCIOLOGICAL PERSPECTIVES

Luhmann (2005) stresses the importance of questioning risk frames. Reflecting on the Nelkin's (1985) discussion of risks associated with changing technologies¹, Luhmann makes the distinction between "first" order observers who insist on one interpretation of facts and "second" order observers who recognise that facts generate different information for each observer. Luhmann accuses safety experts of being first-order observers.

According to Luhmann (2002), "first order observers":

...believe in facts; and when they cross swords or negotiate, it is typically on the basis of differing interpretations or differing claims in relation to the same facts One demands more information, better information, complains about the information being withheld by those who wish to prevent others from projecting other interpretations or making greater demands on an objectively given universe of facts - as though there were 'information' available that one could have or not have as the case may be. And, as we have said, the first-order observer takes this to be the real world. But the observer of the second order faces the problem that what different observers consider to be the same thing generates quite different information for each of them.

This is not true for the second-order observer who is observing another observer to see what the latter can and cannot see. (Luhmann, 2002, p21).

Luhmann (2002) uses this distinction about observers to counter the usual concept by which of risk is framed. Risk is usually counter by the concept of security; the desirable/undesirable dichotomy. Luhmann (2002) contrasts this framing by using “danger” as the counter concept that helps define risk. He argues that this framing recognizes that “absolute safety” cannot be achieved and presupposes that uncertainty exists in relation to future loss (p 21).

In each case, risk/security or risk/danger, Luhmann identifies an asymmetric framing where risk indicates a “complex state” which is a normal part of modern life while security and danger represent reflexive concepts that elucidate the contingent nature of risk (p23). In the case of risk/security, this asymmetric framing appears in the problems posed by measurement; in the case of risk/danger, this asymmetric framing becomes obvious when risk decisions are being made (p23).

Luhmann identifies that the most important advantage of comparing the risk/security schema with the risk/danger schema, is that the matter of “attribution” is raised. He argues that “once this is realized, it is possible to for one observer to observe how another observer makes attributions, for example, internally or externally in relation to himself or others, and either to constant or variable factors, to structures or events, to systems or situations” (p25)¹.

At a later stage we will identify Luhmann’s discussion with the process of “double-loop” learning as defined by Argyris and Schön (1974) and Argyris (1983).

Perri (2009) also uses frames for addressing perceptions of risk. He uses the concepts derived from the sociology of knowledge as a basis for asking for questions to test the adequacy of frames used in addressing perceptions of risk:

1. What is the relationship between sense-making and bias toward action?
2. How are frames individuated?
3. Where do frames come from?
4. How far and how *can* people move between frames?

Perri assesses a number of frames against these criteria. He criticises Schön and Rein’s (1994) approach where frames are defined as “underlying structures of belief, perception and appreciation” (p.95). Perri’s criticism is that this approach does not tell us how many frames there are, nor how frames are derived, and he argues that some frames are only organizing or only biasing in function (p. 96).

In terms of risk perception, Perri is also critical of Kahneman and Tversky’s (2000) “prospect theory” in which individual judgements depend on whether a proposition is posed in risk averse, risk neutral, or risk seeking terms, that is, the frames are treated as “accounts of context that skew individual judgement ...What frames explain are non-linearities, concavities and convexities of preference functions in risky choices” (p.96). Perri’s criticism is that the interest is more related to the measure of non-linear effects than in specifying where the frames come from.

¹ Note the similarities with Argyris’ (1982) distinction between single and double loop learning

Perri concludes that each of the frames has strengths and weaknesses, some being better at organizing experience, while others better at explaining biasing for action; however, none of the frames adequately addresses all the questions posed. Instead, he proposes an approach drawn from a “neo-Durkheimian” position (p.97). In this approach, “cognition is powerfully shaped in semantic content, not only in style, but also by patterns of organisation”. This brings us back to the recognition that frames need to be systemic.

Table 1 describes the Neo-Durkheimian framework used by Perri. The intent of the matrix is to describe the forms of social organisation through which people understand social issues such as risk; it does not present risk perceptions by reference to world views, rather, “it explains world views by reference to institutional forms of social organization” (p.100).

Like Luhmann’s frame, a learning construct is implied based on a dynamic resulting from an understanding that “any viable unit of social organization will give just enough recognition to each of the four solidarities to prevent other solidarities from undermining the structure by backsliding (isolate), defection (individualism), revolt (enclave), reassertion of control (hierarchy)” (p.100, citing Thompson et. al., 1990).

Table 1. Neo-Durkheimian Frames (based on Perri, 2009, p.99)

Social Regulation ↑	Social relations are conceived as if they were principally involuntary. Tragic view of society		
Individual should not be held accountable ←	Isolate No coordination; loose networks; withdrawal; fatalism at the bottom of society, despotism at top; there is little the individual can do.	Hierarchy/ central community Systems are regulated; central community, controlled and managed network; rationality, rule dominant institutions	Individual should be held accountable →
	Individualism Regulated systems are unnecessary or harmful; effective system emerges spontaneously from individual action. Institutions need to be non-intrusive but guarantee basic property rights etc.	Enclave Inward-looking but egalitarian; coordination occurs through mutual consent; charismatic leaders (sects)	
Individual Accountability →	Social relations are conceived as if they were principally voluntary. Heroic view of society		

In summary, we can see the matter of framing the risk concept is not a trivial exercise, with profound implications for policy design and OHS. Two requirements are critical: the theoretical basis of the frame must be transparent, and the frame needs to provide the basis of a learning construct; it is not enough to provide a static taxonomy.

PEPPER’S WORLD HYPOTHESES

While forming frames is an important construct in understanding how risk is perceived, it is a socially defined construct. Pepper (1942) on the other hand provides a system of frames based schools of philosophy and their corresponding modes of thought. He locates these frames between “two opposite extremities of cognitive attitude: utter scepticism and dogmatism”, but rejects both as not having any real practical value. Instead, Pepper chooses a middle path of partial scepticism (pluralism) which he labelled as “world hypotheses” defined as:

... objects in the world. Among the variety of objects which we find in the world are hypotheses about the world itself. For the most part these are contained in books such as Plato’s Republic, Aristotle’s Metaphysics.... Dewey’s Experience and Nature, and Whitehead’s Process and Reality. (Pepper, 1942, p. 1).

Pepper distilled the known world hypotheses down to four from which other metaphysical positions could be derived. He identified a “root metaphor” corresponding to each of the four hypotheses. Pepper’s four world hypotheses and corresponding root metaphors are:

Formism, or realism, or Platonic realism, associated with Plato, Aristotle, the scholastics, neoscholastics, neorealists, and modern Cambridge realists. “Objects of experience are seen as copies of ideal forms, and a total world view can be built up along lines of such essences or categories” (Lilienfeld, 1978, p. 9). The root metaphor is *similarity*.

Mechanism, or naturalism or materialism, associated with Democritus, Lucretius, Galileo, Descartes, Hobbes, Locke, Berkeley, Hume, and Reichenbach. The root metaphor is a *machine*, mechanical or electrical.

Organicism, or absolute idealism, associated with Schelling, Hegel, Green, Bradley, Bosanquet and Royce. The root metaphor is an *organism*, but noting that the term “organism” is “too much loaded with biological connotations, too static and cellular and integration is only a little better”.

Contextualism, or pragmatism, associated with Peirce, James, Bergson, Dewey and Mead. The root metaphor is an *historical event*, but interpreted, not as an isolated past event, but as an “act in its context”.

In a further step towards applying Pepper’s hypotheses to practical areas of management, Barton and Haslett (2007) relate Pepper’s hypotheses to contemporary approaches in systems thinking. Traditional, objectivist approaches to systems thinking relate to the Pepper’s first two hypotheses, while contemporary constructivist approaches relate to the third and fourth. (See Table 2).

Following Emery (2000), the first three categories relate to “closed” systems, and the fourth to “open” systems. While the first three are useful in developing hypotheses using closed systems thinking, the fourth provides for the purposeful application of these hypotheses in the real world. While the first three hypotheses allow one to “map” the terrain, contextualism relates to the “real” world in which people are purposeful and capable of learning, but fallible.

Table 2: Relating Pepper’s World Hypotheses to Systems Approaches

World Hypothesis (Metaphor)	Systems Approach
Formism	Classification Systems
Mechanism	Physical/Engineering/Hard Systems
Organicism	Organic/Biological Systems, including complexity and chaos; evolutionary systems
Contextualism	Open/ Purposeful Human Systems; social ecology and co-evolution

In times of relative stability, the first two systems approaches tend to dominate, but are found to be lacking when we experience sudden change such as world crises relating to the environment, pandemics, the global economy and political conflicts. At this time we see constant references to “system failures” and there is an increased popularity for non-linear, chaotic explanations for our predicament as illustrated by Ronald Wright’s “Short History of Progress” (Wright, 2004), Nassim Taleb’s “The Black Swan: The Impact of the Highly Improbable” (Taleb,

2007), and Joshua Cooper Ramo's "The Age of the Unthinkable: Why the current world disorder constantly surprises us and what to do about it" (Ramo, 2009).

How relevant is this type of "organic" framing of safety? Experience with events with such as the 3-Mile Island accident, the Challenger Space Shuttle tragedy, and the Longford explosion, suggest it is very relevant and offers explanations that are not easily developed using classification systems and engineering systems approaches.

The application of the Pepper framework to OHS is aided by posing a number of questions generated from each of the world views and/or systems approaches. For example, in relation to formism, questions can be asked about the incidence of accidents, their timing, type, circumstances, and consequences etc. Data are grouped in similar categories. Obviously such questions underpin the form of data bases used to record accident statistics. For mechanism, the primary question relates to defining processes. The usual approach is to map processes and identify risk associated with particular points in the process. The System Dynamics mode of mapping systems in terms of stock and flows of physical and informational entities and decision points is extremely powerful in this respect; it provides a highly efficient means of capturing key data that can be further represented as causal maps (McLucas, 2003). Questions stimulated by the organicist view may focus on the possibility of "organically" evolving processes of adaptation which may be of positive or negative benefit to safe practices. They might also focus on the possibility of catastrophic occurrences as discussed above when tightly integrated processes suffer an exogenous shock. Contextualism raises the question: has it happened before, and in what context? It helps focus on the viability of OHS systems, and the learning, co-evolutionary nature of OHS policy.

Some immediate benefits of introducing Pepper's framework to understanding different approaches to OHS are summarised in Tables 3 and 4. The world view chosen results in a different analysis of injury data, resulting in a different view of causalities which in turn results in different suggestions for interventions, policies and cultures. The differing world views suggest different risk assessment processes, OHS Management Systems and auditing, organisational cultures, research methods and access to organisational learning. This taxonomy is further explored in other publications by the same authors.

Table 3. Application of Pepper’s World Hypotheses to OHS Issues

	Root Metaphor	OHS Metaphor	Paradigm	Types of Industries	Types of agents
Formism	Classification	Injury classification	Simple causality	Simple processes	Obvious causes
Mechanism	Machine Process	Reason’s Swiss Cheese Model	Processes; Latent causes; feedback	Manufacturing	Latent causes
Organicism	Organism	Systemic failures; catastrophes	Respond to environment or become extinct	Process industries; supply chains Networked businesses	Environmental agents
Contextualism	Context specific event	High Reliability Organisation	Influence the environment; environment influences the context	Policing / Military; Construction & Mining Health industries; People interaction industries	Complex, multi factorial causes

Table 4: Application to Pepper’s World Hypotheses to OHS Policy and Interventions

World View	Risk Assessment	OHS MS / auditing	OHS Culture	Research Methods	Organisational Learning
Formism	Job Safety Analysis	Checklists	Pathological or Reactive (Parker, et al, 2006)	Statistical analysis	Single loop Did we do it right
Mechanism	Safety Case; HAZOP	OHS Management System AS4801 or ISO18001	Calculative (Parker, et al, 2006)	Correlations; epidemiology	Type 1 and 2: did we do it right; Can we do it better
Organicism	Emergency Planning	Inquiries into systemic failures	Calculative (Parker, et al, 2006)	Probabilistic modelling; forensic analysis	Simulation modelling to study emergence
Contextualism	Situational awareness	Viable Systems	Proactive or Generative (Parker, et al, 2006)	Systemic techniques; Action Research	Scenario Modelling; Type 3: did we do the right things Values and ethics

LEARNING

Experiential learning

Why is experiential learning important to risk management and OHS management systems in particular? Rasmussen and Vincente (1989, p517) define the challenge in terms of understanding nexus between learning and the nature of “error” and the consequent need to appropriately design human-system interfaces that facilitate learning²:

Research during recent years has revealed that human errors are not stochastic events which can be removed through improved training programs or optimal interface design. Rather, errors tend to reflect either systematic interference between various models, rules, and schemata, or

² Rasmussen and Vicente identify four categories of errors: p. 518

- (1) errors related to learning and adaptation;
- (2) interference among competing cognitive control structures;
- (3) lack of resources; and
- (4) intrinsic human variability

the effects of the adaptive mechanisms involved in learning. In terms of design implications, these findings suggest that reliable human-system interaction will be achieved by designing interfaces which tend to minimize the potential for control interference other and support recovery from errors. In other words, the focus should be on control of the effects of errors rather than on the elimination of errors per se.

Rasmussen and Vicente (1989, p517)

This argument not only applies at the “machine” interface but in the design of policy structures and management approaches. To understand how this might be achieved we need to consider the fundamentals of experiential learning. Kolb (1984) describes humans as the “learning species” whose survival “depends on our ability to adapt not only in the reactive sense of fitting into the physical and social worlds, but in the proactive sense of creating and shaping those worlds” (p.1). Clearly this emphasis on *proactive* adaptation aligns with Rasmussen and Vicente’s identification of the need to design socio-technical interfaces. Kolb identifies the intellectual origins as being in the works of John Dewey, Kurt Lewin and Jean Piaget and proposes an experiential learning approach “whereby human development occurs” (xi). This approach emphasises the “process of learning as opposed to the behavioural outcomes and distinguishes experiential learning from the idealist approaches of traditional education and from the behavioural theories of learning created by Watson, Hull, Skinner, and others. ... Experiential learning theory, however, proceeds from a different set of assumptions. Ideas are not fixed and immutable elements of thought but are formed and re-formed through experience” (p.26). (See Figure 4)³.

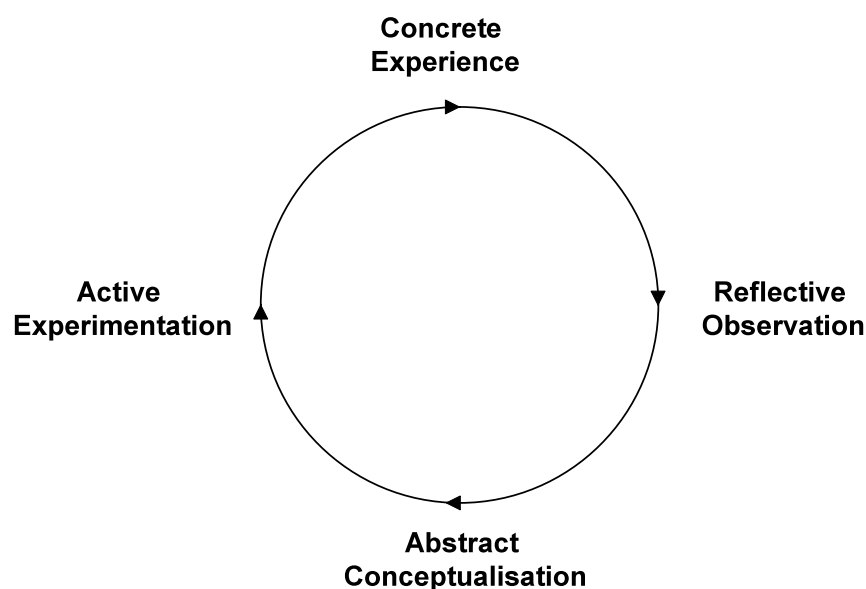


Figure 4. The Experiential Learning Cycle (Based on Kolb, 1984, p. 42)

³ Note that in the terms of John Dewey, experiential learning is a spiral, not a circle, “filling each episode of experience with the potential for movement, from blind impulse to a life of choice and purpose” (Kolb, 1984, p.132).

Dialectics and Adult Learning

Kolb identifies the common theme arising from the contributions of Dewey, Lewin, and Piaget as being the “resolution of conflicts between dialectically opposed modes of adaptation to the world” (p. 29). In summary, these conflicts involve “transactions between the person and the environment” (p. 34). That is, we are talking about learning in the context of “open systems” compared to that relating to “closed systems” (Barton et al, 2009).

Of particular significance to discussing learning in the context of business and organisations, Basseches (1984) emphasises the importance dialectical learning to adult learning.

Basseches describes dialectical thinking as a “third alternative” to “universalistic formal thinking”, which assumes “there are fixed universal truths and there is a universal order to things”, and to “relativistic thinking” in which “there is not one universal order to things, but...many orders...Thus order in the universe is entirely relevant to the people doing the ordering”. In dialectical thinking, “the evolution of the order in the universe is viewed as an on-going process” (Basseches, 1984, pp. 10-11).

Of relevance to adult learning, Basseches claims:

... that dialectical thinking represents a development beyond Piaget's formal operations stage; i.e., that dialectical thinking describes a more epistemologically powerful way of making sense of the world than the structure of formal operations by itself provides. (Basseches, 1984, p. 13).

Emphasizing the links between holistic ontologies and evolutionary epistemologies, Basseches views the dialectical perspective as:

... comprising a family of world-outlooks, or views of the nature of existence (ontology) and knowledge (epistemology). These world-outlooks, while differing from each other in many respects, share a family resemblance based on three features- common emphases on change, on wholeness, and on internal relations. (Basseches, 1984, p. 21).

Pepper's (1942) “World Hypotheses” described previously provides one such “family of world outlooks”. Furthermore, Kolb (1984) links these hypotheses to a structure of “social knowledge”, and to the structure of experiential learning. But it must be understood that this framework and its extensions into approaches to systems thinking, like any classification system has limited utility outside of its ability to lay out an initial landscape and provide a starting point for discussion. Indeed, Pepper when describing his “World Hypotheses” acknowledges that “some of the ascriptions are, no doubt, controversial”, and is at pains to emphasise that the four hypotheses are strongly inter-related (see Figure 5).

Formism and mechanism are *analytic* theories, while contextualism and organicism are *synthetic*. Mechanism and contextualism:

...complement each other in the sense that mechanism gives a basis and a substance to contextualistic analyses, and contextualism gives a life and a reality to mechanistic syntheses.... Yet when mixed the two categories do not work happily, and the damage they do to each other's interpretations does not seem to me in any way to compensate for an added richness. Furthermore, formism and contextualism are "dispersive theories"- showing inadequacy of precision, and mechanism and organicism are "integrative theories"- showing inadequacy of scope. (Pepper, 1942, p. 147).

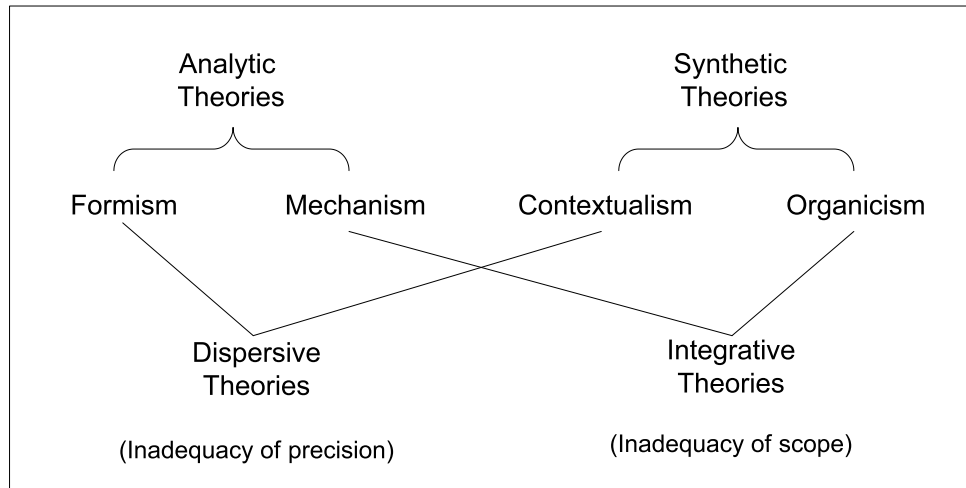


Figure 5. Scheme of World Hypotheses (Pepper, 1942. p. 146)

Rather than see these characteristics as being irreconcilable, Kolb (1984) relates the tension that exists between them as being creative and a framework for learning through dialectic debate (Figure 6):

(Pepper's) system is perhaps best treated in the framework of contextualism- as a set of hypotheses to be verified, as useful tools for examining knowledge structures in specific contexts. (Kolb, 1984, p. 119).

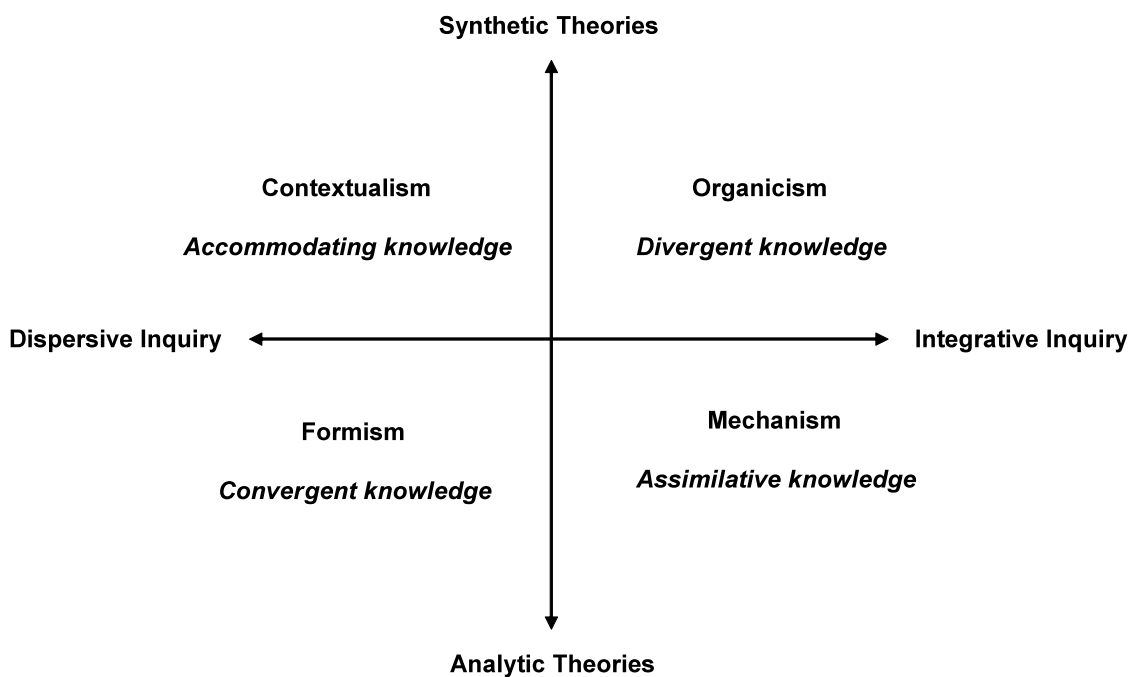


Figure 6. Pepper's System of World Hypotheses and the Structure of Learning (Adapted from Kolb, 1983 p.112)

The Learning Spiral

To understand the manner in which this hierarchy of world hypotheses/systems approaches can be used in practice we need to return to John Dewey view that experiential learning is a spiral, not a circle, “filling each episode of experience with the potential for movement, from blind impulse to a life of choice and purpose” (Kolb, 1984, p.132).

Building on the work of Piaget (1896-1980), Kegan (1982: p. 107) demonstrates the way this spiral path defines two fundamental “yearnings” relating to human experience- the desire to be “included” and the desire to be “independent or autonomous”. Human development is then related to achieving temporary resolutions, or “truces”, of successively higher order of “tension” between these two yearnings. Kegan describes the way in which the individual develops different levels of meaning-making as you move through a helix of evolutionary truces (Figure 7). This framework is then used to describe and synthesize other developmental theories including those of Piaget, Maslow, and Erikson (p86).

Stages 0-1 are characterized by reflexive and impulsive behaviour, while stages 2-3 see a growing awareness of needs and mutuality, while stronger societal and value driven characteristics, including dialectical skills, are associated with stages 4 and 5. Within this context, system thinking, as a way of establishing meaning, is more associated with stages 4 and 5.

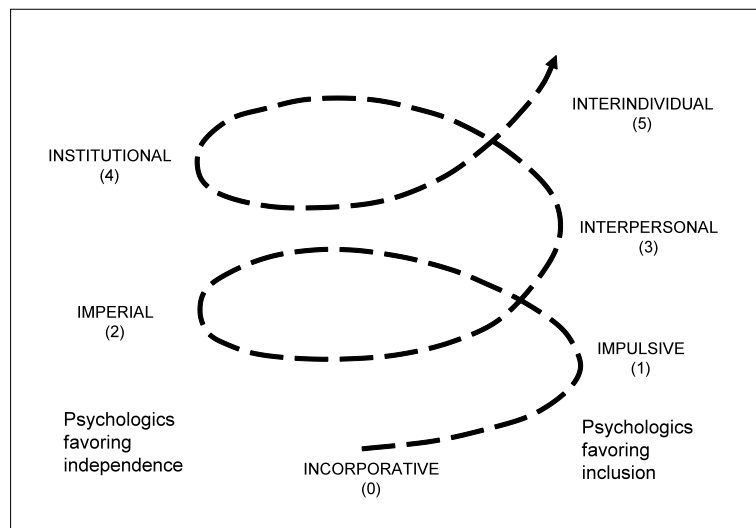


Figure 7. Kegan’s “helix of evolutionary truces” (Kegan, 1982, p. 109)

We can now relate the way Pepper’s root metaphors help define the transitions along the path described by Kegan; this reinforces the earlier discussion of the manner in which Pepper’s world hypotheses were used to stimulate inquiry. The first inclusive stage is for a group of individuals to describe risk categories, or at least injury categories with similar risk or causal characteristics. The second stage is to question underlying processes that integrate these categories, noting that defining processes may lead to some modification of categories. The third stage is to recognise that, for example, tightly coupled processes can give rise to

catastrophic failure when a single element fails. Finally, the realisation is reached that risk and OHS need to be managed using an action learning / action research framework.

A key issue for managing change in OHS is the speed with which members of organisations can be moved through these stages. Also, note the correlation of the stages identified by Kegan and the neo-Durkheimian categories described earlier by Perri.

Action Research

Although the origins of action research are diverse (see Reason and Bradbury (2001)), the most common attribution is to the work of the Gestalt psychologist Kurt Lewin. Blum (1955) provides one of the most useful accounts of Lewin's practice of action research at the Research Centre for Group Dynamics, University of Michigan, in the period 1945–1955. Blum (1955: 1) defines Lewin's action research as meaning "diagnosis of a social problem with a view of helping improve the situation. All action research has, therefore two stages:

- (1) A diagnostic stage in which the problem is being analysed and hypotheses are being developed.
- (2) A therapeutic stage in which the hypotheses are being tested by a consciously directed change experiment, preferably in a social "life" situation" Blum (1955: 1)

Blum argues that the inclusion of the second stage is the key differentiator from positivist science with fundamental consequences for the "overall research design, the methods and the techniques used".

Barton et al (2009) identify the logical foundations of this approach to action research within the context of *three* modes of inquiry: abduction (the process of forming hypotheses), deduction, and induction as initially defined in Greek philosophy but articulated by the 19 Century American polymath Charles Sanders Peirce (1839-1914) and founder of pragmatist philosophy⁴. Peirce's form of inquiry (Figure 8) is the basis of Dewey's experiential learning model (Dewey, 1910) and its extant versions including, for example, Kolb (1984), Shewhart (1939) and Deming (1950), and Argyris et al's (1985) "Action Science".

Despite his emphasis on rigour, Peirce was aware that this process was subject to error (fallibilism) and that all inferences were conditional. On this basis, we can differentiate between the logics of laboratory sciences and social science methods. In a laboratory science, and within reasonable limits, the conditionals (such as room temperature) can be identified, measured and controlled; in systems terms, a "closed" system is created. In the social sciences, and in designing public policy such as in OHS, this is clearly impossible: we are dealing with "open systems" in which not all conditionals are knowable, let alone

⁴ See earlier description "contextualism" in Pepper's World Hypotheses.

controllable. In this sense, laboratory science is a “special case” of social science! To minimise the problems of fallibilism, and to facilitate the multiple perspectives advocated by Lewin, team processes are essential to the inquiry process and correspond to what Peirce termed “communities of inquiry”.

Barton et al also trace more recent developments of action research within the systems thinking community, specifically identifying contributions by Argyris et al (1985), Checkland and Holwell (1998) and Flood and Romm (1996) to the enhancement of processes for double and triple loop evaluation, and of Fred Emery and Merrelyn Emery to understanding the dynamics of action research (Emery, 1999).

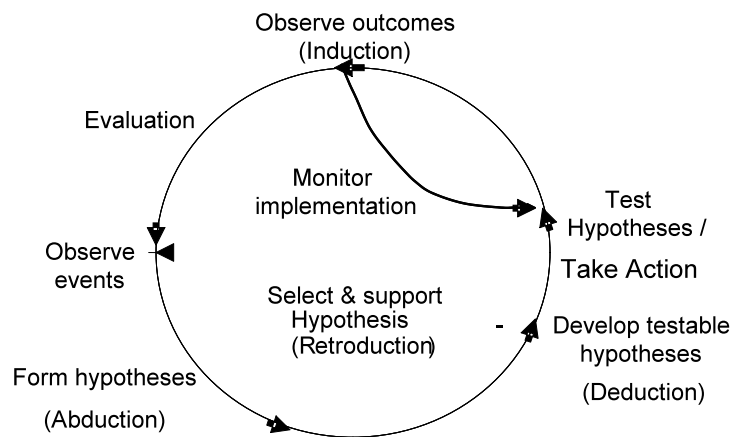


Figure 8. Peirce’s Inquiry Process

CONCLUSIONS

It has been demonstrated that risk can be framed using different sociological and knowledge frames with different implications for OHS policy. What we learn from cognitive science is that such conceptualisations are essentially metaphorical (Lakoff & Johnson, 1999). Perri (2009, p 94) explains that frames emphasise “the variety of ways people can understand the same problem” and distinguishes two functions that frames perform. “First, frames organise experience; that is to say, they enable people to recognize what is going on, they provide boundaries, define what counts as an event or a feature; crucially, frames define what counts as relevant for attention and assessment. Secondly, they bias for action; that is to say, they represent peoples’ worlds in ways that already call for particular styles of decision or behavioural response”. Barton and Haslett (2007) identify the issue of framing with systems thinking; systems are cognitive constructs for understanding complexity. Consequently, we can define risk management in systemic terms, and we can expect to end up with different perceptions of risk depending on the systemic framing used.

This results in the possibility of using different frames to establish the basis for dialectic debate, experiential learning and action research. Essentially we are arguing that OHS policy requires a pluralistic approach in the context of open systems thinking.

This contrasts with the current mainstream approaches which, in Luhmann's (2005) terms, are heavily biased towards risk management as interpreted by "security" (and we may question whether this is being applied to more protect the company from litigation or the employee from accidents). Furthermore, we can recognise that this approach assumes the "hierarchy/ central community" social framework described by Perri (2009).

While the need to respond to Luhmann's (2005) call for more "second-order observers" has been recognised in the literature (Rasmussen (1997), etc), there is little evidence that the stakeholders in OHS policy have shown much inclination to move in this direction. Gilbert et al (2007) write: "1980s and 90s research underline the importance of organizational factors in system vulnerabilities. But the basis of safety policies and management remain unchanged with a strong reliance on rules and procedures". This is understandable, because the alternatives to the current frameworks and processes are not well defined and articulated. In Kahneman and Tversky's (2000) terms, because stakeholders are risk averse, they will not be seeking to change. For change to occur, they must become "risk seekers" on the understanding that this improves their likelihood of success.

In this paper, we have attempted to provide some directions to this effect. An approach that searches for underlying structures that explain OHS data patterns is advocated. Furthermore, multiple approaches are advocated in the way these structures are framed. This pluralist approach to ontology is then complemented with an experiential learning epistemology which guides the policy maker through a hierarchy of systems frames using action research principles as a rigorous basis to policy development, implementation and evaluation.

Many thanks to: Kelly Fisher, Monash University, Dr Tim Haslett, Monash University, Professor Patricia Rogers, RMIT University, Mr Leo Ruschena, RMIT University.

REFERENCES

- Archer, R., Borthwick, K., Tepe, S. (2009). *OH&S, A Management Guide* (2nd Ed). Cengage Learning Australia.
- Argyris, C. (1983). Action Science and Intervention. *Journal of Applied Behavioral Science*, 19, 115-140.
- Argyris C & Schön, D. (1974). *Theory in Practice*. San Francisco: Jossey-Bass.
- Argyris, C., Putman, R., & McLain Smith, D. (1985). *Action Science*. San Francisco: Jossey-Bass.
- Barton, J., & Haslett, T. (2007). Analysis, Synthesis, Systems Thinking and the Scientific Method: Rediscovering the Importance of Open Systems. *Systems Research and Behavioral Science*, 14, 143-155.
- Barton, J, Stephens, J, and Haslett, T. (2009). Action Research: An exploration of its logic and relationship to the scientific method. In *Systemic Development: Local Solutions in a Global Environment*. Sheffield, J (Ed). ISCE Publishing.
- Basseches, M. (1984). *Dialectical Thinking and Adult Development*. Norwood, New Jersey: Ablex Publishing Corporation.

- Blum, F., H. (1955). Action Research- A Scientific Approach? *Philosophy of Science*, 22(1), 1-7.
- Checkland, P., & Holwell, S. (1998a). Action Research: Its nature and validity. *Systemic Practice & Action Research*, 11(1), 9-21.
- Deming, W. E. (1982). *Out of Crisis*. Cambridge: CUP
- Emery, F. E., & Emery, M. (1997). Toward a Logic of Hypotheses: Everyone Does Research. *Concepts and Transformations.*, 2(2), 119-144.
- Emery, M. (1999). *Searching*. Amsterdam: Johns Benjamins.
- Emery, M. (2000). The Current Version of Emery's Open Systems Theory. *Systemic Practice & Action Research*, 13(5), 623 - 644.
- Flood, R. L., & Romm, N. R. A. (1996b). *Diversity Management- Triple Loop Learning*. Chichester: Wiley.
- Forrester, J. W. (1961). *Industrial Dynamics*. Cambridge, Mass.: MIT Press.
- Forrester, J.W. (1969). *Urban Dynamics*. Waltham, MA: Pegasus.
- Gilbert, C., Amalberti, R., Laroche, H., & Paries, J. (2007). Errors and Failures: Towards a New Safety Paradigm. *Jnl of Risk Research*, Vol 10, No 7, 959-975.
- ILO (2009) *Safety and Healthy: A little bit of history*. Vol DOI
- International Labor Office (ILO) LABORSTA (2009) [Occupational injuries - 8B Rates of occupational injuries, by economic activity](http://laborsta.ilo.org/STP/guest), by country. <http://laborsta.ilo.org/STP/guest> accessed 16/04/09
- Kahneman, D., & Tversky, A. (Eds.). (2000). *Choices, Values, and Frames*. N.Y.: Cambridge University Press.
- Kegan, R. (1982). *The Evolving Self: Problem and Process in Human Development*. Cambridge, Mass.: Harvard University Press.
- Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, New Jersey: Prentice-Hall.
- Lakoff, G. (2004). *Don't Think of an Elephant: Know your values and frame the debate*. Melbourne: Scribe Short Books.
- Lakoff, G., & Johnson, M. (1999). *Philosophy in the Flesh: the embodied mind and its challenge to western thought*. N.Y.: Basic Books.
- Lewens, T. (Ed). (2007). *Risk: Philosophical Perspectives*. London: Routledge.
- Luhmann, Niklas (2005). *Risk- A Sociological Theory*. New Brunswick: Aldine.
- McLucas Alan C. 2003 *Decision Making: risk management, systems thinking and situation awareness*. Argos Press
- Nelkin, Dorothy ed. (1985), *The Language of Risk: Conflicting Perspectives on Occupational Health*. Beverly Hills.
- Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, 5(1), 14-37.
- Nonaka, I, Toyama R, & Hirata, T. (2008). *Managing Flow: A Process Theory of the Knowledge-Based Firm*. New York: Palgrave.
- Parker, D, Lawrie, M and Hudson, P. (2006) A framework for understanding the development of organisational safety culture. *Safety Science* 44: 551-562
- Pepper, S. C. (1942). *World Hypotheses*. Berkeley: University of California Press.
- Perri (2009) What's in a frame? Social organization, risk perception and the sociology of knowledge. *Journal of Risk Research*, 8:2,91, 91-118
- Polanyi, M. (1958). *Personal Knowledge*. Chicago: University of Chicago Press.
- Ramo, J.(2009). *The Age of the Unthinkable: Why the current world disorder constantly surprises us and what to do about it*. London: Little Brown.
- Rasmussen J. (1997) Risk Management in a Dynamic Society: A modeling problem
Safety Science Vol. 27, No. 2/3, pp. 183-213.

- Rasmussen, J & Vicente, K.(1989) Coping with human errors through systems design: implications for ecological interface design. *Int. J. Man-Machine Studies* 31, 517-534
- Reason, J. (1990) *Human Error*. New York: CUP.
- Reason and Bradbury (2001) *A Handbook of Action Research: Participative Inquiry and Practice*. London: Sage.
- Rescher, N.(2007). *Error*. Pittsburgh: University of Pittsburgh Press.
- Schön,D. & Rein, M. (1994). *Frame Reflection: Toward the Resolution of Intractable Policy Controversies*, New York: Basic Books.
- Shewhart, W. (1939) *Statistical Method from the Viewpoint of Quality Control*. Grad School of the Dept of Agriculture, Washington. (Also Dover, 1986).
- Shrader-Frechette, K. (1991). *Risk and Rationality: Philosophical Foundations for Populist Reforms*. Berkeley: University of California Press.
- Sterman, J. (2000). *Business Dynamics*. Boston: Irwin-McGraw Hill.
- Taleb, Nassim. (2007). *The Black Swan: The Impact of the Highly Improbable*. New York: Random House
- Tepe, S. & Haslett, T. (2002). Occupational Health and Safety Systems, Corporate Governance and Viable Systems Diagnosis: An Action Research Approach. *Systemic Practice and Action Research*, Vol. 15, No. 6, December. Pp 509-522.
- Thompson, M., Ellis, R.J. and Wildavsky, A. (1990). *Cultural Theory*, Boulder, Colorado: Westview.
- Vennix, J. (1996). *Group Model Building*. Chichester: John Wiley.
- Wheeler, D. (1993). *Understanding Variation: The Key to Managing Chaos*. Knoxville, Tennessee: SPC Press.
- Wright, R. (2004) *Short History of Progress*
-