GSB WORKING PAPER
NO. 20

Decision Making and Decision Taking: GSS and Complex Adaptive Systems Theory

Professor Alma Whiteley and Elliot Wood

Decision Making and Decision Taking: GSS and Complex Adaptive Systems Theory

by

Professor Alma Whiteley and Elliot Wood

Graduate School of Business
Curtin University of Technology

Decision Making and Decision Taking: GSS and Complex Adaptive Systems Theory

Professor Alma Whiteley and Elliot Wood

Abstract

The paper reports on research to explore the anticipatory capabilities of individuals when faced with a decision scenario and when asked to take into account the anticipated responses of the recipient of the decision – the decision taker. It reports on the effectiveness of Group Support Systems (GSS) technology in emerging imaginative and anticipatory data. The assumption is that the decision maker can involve the decision taker as an adaptive agent in the decision maker's final (collapsed) decision choice. GSS proved to be easy for individuals to use and productive in output. The calibre of the imaginative and anticipatory stories suggested that the mechanistic appearance of computer-aided data collection did not have an adverse effect.

Theoretically, there is a preponderance in decision theory of rational choice making but little to see in decision research about the drama of human interaction. Typically, literature focuses on decision formulation and often the decision taker role is somewhat taken for granted as being either compliant or non compliant. The idea in this research, stimulated by chaos and complex adaptive systems theory, is to bring the decision taker inside of the decision maker's self organising and sense making processes. In particular, the suggested human capabilities of anticipation, imagination and personal schema building of 'if then' rules are being explored.

Systems theory is an important element of the theoretical framework, particularly as Group Support Systems technology was used as the main data collection device. Given the nature of the research issue, an argument is presented suggesting that GSS and indeed much research in the systems area continues to be affected by antecedents of positivist science. Studying adaptivity in decision making/taking is largely a constructivist undertaking. However, there is also a sense of the real and rational. Complexity theory may provide a way to incorporate both perspectives in a similar way to physicists now talking about a qualitative science.

Introduction

The focus of this research is on decision implementation and the role of the decision taker in the implementation process. It seems that in the management literature, including practical management development disciplines, the focus is either on the manager (Argyris, 1995; Argyris, 1996), on the organization (Senge, et al., 1994) or on the decision formulation process (Phillips & Phillips, 1993). Writers such as Schein (1993) concentrate on tacit knowledge and in an indirect way they refer to the effects of those *receiving* organizational knowledge (such as decisions from others). However, it is unusual to see writing specifically combining interactive partners in the decision process.

A somewhat adapted version of symbolic interactionism (Blumer, 1969; Blumer, 1984; Mead, 1963), was used. In particular, the imagery of Mead's 'mind and self' conjures up the personal and social rules that people refer to in their sense making. The decision taker, it is proposed here, needs to be taken into account as an active and interactive part of decision implementation. In a practical sense, it can be argued that the decision taker is often closer to implementation than are those who make decisions.

Early findings on a study into 'underground rules' (UGR's) (Whiteley, Simpson & Soutar, 2000) reveal that there is a different world experienced by those being managed (these might be typical decision takers) than the world assumed by those developing official policy and decisions, (typically decision makers). It can not be taken for granted that a decision taken will be construed in the same way as a decision given. Stimulated by some of the metaphors in chaos (Hayles, 1991) and complexity theory (Waldrop, 1992) we were interested to explore whether it was possible to improve the decision implementation activity. Some concepts such as the anticipatory and adaptive qualities that characterize human thinking and acting (Holland, 1995; Kauffman, 1995) and the human capacity to experience several 'virtual realities' at once, internally organizing them to collapse into one outcome or decision (Zohar, 1994) resonated with our ideas on decision taking.

> The existence of virtual states shows that we can experience more than one reality at a time, each playing out its individual drama simultaneously with that of others…we are both aware of all these possibilities and they affect the way we relate now. In quantum language these multiple realities are known as 'superpositions'. We get one reality literally on top of another (Zohar & Marshall, 1994:27).

On the basis of this thinking, we designed an exploratory research activity to present a contrasting view to the somewhat passive and rational or bounded rational view of decision making. Based on emerging concepts from complex adaptive systems theory, the decision taker's (imagined) responses become an active component of the decision maker's choice of ways to present a decision. Acting as a repository of knowledge to both decision maker and decision taker is the ongoing set of internal rules and wisdom that individuals use to inform their activities.

> *…the agent must select patterns from the torrent of input it receives and then must convert those patterns into changes in its internal structure. Finally, the changes in structure, the model must enable the agent to anticipate the consequences that follow when the pattern (or one like it) is encountered (Holland, 1995:31-32)*

Gell-Mann (1994:17) suggested that individuals function in many ways as complex adaptive systems. They use processes to learn and to deal with the simple and complex things in life. He supports Holland's position, discussing how people acquire information about the environment and in particular their own interaction with it. Once they are faced with, as Holland calls it, the 'torrent of input' that seems to be part of contemporary life, people look for regularities. From these they are able to develop what could be called working hypotheses for action, what Holland calls if-then rules and what Gell-Mann calls schemata. Gell-Mann (1994:17) points out that there will always be competing schemata and *"the results of the action in the real world feed back to influence the competition among those schemata"*.

It was clear that a manual data collection method would present difficulties in terms of interrupting the individual's flow of thinking by manually recording a fairly heavy cognitive activity. Previous research was encouraging in the preference of people for the GSS method (Lewis & Whiteley, 1992) and so GSS was chosen. A second reason was that what we were studying came from the systems area and any theoretical framework that might emerge would relate to systems theory. For this study, the parallel processing capacity of GSS technology was used.

Group support systems technology is better recognized for its group related qualities such as anonymity (Connolly, Jessup, & Valacich, 1990), structured processes (Jessup & Connolly, 1993), facilitation (Bostrom, Clawson, & Watson, 1996), and group dynamics (Watson, DeSanctis, & Poole, 1988). However, its ability to process responses in parallel was the major attraction for this study. This is the first in a series of studies aimed at building

up tacit and imaginative qualitative knowledge (Checkland, 1999) about how individuals, and later, dyads and groups act as adaptive agents. For the study, a scenario was designed as a tacit knowledge data collection device. The aim was to probe whether the scenario data device, when used in a GSS environment would be effective in gathering anticipatory response data. We were looking at the anticipated responses of individuals as they responded to other adaptive agents. The decision maker's adaptation would be on the basis of the decision taker's anticipated responses. On this basis a chosen decision would be made.

The theoretical base for the adaptive agent study is Complex Adaptive Systems (*cas*) as visualised by the Santa Fe Institute (Walker & Guest, 1952) (Griffin, Shaw, & Stacey, 1998). The study was, in one sense, an adapted version of Holland's (1995) idea of the human subject as an adaptive agent. S/he would utilise anticipatory capabilities to take into account anticipated responses of other adaptive agents with whom they were interacting. The aims of the present study were somewhat modest in that, as yet, a robust inclusion of methods of developing internal models and if-then rules had not been attempted. It is important to note that whilst some aspects of Holland's approach were adopted, the fundamental mathematical scientific approach was not.

Our thinking differs from Holland (1995) in line with Griffin et al. (1998)'s criticisms. Holland's thinking, linked as it is to mathematical modeling reflects adaptation more in the predictive than uncertain and the discrete rather than continuous. The notion of prediction implied in Holland's model almost reflects a scientific system with its premise that there is an order (hidden) that can be made clear through scientific investigation of interactions. There is a hint here of the apprehendable and as Griffin et al. (1998:320) point out, "with this view of action and interaction, Holland is then able to focus on the objective, scientific modeling of complex adaptive systems in order to find the levers that will enable one outside the system to change it in intentional ways."

Rather than hypothesise, reduce and refute if-then rules in action using a mathematical theoretical perspective, this series of studies will be trying to understand the phenomenon of mechanisms for anticipation that individuals might use to inform their choice from the range of potential or 'virtual' options as proposed by chaos theorists (Hayles, 1991). As such they have an Heideggerian (Cooper, 1996:716) phenomenological perspective "The individual self should be seen as something of an *achievement* performed by the 'authentic' person who manages within limits to rise above 'Their' [people at large] conventional ways of interpreting the world" (authors italics, our brackets). The research will adopt the ideas of

Kauffman (1991), also from the Sante Fe Institute, in particular those of co creation, emergent qualities of interactions and self reinforcing feedback. GSS is ideally placed to elicit in an emergent way, qualities that come from interaction. The assumption is that GSS will allow us to gain some ideas about the cocreation process (although in this first study, the ' co-creating partner' is a hypothetical one).

The collaborative and interactive capacities of GSS have not been harnessed for this study. Nevertheless, as the sequence of research activities develop, it will become clear that the methodological home for GSS-facilitated adaptive agent studies will be within the electronic meeting systems (EMS) framework (Nunamaker, Chen, & Purdin, 1991). EMS itself grew out of what Checkland (1999) calls systems thinking. A brief analysis of the types of research conducted over the years in GSS-related disciplines will show that a paradigmatic allegiance seems to have been made to the realist philosophy, positivist ontology, empirical epistemology and quantitative methodology. Clearly this is problematic for this set of studies. GSS was, until around the 1990's, formerly named Group Decision Support Systems. Judging by the (then) literature an assumption that seemed to run through many of the research designs was that individuals acted rationally. Research designs assumed that prediction was possible and that contextual variables could be variously manipulated, controlled or modeled. In the sense that *cas* is predicated on subjective interactions and adaptations, there is a need to include the idealist philosophy, constructivist ontology, interpretive epistemology and qualitative methodology. In this ontology, humans seek understanding, not causal explanation. The goals of reasoning, prediction and control in quantitative work need to be complemented by qualitative interpretation, emergence and contextual meaning.

The complementary idea departs from the usual debate about which of the positivist or constructivist ontologies is superior (Guba & Lincoln, 1994). As will be tentatively argued, both positivist and constructivist approaches are required to capture the combined rational and interpretive capabilities of individuals as they intuitively and rationally self organise in an adaptive way. As yet, it being early in the series of studies, the attempt toward a more encompassing way of thinking is fledgling but the dualism of the positivist and constructivist research stances is rejected in favor of a more encompassing concept.

Theoretical framework

It is appropriate to choose the systems framework as a major theoretical perspective because of its 'soft' and 'hard' qualities, its relation to GSS and its compatibility with complex adaptive systems theory. Checkland (1999) and other noted systems writers (Simon, 1969), particularly those adopting the open systems view (Bertalanffy, 1968) captured many of the characteristics that have come to be acknowledged as 'complexity theory' (Waldrop, 1992; Gell-Mann, 1994; Holland, 1995; Kauffman., 1995). These focused on the idea of open systems interacting with the environment (Morel & Ramanujam, 1999) in a non linear dynamical and unpredictable way. The received wisdom in organizational theory has already embraced systems thinking. The image of organizations proactively adapting and evolving within and outside of the organizational setting is popular in contemporary theory (Senge, 1992; Daneke, 1999).

For over a decade, the hitherto separate worlds of physical and social science have presented organizational theory with ideas, metaphors and methodologies that allow untraditional conceptual thinking to surface. Images such as the existence of order hidden in the swirls of chaos (Gleick, 1987, 1997) resonate with corresponding images of the turbulence expected in the not too distant future (Kurian, 1996).

> *For in an era of increasing turbulence and surprises, nonlinearity - which is the science of surprises - should be a vital requirement in any social inquiry, particular those which purport to improve practical policy and management (Daneke, 1999:1)*

The theory behind decision making and decision taking has its antecedents in Western philosophy. In particular, two philosophical schools of thought have prevailed through the ages, spanning many centuries [Tarnas, 1991]. We agree with Checkland (1999) that it is important to recognise both the power of early thinking and its ability to persist over time. Checkland, Tarnas (1991), Cooper (1996) and others trace a path through early Greek and medieval thinking, all pointing to its scientific absolutism.

It was during these centuries that mythical speculation was challenged by philosophies of objectification (observational science/empiricism) and subjectification (the human as a purposive thinking and reasoning being). Frameworks of thought from Greek philosophers such as Empedocles, Hippocrates, Socrates, and Aristotle (Tarnas, 1991) had already laid the foundation for empiricism, logical rational thinking and argument, and what postmodern thinkers call the "objectification" of social as well as natural phenomena (Hancock, 1999).

The Age of Reason or the Enlightenment (Tiles, 1996), coming as it did in the 'great' industrial age (Comte, 1875/1968) fitted well with rational rather than speculative or mythical thinking. Rational thought must employ logic, consistency, doubt and contradiction. Empirical truth could be gained through speculation, observation, verification and generalization. Reasoning as a way of acquiring knowledge and understanding of the physical and social world was a view greatly influenced by the seventeenth century mathematician Descartes, (knowledge studied from the bottom up through chains of reasoning), the physicist Newton (experimentation and expressing nature through mathematical language) and later the twentieth century physicist Einstein (mathematical elegance and unity in science) (Tiles, 1996).

Together, rationalism and empiricism came to represent enduring world views and these are further explored by Checkland (1999) within the systems framework. Permeated by formal logic on the one hand and objectification on the other, the status of acceptable knowledge was that it be either cognitively or experientially provable. Rationalism has been closely connected to mathematics which was a useful vehicle for expressing ideas of a perfectly ordered and regulated world and "to be scientific in these times is almost inherently to be mathematical" (Mahoney, 1991:40). Empiricism, where the experience of the senses is a valued source of knowledge, captured the stage as a fundamental principle of business.

Alongside the development of mechanization, as Mahoney (1991:44) recounts, "the philosophy that undergirded science was a hybrid of a new rationality (inductive inference) with systematic observation and experimentation. It was rational objectivism in its finest hour, with the grand machine of science grinding out a rich supply of facts to form the brickwork for the edifice of knowledge".

An interesting idea for this decision taking study is the assumption of a single, external reality, independent of human perception and conception. Also of importance is the position of the researcher, separated from the respondent. Emotional and imaginal capabilities set within a framework of multiple and socially constructed realities have not historically been part of the sensemaking equipment of scientists, social or otherwise (Crotty, 1998). The philosophical antecedents, then, go some way towards explaining why we have had to wait for metaphors from chaos and complexity theories to first free us from the cage of scientific and mechanical language and secondly to produce a framework that will encompass rather than constrain the fullness of human capabilities.

Group Support Systems (GSS) Thinking

Group support systems (GSS) is a computer-based information technology. The term is almost used as a generic now as there are so many varieties of GSS both in terms of technological layout and purpose/method (see Jessup and Valacich, 1993:34). In effect this technology allows a range of focus group and interview activities in a way that would not be easy in a manual setting (Lewis, 1992). Parallel processing allows simultaneous 'conversations' to be recorded. As they are recorded by respondents themselves they are as authentic as it is possible to achieve. Responses (individual or group) can be displayed on a public screen or kept private. It is possible to be anonymous and to have exactly the same opportunity to input as everyone else. Whilst these features of parallel processing, anonymity and distributive justice are special characteristics, still GSS works in a similarly human way to other meeting arrangements. A group of people gather to generate, exchange, discuss and evaluate ideas and issues.

However, GSS is somewhat (although not totally [DeSanctis, 1989]) defined by its technological environment. A GSS room will have unobtrusively placed computers or keyboards, usually one to each seating. Installed in the computers is software with a set of process tools. These allow individual brainstorming, group discussion (not necessarily computer-aided), organizing, commenting, and evaluating. The technology allows information to be imported and a very important facility is the recording and printing of every input in the meeting, ready to be taken away at the meeting's end. What GSS was designed to do was to show the human face of technology (Dennis, Tyran, Vogel, & Nunamaker, 1990). It was deemed possible, using the technology, to elicit soft and tacit knowledge and to capture the interpretive aspect of human interactions.

There is an intriguing question when embarking on an inquiry into the background thinking about the Group Support Systems methodology, living as it does within the broad systems framework (Bertalanffy, 1968). The question is, given that so much of the substance of collaborative work must be interpretive and perceptual, especially that involving socially negotiated order (Eden, 1992:801), why are so many GSS studies 'fitted' within the scientific framework? Pervan (1998) reviewed literature from thirteen core Information Systems (IS) and Group Support Systems (GSS) journals from the first publication until the end of 1996. It seems that the literature is very much focused on the 'hard science' protocol.

An additional point comes from Pervan's work. "Despite having some strong reference disciplines (such as Psychology and Sociology) which have established theories on the

behavior of groups (prior to the consideration of their support with information technology), GSS researchers have done relatively little conceptual work overall" (1998:156). The need for theory building has been voiced since the late 1980's (Nunamaker et al., 1989). However, what appears to be implied is that the required theory lies in the quantitative, experimental area of GSS (Fjermestad & Hiltz, 1999). The importance of interpretive studies appears to be in inverse proportion to that of experimental research and some writers suggest that 'out in the field' seems to be less preferred than 'in the laboratory' (Martz, Vogel, & Nunamaker, 1992).

A brief look at what is entailed in letting go of the positivist mindset explains this in part. First the fundamentalist and orthodox nature of the scientific mindset, evolving as it did over centuries needs to be borne in mind. The imperative of the separability of knower, knowing and known has come to be assumed without the need for justification (Fjermestad & Hiltz, 1999). This means that there are limited opportunities for critical skepticism and contemplation. The fact that group interaction, central to the GSS concept, embraces the subjective, tacit and interpretive, should give pause for thought. Rarely are researches presented based on figurative and metaphorical expression. Rather they prefer the precise and definitional (representational) language (Chia, 1997).

The question about the under-adoption of constructivism and interpretivism in GSS extends to the wider systems environment where ontological and epistemological antecedents seem to follow two distinct paths, hard and soft systems (Checkland & Scholes, 1999). These authors provide some interesting insights into the development of these two paths. First, they discuss systems development within a scientific context. They do so with the express intention of understanding the nature of systems thinking. They reflect that scientific development in the West was a cultural invention "Science is a product of Western civilization as a whole" (Checkland et al., 1999:23). This was not a universally accepted invention as can be seen when comparing Western thinking with, say Chinese (Fung, 1948/1997) or other Eastern thinking (Stevenson & Haberman, 1998). Here, a strong relational and suggestive emphasis is preferred (Whiteley, Cheung, & Zhang, 2000).

Checkland (1999) follows the theme of problems when the scientific is applied to the social in systems thinking. He elegantly captures the essence of the difference between what he calls established science and social, "would be" science. At the core of social science, he argues, is "the self-consciousness of human beings and the freedom of choice which that consciousness entails" (Checkland, 1999:70). Furthermore, Checkland proposes that an observer can *never* obtain an up to date account of the state of mind of an agent he is

observing which it would be correct for the agent to accept. This is because, he says, the observer's observation would be incorporated into the belief system of the agent thereby producing a changed state in the brain. Talking about an observer who might claim a perfect state of knowledge of an agent's mind and go on to make a prediction, is, to Checkland, not tenable. A reflection on much of the research within the systems thinking community shows that the observation assumption underpins many of the social experiments reported.

> *The agent himself would actually be wrong to believe that prediction before he makes up his mind what action to take (!) since his belief would render the perfect account of his state of mind, upon which the (prediction is based) obsolete. Nothing can therefore remove from the agent his freedom to select his action, thereof no one outcome which he would be correct to regard as the only possible one. (Checkland, 1999:70)*

Nevertheless, although he does point out many problems, including complexity in general, Checkland still works within a framework of scientific thinking but one that challenges the deterministic and reductionist view. What comes across from Checkland's description of 'hard' science is his notion of science as an institutionalised activity (Zucker, 1991). It is aimed at acquiring publicly testable knowledge of the world, characterised by the application of rational thought to experience, derived from deliberately designed experiments. Science is committed to provide concise expressions of the laws which govern regularities, these laws being expressed as mathematically as possible. What comes from his description of "hard' systems thinking is very close to describing the empirical studies of social phenomena that are common in GSS research (Fjermestad & Hiltz, 1999). These characterise goal oriented, definitional hypothesizing activities, capable of isolating variables and controlling them and of using quantitative statistics or mathematical modeling to determine "common causes of common characteristics" (Holland, 1995:170).

In their 1997 overview of GSS research, Williams and Wilson confirm that the preponderance of empirical studies continue to dominate. Laboratory studies (Zigurs, Poole, & DeSanctis, 1988), controlled laboratory studies (Ho & Raman, 1991) and experiments (George, 1992) are well represented. It is difficult to comment accurately on justification for chosen ontologies and epistemologies in GSS research over the last ten years because typically these are not stated. However, we would argue that justification is not secured by omission. On that basis many socially oriented GSS studies could bear scrutiny. The problem has made the GSS theory field appear somewhat one-sided, in favour of hard science.

However, the answer to this imbalance does not lie only in arguing the case for constructivist epistemologies and soft sciences as alternatives. Rather, it lies in an examination of the consequences of a dualist approach. Researchers appear to choose one of the two as research frameworks (Marshall & Zohar, 1997:13). Given that we are embarking on a research initiative that centres around concepts of non linear and adaptive, as well as rational and concrete, we need to and look for a more encompassing framework to meet the changing, some say chaotic, future (Pascale & R.T., 1999). Our use of GSS for this study assumes **both** interpretations - *verstehen* (understanding) and *erklären* (explaining) (Crotty, 1998)

Decision Theoretical Thinking

> *Since its inception, (Edwards, 1954) behavioral science research has been strongly influenced by classical decision theory. This theory derives primarily from economic theory and secondarily from statistical theory, and has generally been interpreted as both prescriptive and descriptive of decision making in personal and organisational contexts (Beach, 1990:1)*

How do decision theorists describe their work and also their assumptions about those who are to follow the theory? French, in his classical book "Decision Theory: an introduction to the mathematics of rationality" says " we shall accept as a matter of empirical fact that each of us has the power of choice…[that some decisions] are sufficiently important that we undertake a careful analysis before deciding on a course of action". He says of his readers (1986:9) that "…those in industry, commerce and government [who take decisions] …as a rule they lack the technical, mathematical skills which I have assumed of my readers".

In writing about decision theory for a mathematical audience, and demanding mathematical maturity, together with the willingness to follow proofs and logical arguments, French is aligning decision theory with rational philosophy. There is a distinct and explicit reference to the objectifying of uncertainties. Menz (1999), talking about self organizing, ambiguity and decision making in business argues that organizations are traditionally functionally differentiated and characterized by hierarchical order and rationality.

This presents the organization with the problem of limiting both complexity and insecurity. Standard and routinised procedures dominate decision making and communication. Menz (1999:103) describes the beginning of a decision meeting "…the first impression is of a chaotic, poorly structured and rather inefficient interactional sequence. Nonetheless, the firm studied here is highly successful in one of the most turbulent markets" Menz goes on to

hypothesise that organizations need to both reduce and retain complexity. These ideas sit comfortably within complexity theory.

Winterfeldt and Edwards (1986:1) acknowledge that decision making can be complex, confusing and stressful. Their solutions to this could have gone two ways. Either the confusion could be facilitated and treated as part of human complexity or efforts could be made to circumvent the problem. Much of the decision theory seeks to render problems less confusing. Formal, mathematically based models are often presented. Decision tasks are structured so that they become as simplified as possible, able to be analysed and presented. Underpinning much decision thinking is rationality. Winterfeldt and Edwards (1986:1) insist that the rationality of inference and the rationality of decisions are desirable and attainable goals (figure 1).

The thinking extends, indeed their work is centred around, quantifying attributes of decisions. For example, in multi attribute situations, using multi attribute utility theory (MAUT) trade offs among attributes are quantified as importance (or other scaling factor) or weights. It is interesting to note here that both quantitative and qualitative decision theorists undertake similar activities. Both need to identify a problem or issue that needs some sort of decision, although in the qualitative framework, identification is basically a starting point for an evolving process.

Figure 1: A rational model of the decision making process
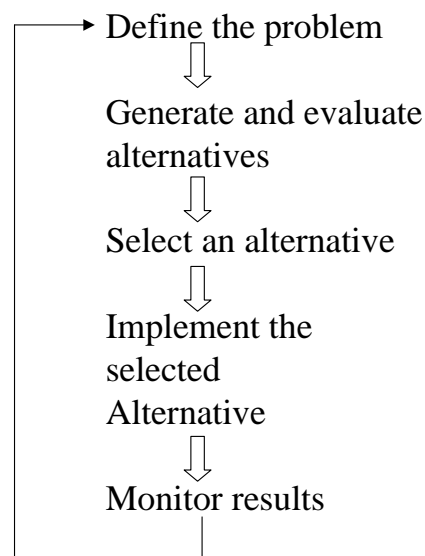
Source Hatch, M. J. (1997). *Organization Theory: Modern, Symbolic, and Postmodern Perspectives.* New York: Oxford University Press.

Some of the bases and judgments upon which decisions will be made need to be surfaced and agreed upon (Hatch, 1997). These are often called value judgments and there will usually be a further stage of analysis to ascertain the value attributes that impact on the decisions. In MAUT cases, there is a need to enter into discussion about the relative assessments of attributes to be accorded by those involved in the decision making process. This brings in some of the interactive and interpretive elements of a shared decision making process. The work of Habermas (1984) was pivotal in adding the communicative element to (bounded) rational decision making. There are also decision theorists who strongly support the interpretive perspective. Eden, for example, demonstrates that even when there are tangible scores attached to attributes, social constructions and deconstructions can retain the spontaneity and fluidity resonant of socially negotiated decision making (Eden, 1992).

Major unifying themes of decision theory include acceptance of rational inference and, as Winterfeldt and Edwards (1986:3) explain, "elicitation techniques for obtaining numbers bearing on the merits of well-defined options and mathematical tools for using those numbers to make decisions". Apart from thesis by researchers like the Payne team (Payne, 1989), who present adaptive rather than classically rational decision maker qualities, there are few contingency theories of decision making. Payne et al. (1989) conclude that decision making is a highly contingent form of information processing where behavior is sensitive to feelings of task issues such as complexity, the perceived similarity of choices, reference points and the framing activities of the decision maker. In particular, here, there is the idea of the repertoire of decision strategies residing in the decision maker. These are activated by perceived complexity dimensions, which personalises and internalises decision making more than the external, rule based rational thinking model (although, as the authors say, the ideas still fit bounded rationality).

There are theorists who have departed from classical theory. Social process theorists like Weick (1979), 'typology' theorists (Mintzberg, Raisinghani, & Theuret, 1976) and other discipline related theorists, recognize the limitations of rationalism in this context. Beach (1990:3) presents what he calls "Image Theory". He rejects classical theory on the basis that people rarely made decisions in accordance with what classical theory prescribed. In his research, Beach says that neither the explicit balancing of costs and benefits nor the activity of taking a gamble were found, any more than was the decision maker's continued control over post decision events. In particular, Beach rejects the notion of the isolatable and unique

decision. Rather, he says, decisions are part of a larger scheme of affairs and individuals develop decision processes, the social processes being the target of image theory.

Stated briefly, Beach theorises that decision makers employ three images in the decision making process: the value image consists of the decision makers values, ideals, morals and ethics, summarised as principles. The trajectory image is an 'ends' image, depicting where the decision maker wants to go as an overall goal-oriented strategy. The strategic image contains the plans that the decision maker converts into tactics. Inherent in plans are anticipation of possible results and also of the workability of the existing stock of values principles, desired ends and acceptable means. This is the version of decision theory that best suits this research. There may well be rational components to decision making and taking and these will complement the emotional or affective knowledge that those making and taking decisions will call upon.

Complex Adaptive Systems Thinking

> *Most biologists, heritors of the Darwinian tradition, suppose that the order of ontogeny is due to the grinding away of a molecular Rube Goldberg machine slapped together piece by piece by evolution. I present a countering thesis: most of the beautiful order seen in ontogeny is spontaneous, a natural expression of stunning self-organization that abounds on complex regulatory networks. It seems that we have been profoundly wrong. Order, vast and generative arises naturally. I propose that much of the order in organisms may not be the result of selection at all but of the spontaneous order of self organized systems (Kauffman, 1995:25).*

Complementing the metaphor of chaotics (Hayles, 1991) and particularly quantum (Zohar & Marshall, 1994) that stimulated our thinking was complex adaptive systems theory (Gell-Mann, 1994; Waldrop, 1992). The chaotic concept was appropriate for the study of decision making and decision taking because it embodied a general awareness of the non linear, saw unpredictability as a source of new information and above all, allowed a way of conceptualizing human activity in 'more than' either a straightforward positivist or constructivist way. Our conceptualizing was obtained through visualizing and imagining the decision process.

Thinking about the wave idea in the quantum metaphor, Zohar and Marshall (1994:30) talk about the way (through the wave function) that humans' many 'virtual realities' can be envisaged at once. "In our imagination we constantly throw out and experience a multiplicity of future scenarios before these collapse into one at a moment of choice". This seemed intuitively appealing from our observation of decision processes at work. In the case of decision making, we asked ourselves "what is it that makes a decision maker choose to

present one (collapsed) version of the decision to the decision taker"? We were interested in the decision taker. "What makes the decision taker collapse the possible responses into the one made"?

Complex adaptive systems theorists typically focus upon the three concepts in the title, complexity, adaptability and systems. The Santa Fe Institute scientists, many of whom are mathematicians or physicists, exhibit a tendency to model (preferably mathematically) the dynamics of networks of interacting agents (Holland, 1995), (Waldrop, 1992). Like the soft systems theorists, (Checkland & Scholes, 1999b,) there is a recognition of the 'more than sum of parts' or wholeness.

When we were visualizing this research issue, we thought about partners in a decision taking activity, one being the decision maker and the other the decision taker (figure 2).

Figure 2: Potentials and co created meaning.
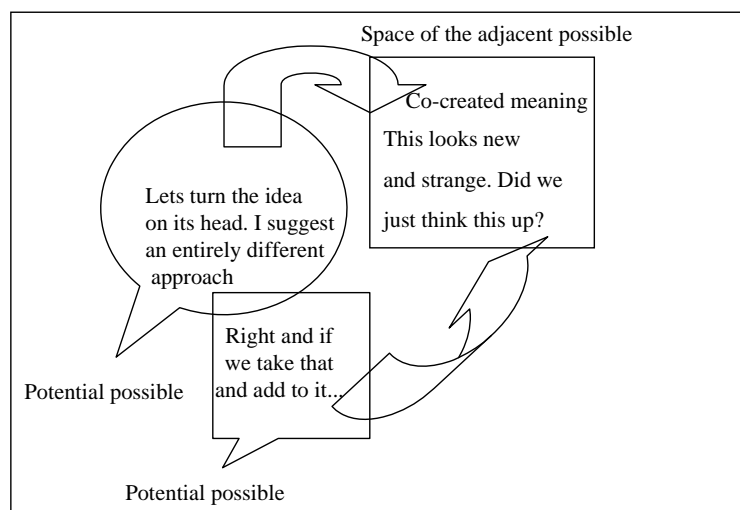
Source: Adapted from an idea by Kauffman S. A. (1995). *At Home in the Universe: The Search for the Laws of Complexity*. London: Viking.

The decision maker and taker will bring knowledge and wisdom to the interaction. The knowledge and wisdom will contribute to the personal schemata or model of how the world works. We call this the actual knowledge, that is knowledge that is to be shared but has already been created by one or the other of the pair. However, there will be some knowledge that is not yet created. It is being constructed in the fluidity of the moment. It moves, imaginatively from the context of actual to the context of potential. As it moves it changes nature and becomes the raw material with which people can create.

Potential knowledge is very different form actual knowledge because it is spontaneous, unpredictable with a self organizing quality. It is in the way that it is allowed to emerge these qualities that makes it different. In practice, rather than individuals expressing themselves as wholes, as it were, they become part of each others' whole, part of one intersubjective relational experience (Goodwin, 1994).

As discussed earlier, it is proposed here that the dualist scientific ontology, (human subject *acts upon* some aspect of the material world) is not appropriate. Nor are the predictive, observational and explanational qualities of the empirical epistemology. Yet it needs to be realised that the nature of self organization is such that from the 'self' or in the case of co-creation, the 'selves' may emerge logical, rational, orderly patterns of organising, in which case, positivist and empirical perspectives would have value. We have stated that what is needed is a more encompassing approach. Thinking about certain elements of post-structural concepts (Hancock, 1999), is part of our future research agenda.

Although post structuralists argue that stability of meaning is challengeable, we would argue that it can exist *within* a meta-narrative and metaphorical framework. There is little doubt that for researches such as this one where the research aim is to investigate self organization, and later co-creation, the search for an ontology, one that is able to support paradox alongside regularity needs to be continued. From *cas* theory and Goodwin (1994) (as well as scientists like Checkland [1999]) comes an intriguing idea of a 'qualitative science'.


Study design

> *Does the data gathered in the decision scenario show evidence of anticipatory capabilities to take into account anticipated responses of other adaptive agents with whom they are interacting?*

> *Is GSS technology a useful mechanism for eliciting a 'participatory awareness' from its participants in relation to the decision scenarios with which they are faced in a GSS session?*

At the outset this study was exploratory. Before embarking on a more rigorous investigation of if-then rules, anticipatory mechanisms and co created meaning, we needed answers to two main questions. The study of the decision maker in action as s/he anticipates the imagined responses of the decision taker was designed to elicit the story of the imagined anticipatory actions and interactions in a given scenario. GSS was tested as a possible means of eliciting participatory awareness data. If it proved to be facilitative, then GSS

would be used for the next round of planned activities involving dyads engaging in real time on a decision problem. Figure 3 below, gives an impressionistic view of the adaptive agent concept.

Figure 3: Adaptive agents anticipating and responding
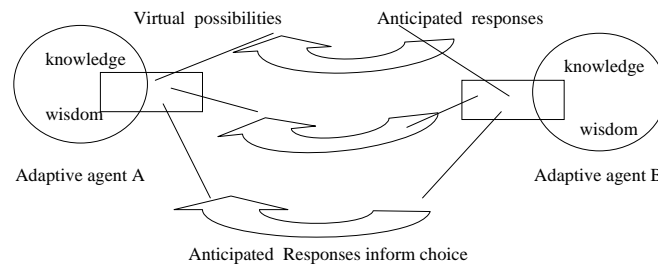
The sample for this study consisted of 59 participants from the workplace selected 'off the street' by a market research organisation. The brief was to provide a heterogeneous sample in terms of gender, age, and occupation. Group Support Systems technology was used to collect the data. It was ascertained at the start of each GSS session (there were six sessions) that participants had not previously been acquainted with GSS technology.

Participants each sat at a GSS workstation placed around a single conference table. MeetingWorks version 2.3 software (Lewis, 1993) was used for the sessions (see figure 4).

Figure 4: The MeetingWorks ™ (GSS) Room
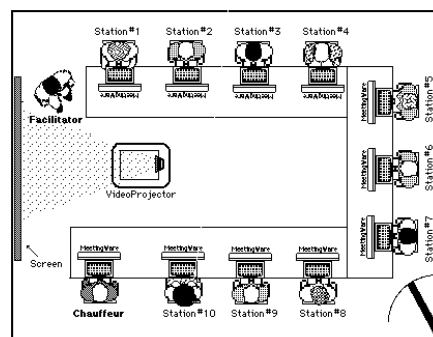
After introducing the researchers and explaining briefly the formal structure of the GSS session, a scenario was given in hard copy and also read out to the participants. The scenario read as follows:

> *You are at home very late on a Saturday night watching television when the phone rings. You walk to the phone, pick it up and who would be on the other end but your daughter – the daughter who has <u>finally</u> passed her driving test after 3 attempts, a few hundred dollars of driving lessons, and many hours of frustrating sessions in the family car. You have allowed her to take your new car out this evening to a party over the other side of town on the understanding that she take a taxi home when the party is finished. You are happy with this and settle down to watch your favourite late-night movie. The phone call is your beloved daughter who is fighting to make her voice heard above the revelry. She says "Dad/Mum, my friends tell me it is really hard to get taxis out here. I've told them not to worry. I have hardly had anything to drink so I will drive them home and then come back myself. Is that OK?"*

This scenario was designed to be one that was understandable to participants, as well as providing them with information relevant to a possible interaction with an agent (in this case the daughter) to whom they would have to adapt and who would have to adapt to them. As a preliminary effort towards developing the efficacy of GSS for this purpose, participants were asked to work individually in parallel. Each person was asked to give responses to each of a set of questions. Participants were advised to ask for clarification of the process at any time. The questions were (in order):What are some of the thoughts running through your mind at this point? What is your choice - choose between 5 possible responses; Why did you make this response? Give a thumbnail sketch of your daughter? How do you predict your daughter will respond? How do you think your daughter perceives the situation now? Each question in the study was presented upon completion of the previous question by <u>all</u> respondents.

a) What are some of the thoughts running through your mind at this point?

This initial question was designed to provide evidence of the ability of respondents to report on what Zohar describes as a multiplicity of virtual (that is imaginary) realities. At this stage, data provided evidence of participant responses invoked <u>before</u> a participant's action toward the agent.

b) 5 possible responses –   NO (unconditional)
NO (conditional)
UNDECIDED
YES (conditional)
YES (unconditional)

Question b) This was the 'collapsing' question. There were two elements of it. One was to achieve a choice by collapsing the possibilities open. The other was to activate the 'if-then'

rules taking into account the anticipated corresponding rules of the daughter. The question initiated the participant-agent interaction and called for a personal decision-making choice from the participant – since the question was designed to provide a collection of potentials to be chosen from, the participant was forced in this stage to collapse these potentials into one.

c) Why did you make this response?

Question c) was of particular importance in this study. In line with the suggestions of Checkland (1999), this question was designed to provide an opportunity to test whether the making of a response altered the cognitions of the participant from those reported in question a).

d) Give a thumbnail sketch of your daughter.

Participants were asked to then give a thumbnail sketch of the agent. This question was designed to provide data on the effectiveness of the GSS technology in eliciting spontaneous, intuitive, imaginising from respondents. It was not known whether the mechanistic environment of the computers would constrain the data.

e) How do you predict your daughter will respond?

This question was designed to invoke Holland's notion of each agent having a 'mechanism for anticipation' that drives its behaviour – data was elicited on the anticipatory capability of the respondent to hypothesise on the other agent's responses.

f) How do you think your daughter perceives the situation now?

There was to be a link between question e) and the final question in this study. It was designed to provide information on the perceived robustness of participant's understanding of the anticipatory capabilities of the agent. In other words were the if-then rules accurate or not?

Results

The first question asked was,

> ***Does the data gathered in the decision scenario show evidence of anticipatory capabilities to take into account anticipated responses of other adaptive agents with whom they are interacting?***

In overview, the findings indicated that the assumption being tested here, that individuals employ their anticipatory capabilities imaginally and plurally in decision making was well supported.

Responses varied but the single utterances were in the minority. In each of the sessions there were multiple and simultaneous responses made. The one below was indicative of the number and length of several of the responses.

> *How much has she had to drink/what kinds of drinks has she been drinking/who are the friends she is offering to take home/How far does she have to travel to take them all home/What time should I expect her home/When is she leaving the party I will pick her up and drop her friends as well/ will she refrain form having any more drinks before she leaves the party/How much experience has she really had at night driving/what sort of influence will her friends have on her behavior?*

The second major question was,

Is GSS technology a useful mechanism for eliciting a 'participatory awareness' from its participants in relation to the decision scenarios with which they are faced in a GSS session?

Again the response was positive and encouraging. Effectiveness was evidenced by the distinctiveness of much of the information elicited. The wide variety of comments, such as "*as the phone rings – my God, she's had an accident*", "*there will be a screaming match but she will do as I say*" and "*this scenario has been thought through and to a certain degree has been planned for as children if given the opportunity will try to play one parent against another*" suggested that participants were willing and able to use the GSS technology to provide ideographic responses to the scenario at hand. Given the lack of GSS experience amongst all participants, the number of positive comments regarding ease of use, and the lack of clarification required by participants was further welcome evidence of the usefulness of GSS technology for this research. Following this finding the plan for a future dyadic simulation will go ahead.

Themes

In analysing responses to the questions above, several themes emerged from the qualitative data

Question a: What are some of the thoughts running through your mind at this point?,

Responses to this question centred upon emotional reactions to the scenario, possible decision choices to be made, and information required for a decision choice to be made. For example, participants answered

> *// panic, concern for my daughter. Concern for my lovely new car // I will worry the whole time, won't be able to sleep until I see the headlights pull up in the driveway // /Has she really had as little to drink as she says or does she just think she hasn't. Should I pick her up or should I trust her. If I trust her and something happens can I live with myself // ask her if any other people have transport…is she over the limit…what sort of cover for young drivers?…ask whether there is any possibility that people can ring their folks // No it's not OK. I don't know how much she has had to drink and I don't want her to drive if she's had just a little //*

Some participants answered with a decision itself, anticipating the second question, for example

> *// I would tell her no // you are not to take anyone home, what do you think you are doing, wait till I get my hands on you // No way at all I would drive and get her rather than let her drive at all, the deal was taxi home or no go //*

Question b: What is your choice between 5 possible responses*? (Respondents could give 5 possible responses* to the second question, *NO unconditional; NO conditional; UNDECIDED; YES conditional; YES unconditional)* Responses were, not surprisingly, related to the information provided in question a) with some participants having already decided their response in the process of providing information for the first question.

Question c: Why did you make this response? The analysis of information given in response to question c) provided an interesting comparison with responses to question a). Reasons for making the decision choice in question b) seemed to involve participants answering the thoughts they had proposed in question a). For example, the progression from question a to question c commonly ran like this:

> *// How strict are the rules I set her? b) NO unconditional c) The rules were clear when she left. If I let her change the conditions of using the car now she will take advantage again // a) will she be coming straight home? b) NO but she can drive home c) I took into consideration that she had just got her licence and I just needed her to be at home to take the worry out of it // a) Has she really had as little to drink*

as she says or does she just think she hasn't. Should I pick her up or should I trust her. If I trust her and something happens can I live with myself b) YES if you are sure that you haven't had more than one drink all night c) We must trust her judgment //

In addition, this data demonstrated that a change in focus from question a) to question c) through the collapsing of potential actions was easily captured from information gained through the use of GSS.

Question d: *Give a thumbnail sketch of your daughter.* Further evidence from the thumbnail sketch in question d) showed the success of the scenario in providing life-like decisions for the respondents as well as the appropriateness of GSS technology for elicting the data.

She is a very strong willed daughter. She does not like to be told what to do. She only responds if you talk with her like a friend and not a father. She is also moody. She is fairly responsible // Still at school, large group of friends, has not had many experiences outside of school/family/friends. Is confident but at times naïve about consequences to particular situation. Often feels her parents are naïve themselves and have no concept of how the world works nowadays// young, naïve, easily persuaded by her friends. Social butterfly who likes to please people so would misjudge the consequences of a situation //

Examples of responses such as those above stimulated us to consider a third avenue of investigation for the next study. This was the question of what the respondent brings to the situation in the way of what Gell-Mann (1994:17) calls a schema, " …[acquiring] information from the environment and its open interaction with that environment, identifying regularities, condensing those regularities into a kind of "schema" or model, and acting on the world on the basis of that schema." The thumbnail sketch of the daughter and the nature of responses provided some indicative support for the existence and utility of a schema in the decision making process. At this stage, tentatively, Beach's (1990) three images, values, trajectory and strategy may provide a working framework for the next study.

Question e: *How do you predict your daughter will respond?* was designed to examine the existence of anticipatory mechanisms in participants 'making-sense' of the scenario. Following the character sketch in the previous question, we invited participants to anticipate the agent's response, and, in conjunction with the final question (asking for the participant's perception of how the agent then perceived the situation) we were interested in whether or not the GSS process could provide evidence on the nature of these anticipatory mechanisms – would participants, in line with the suggestions of Holland (1995) exhibit if-then rules in their view of the agent's perceptions and importantly, would this be indicated by GSS-collected data?

Question f: *How do you think your daughter perceives the situation now?* Although the data indicated that participants were enable and willing to engage an anticipatory mechanism, we were not able to clearly ascertain confirmation of the if-then rules.

> *// her answer would be cool Dad and would not think there would be a negative answer // she will not be happy. She will probably argue with me and try to get me to change my mind. She will be worried about how she is now going to explain to her friends that Mum said she couldn't // she will be annoyed that I have told her no. she believes that she is in control of herself and the situation and won't like to look bad in front of her friends // my daughter is impatient that I have not yet said yes. She is so keen to get an affirmative response from me that she is not very keen to listen to a lot of reasoning or wanting to enter into a lot of discussion //*

Respondents for the large part were unable to distinguish between the question *How do you predict your daughter will respond?* and the question *How do you think your daughter perceives the situation now?* The responses may have surfaced a weakness in our questioning, in that we tried not to lead the respondents. One of the dilemmas we faced in examining participants' use of if-then rules was the autosuggestion implicit in the act of asking about rules, that these rules exist in the first place. *How do you think your daughter perceives the situation now?* was thought to be more appropriate than asking participants about the way they referred to their model of the daughter in making their decisions.

Nevertheless, information from the final question centred on the agent's perception of the effect of the participant's action and did show the importance (to the participant) of the effect of the participant's action on the agent. For example, *// My daughter is thinking that I am a bit unfeeling and that I am not treating her as an adult // In a relationship based on trust and respect she would be thinking that the decision has been made, a decision that has gone the way she thought it would, and she will accept it without much fuss //* There was little evidence of the participant perceiving the agent as invoking an anticipatory mechanism toward the him/herself. Such evidence could have been, for example, a response such as *// my daughter is now thinking about how I have perceived the situation //* This is despite at least one participant recognising the importance of this process in achieving clarity of decision *// As I did think about what she was thinking I might regret the next day making that decision. Her expressing her disappointment may make me regret the decision //.*

Conclusion

The decision to align with the 'complexity' ontology and to move away from an allegiance to one or the other has proved to be a good starting point for our future studies. There was a mix in the research design of 'real' and enforced elements (the scenario decisions) and

constructed, emerged ones (the stories). However, a dilemma we faced in using the complexity rather than positivist or constructivist ontologies lay in the reporting methods available. Holland (1995) and many of his colleagues at the Santa Fe Institute have solved this problem through mathematical modeling.

Social scientists such as Griffin et al (1998) report using constructivist or group analytic 'voices' within their matrices of communication. Menz (1999) uses the conventions of discourse analysis. Remembering that chaos and complexity theories are used in the metaphorical rather than scientific sense, a reporting format of the narrative has been adopted for this study. However, as the series of planned studies are implemented, other reporting formats will be explored within the existing parameters of authenticity facilitated by GSS technology.

Overall, the conclusion was that individual agents did exhibit characteristics of anticipating, adapting and then acting and that such information can be readily obtained using GSS technology. They also appeared to build overall patterns of self-interaction which were emergent in an unpredictable sense. Now that the data collection method has been shown to be appropriate, it is planned in the next study to investigate whether such patterns are built when the situation is allowed to develop naturally. The next design will comprise dyads. As the series of questions and responses unfold, each adaptive agent's emerging responses and decisions will be made available to the other during the 'collapsing' process. The use of dyads will enable the research to more fully explore Zohar and Marshall's notion of a multiplicity of virtual possibilities. We will explore ways in which they affect and are affected by, the total decision-making experience of the individual. This includes from pre- to post-decision cognition. In addition, the next study will further test GSS capabilities of anonymity and parallel processing by introducing real-time anticipations and responses.

References

Argyris, C. (1995). Action science and organizational learning. *Journal of Managerial Psychology, 10*(6), 20-26.

Argyris, C. (1996). Actionable knowledge: Intent versus actuality. *Journal of Applied Behavioral Science, 32*(4), 441-444.

Beach, L. R. (1990). *Image Theory: Decision Making in Personal and Organizational Contexts*. New York: John Wiley.

Bertalanffy, L. (1968). *General Systems Theory*. New York: Braziller.

Blumer, H. (1969). *Symbolic Interactionism*. Englewood Cliffs, N.J.,: Prentice Hall.

Blumer, H. (1984). Sociological Implications of the thought of George Herbert Mead. In Cosin, G.M. Esland, D. Mackinnon, D.F. Swift (Ed.), *School and Society: A sociological reader* . London: Routledge.

Bostrom, R. P., Clawson, V. K., & Watson, R. T. (1996). The Importance of Facilitator Role Behaviors: Implications for Training Facilitators and Teachers to Use GSS. In A. Whiteley, M. (Ed.), *The Teaching of Organizational Behavior Across Disciplines and National Boundaries* . New York: International Business Press.

Brown, S. L., & Eisenhardt, K. M. (1998). *Competing on the Edge: Strategy as Structured Chaos*. Boston: Harvard Business School Press.

Checkland, P. (1999). *Systems Thinking:Systems Practice*. New York: Wiley.

Checkland, P., & Scholes, J. (1999). *Soft Systems Methodology in Action*. New York: Wiley.

Chia, R. (1997). Essai:Thirty Years On: From organisational structures to the organisation of thought. *Organisation Studies, 18*(4), 685-707.

Comte, A. (1875/1968). *System of positive polity*. New York: B.Franklin.

Connolly, T., Jessup, L. M., & Valacich, J. S. (1990). Effects of anonymity and evaluative tone on idea generation in computer-mediated groups. *Management Science, 36*(6, June), 689-703.

Cooper, D. E. (1996). Modern European Philosophy. In N. Bunnin & E. P. Tsui James. (Eds.), *The Blackwell Companion to Philosophy* . Oxford: Blackwell.

Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process*. St Leonards: Allen and Unwin.

Daneke, G. (1999). *Systemic Choices: Nonlinear Dynamics and Practical Management*. Ann Arbor: University of Michigan Press.

Dennis, A. R., Tyran, C. K., Vogel, D. R., & Nunamaker, J. F. J. (1990, December 16-19). *An evaluation of electronic meeting systems to support strategic management*. Paper presented at the 11th International Conference on Information Systems, Copenhagen, Denmark.

Eden, C. (1992). Strategy Development as a Social Process. *Journal of Management Studies, 29*(6 - November), 799-811.

Emery, F. E. (Ed.). (1993). *Participative Design for Participative Democracy*. Canberra: Centre for Continuing Education, ANU.

Emery, F. E., & Trist., E. (1964). The Causal Texture of Organisational Environments. *Human Relations, 18*(1), 21-32.

Emery, F. E., & Trist, E. (1973). *Towards a Social Ecology*. London: Tavistock.

Fine, A. (1995). Einstein, Albert. In Robert Audi. (Ed.), *The Cambridge Dictionary of Philosophy* . Cambridge: Cambridge University Press.

Fjermestad, J., & Hiltz, S. R. (1999). An Assessment of Group Support Systems Experimental Research: Methodology and Results. *Journal of Management Information Systems, 15*(3), 7-149.

French, S. (1986). *Decision Theory: an introduction to the mathematics of rationality*. Chichester: Ellis Horwood Ltd.

Fung, Y. L. (Ed.). (1948/1997). *A Short History of Chinese Philosophy*. New York: The Free Press.

Gell-Mann, M. (1994). *The Quark and the Jaguar: Adventures in the simple and the complex*. London: Abacus.

George, J. F. (1992). An Examination of Four GDSS Experiments. *Journal of Information Science,* (18), 149-158.

Glaser, B., & Strauss, A. (1967). *The Discovery of Grounded Theory*. Chicago: Aldine.

Gleick, J. (1987). *Making a New Science*. New York: Viking.

Gleick, J. (1997). *Chaos: The amazing science of the unpredictable*. (Second ed.). London: Minerva.

Goodwin, B. (1994). *How the Leopard Changed its Spots: The Evolution of Complexity*. London: Weidenfeld and Nicholson.

Griffin, D., Shaw, P., & Stacey, R. (1998). Speaking of Complexity in Management Theory and Practice. *Journal of Organization, 5*(3), 315-339.

Guba, E. S., & Lincoln, Y. S. (1994). Competing Paradigms in Qualitative Research. In N.K. Denzin. & Y.S. LIncoln. (Eds.), *Handbook of Qualitative Research* (pp. 105 - 117). Thousand Oaks, CA: Sage.

Habermas, J. (1984). The Theory of Communicative Action, *Reason and the*

Hancock, P. (1999). Baudrillard and the metaphysics of motivation: A reappraisal of corporate culturism in the light of the work and ideas of Jean Baudrillard. *Journal of Management Studies, 36*(2), 155-175.

Hatch, M. J. (1997). *Organization Theory: Modern, Symbolic, and Postmodern Perspectives*. New York: Oxford University Press.

Hayles, N. K. (1991). *Chaos and Order: Complex Dynamics in Literature and Science*. Chicago/London: University of Chicago Press.

Ho, T. H., & Raman, K. S. (1991). The effect of GDSS and elected leadership on small group meetings. *Journal of Management Information Systems, 8*(2 - Falol), 109-133.

Holland, J. H. (1995). *Hidden Order: How Adaptation Builds Complexity*. Reading, M.A.,: Helix Books, Addison Wesley Publishing Co.,.

Jessup, L. M., & Connolly T. (1993). The Effects of Interaction Frequency on the Productivity and Satisfaction of Automated Problem-Solving Groups,. , 142-151, 56.

Kauffman, S. A. (1991). Antichaos and adaptation. *Scientific American, 265*(2), 64-70.

Kauffman., S. (1995). *At Home in the Universe: The Search for the Laws of Complexity*. London: Viking.

Kurian, G. T., and Molitor, G.T.T. (Ed.). (1996). *Encyclopedia of the Future*. (Vol. 1 (P1-351), 2 (532-1115)). New York: Simon Schuster Macmillan.

Lewis, F. L. a. W., A.M. (1992). *Initial Perceptions of professional Facilitators Regarding GDSS Impacts: A study using grounded theory approach.* Paper presented at the Proceedings of the 25th International Hawaii Conference on Systems Sciences, University of Hawaii.

Lewis, L. F. (1993). Decision-aiding Software for Group Decision Making. In S. Nagel (Ed.), *Computer-Aided Decision Analysis: Theory and Applications* . West Port, Connecticut: Quorum Books.

Mahoney, M. J. (1991). *Human Change Processes*. New York: Basic Books.

Marshall, I., & Zohar, D. (1997). *Who's Afraid of Schrodinger's Cat?* New York: Quill.

Martz, W. B., Vogel, D. R., & Nunamaker, J. F. J. (1992). Electronic meeting systems: Results from the field. *Decision Support Systems, 8*(2), 141-158.

Mead, G. H. (1963 (1934),). *Mind, Self and Society*. Chicago: Unversity of Chicago Press.

Menz, F. (1999). 'Who am I gonna do this with'?: Self organisation, ambiguity and decision making in a business enterprise. *Discourse and Society, 10*(101-123).

Mintzberg, H. D., Raisinghani, D., & Theuret, A. (1976). The Structure of 'Unstructured' Decision Processes. *Administrative Science Quarterly, 21*, 246-275.

Morel, B., & RAmanujam, R. (1999). Through the Looking Glass of Complexity: The Dynamics of Organizations as Adaptive and Evolving Systems. *Organizational Science, 10*(3), 278-293.

Morgan, G. (1997). *Images of Organization: the executive edition*. (2nd., ed.). San Francisco: Berrett-Koehler.

Nunamaker, J. F., Jr., , Vogel, D., Heminger, A., Martz, B., Grohowski, R., & McGoff, C. (1989). Experiences at IBM with group support systems: A field study. *Decision Support Systems, 5*(2), 183-196.

Nunamaker, J., Chen, M., & Purdin, T. (1991). Systems development in information systems research. *Journal of Management Information Systems, 7*(3 - Winter), 89-106.

Pascale, & R.T. (1999). Surfing the Edge of Chaos. *Sloan Management Review*(Spring), 83-94.

Payne, J. (1989). NZ Notes. *Australian Transport & distribution Management*(December), 28.

Pervan, G. P. (1998). A Review of research in Group Support Systems: leaders, approaches and directions. *Decision Support Systems, 23*, 149-159.

Phillips, L., D., & Phillips, M., C. (1993). Facilitated Work Groups: Theory and Practice. *Journal of the Operational Research Society, 44*(6), 533-549.

Rationalization of Society (Vol. 1,). London: Heinemann.

Schein, E. H. (1993). On dialogue, culture and organizational learning. *Organisational Dynamics, 22*(2), 40-52.

Schwandt, T. A. (1994). Constructivist Interpretivist Approaches to Human Inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (Vol. Chapter 7, pp. 118 - 137). California: Sage.

Scruton, R. (1997). *Modern Philosophy: an introduction and survey*. London: Arrow Books.

Senge, P. (1992). Building Learning Organizations. *Journal of Quality and Participation, 15*(2 - March), 30-38, 7.

Senge, P. M., Roberts, C., Smith, B. J., & Kleiner, A. (1994). *The Fifth Discipline Fieldbook: Strategies and tools for building a learning organisation*. New York: Currency Doubleday.

Simon, H. A. (1969). The Sciences of the Artificial. . *Massachusetts: MIT Press*.

Stacey, R. (1998). Emerging Strategies for a Chaotic Environment. *Long Range Planning, 29*(2), 182-189.

Stevenson, L., & Haberman, D. L. (1998). *Ten Theories of Human Nature*. Oxford: Oxford University Press.

Tarnas, R. (1991). *The Passion of the Western Mind: Understanding the ideas that have shaped our world view*. New York: Ballantine Books.

Taylor, F. (1911). *The Principles of Scientific Managment.* New York: Harper.

Tiles, M. (1996). Philosophy of Mathematics. In N. Bunnin & E. Tsui-James (Eds.), *The Blackwell Companion of Philosophy* . Oxford: Blackwell.

Trist, E. (1981). The Evolution of Sociotechnical Systems". In A. H. V. d. Ven & W. F. Joyce (Eds.), *Perspectives on Organisation Design and Behaviour* . New York: Wiley Interscience.

Tsoukas, H. (1998). Introduction: Chaos, Complexity & Organisational Theory. *Complexity and Chaos*.

Waldrop, M. M. (1992). *Complexity: The Emerging Science at the Edge of Order and Chaos*. London: Viking.

Walker, J., & Guest, R. H. (1952). *The Man on the Assembly Line*. Cambridge Mass.: Harvard University Press.

Watson, R. T., DeSanctis, G., & Poole, M. S. (1988). Using a GDSS to facilitate group consensus: Some intended and unintended consequences. *MIS Quarterly, 12*(3 - September), 462-478.

Weick, K. (1979). *The Social Psychology of Organizing*. (2nd ed.). Reading, Massachusetts: Addison-Wesley.

Weisbord, M. R. (1987). *Productive Workplaces: Organising and Managing for Dignity, Meaning and Community*. San Francisco: Jossey Bass.

Whiteley, A., Cheung, S. F. Y., & Zhang, S. Q. (2000 (in press)). *Human Resource Strategies in China*. Singapore: World Scientific Press.

Wilkinson. (1998). FOcus group methodology: A review. *International Journal of Social Research Methodology, 1*(3), 181-203.

Williams, S. R., & Wilson, R. L. (1997). Group support systems, power and influence in an organisation: A field study. *Decision Sciences, 28*(4), 911-937.

Winterfeldt, D., & Edwards, W. (1986). *Decision Analysis and Behavioral Research*. Cambridge: Cambridge University Press.

Zigurs, I., Poole, S., & DeSanctis, G. L. (1988). A Study of Influence in Computer-Mediated Group Decision Making. *MIS Quarterly*(December), 625-644.

Zohar, D., & Marshall, I. (1994). *The Quantum Society: Mind Physics and a new social vision*. London: Hammersmith.

Zucker, L. G. (1991). The Role of Instutionalization in Cultural Persistence. In W. W. Powell & DiMaggio P. J. (Eds.), *The New Institutionalism in Organizational Analysis* . Chicago: The University of Chicago Press.

Other Titles in the Graduate School of Business Working Paper Series

94.01   Nowak, M and Whiteley, A, New Strategies to Develop 'Real' Engagement by Students with the Learning of the Knowledge and Skills Required for International Competitiveness.

95.01   Travaglione, T, Pinto, D and Cacioppe, R, Employee Share Plans: Recent Industrial Relations and Taxation Developments.

95.02   Whiteley, A, Levantard, M and Anderson, P, Critical Thinking/Questioning Skills a Meta-Model for Cognitive Development in Management Education.

95.03   Cacioppe, R and Bedford, R, Evaluation of a Participative Change Program Over Two Years.

95.04   Travaglione, T and Williams, P, The Move to Individualism by The Western Australian Education Department.

95.05   Firns, I, Travaglione, A, and Fink, S, Employee Commitment in Westrail.

95.06   Clifford, P and Evans, R, Corporate Governance: A Question of Independence

95.07   Silcox, S, Cacioppe, R and Soutar, G, Quality Sub-Cultures and Their Influence on Change Interventions

96.01   Whiteley, A, McCabe, M, and Savery, L. Preliminary Findings on Waterside Workers' Responses to the role of Unions following the 1991 Enterprise Based Agreement.

96.02   Whiteley, A, McCabe, M, and Savery, L. Human Resources on the Waterfront: Managing History

96.03   Whiteley, A. Report on a preliminary investigation into the need and support for a (tentatively named) director's development centre

97.01   Whiteley, A, McCabe, M, and Savery, L. Trust and Communication Development Needs: An Australian Waterfront Study

97.03   Cacioppe, R. An Integrated Model and Approach for the Design of Effective Leadership Development Programs

97.04   McCabe, M. & Nowak, M. The Impact of Baby Boomers' Longevity: Are There Implications for Boards of Directors

98.01   Whiteley, A., McCabe, M., Buoy, L., Howie, F., Klass, D., Latham, J., Bickley, M. & Luckeenarain, L. Planning the Qualitative Research Interview.

98.02   Nowak, M. J. The Role of Information in Internal Labour Markets.

99.01   Stockwell, C. & Nowak, M. An Application of National Competition Policy: Parking Services, City of Perth.

00.01   Dumont, E. & Cacioppe, R. Leadership Directions for Non-Profit Boards of Management

00.02   Whiteley, A. Grounded Research: A Modified Grounded Theory for the Business Setting

For further information on this discussion paper series please contact:

Dr Des Klass, Course Co-ordinator

Graduate School of Business, Curtin Business School

Curtin University of Technology

GPO Box U1987, Perth, Western Australia 6001

Fax: 61 8 9266 3368 Telephone: 61 8 9266 7057