A SYSTEMS VIEW OF MANAGERIAL DECISION MAKING

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Abstract

There is ample evidence to suggest that all managers struggle to deal effectively with complex, dynamic problems. Managers have a propensity to rely on tools to help manage within a complex world rather than investigating and understanding in detail the problems they face. Successful management depends on understanding the dynamics of organisational and business problems. To be fully effective in their task, managers also need to understand the strengths and limitations of their thinking, and how organisational cultural issues impact on everything they do. Knowing these things enables choices about the gains that might be made by using systems thinking, particularly soft systems methodology and system dynamics modelling to aid organisational change interventions. This paper addresses managerial choice and decision-making. It looks both at recent research and lessons we might all draw from that research. It makes explicit what can be done to enhance our skills in finding out about complex problem situations organisations and their managers face.

Initial and Ongoing Reliance on the Views of Actors[1]

When we set about any organisational change intervention, there is an initial period when we are most strongly influenced by how actors view particular organisational problems. Individual views of the actors are almost always incomplete, fuzzy, linked to ingrained assumptions or involve imperfect knowledge, yet they can form the basis for building models we then go on to use for analysis and strategy development (Doyle and Ford, 1998: 3-29). This begs research into how we define, elicit and exploit the knowledge of those who face or, indeed, are an integral part of organisational and business problems. We need to understand the mental models of the actors, how they were formulated and how valid they might be, especially if we are to use knowledge drawn from those mental models as input to the formulation of models for strategy development or decision support.

Though the extent might be lessened as we proceed, we repeatedly draw upon the knowledge and perspectives of actors in a given problem situation to help us develop the business rules that are the building blocks of system dynamics models. Our reliance on their views may be heaviest when dealing with *soft* variables, that is, those that are not easily quantifiable but still have an important impact. Here, perspective plays its most influential role.

In the problem conceptualisation phase we rely heavily on actors' views, as correct or incorrect as they may be, until we can formulate, verify and validate our own views.

As we proceed through conceptualisation to model building, as modellers (researchers or consultants) we make many choices:

- Where do the boundaries of the problem space lie?
- What are the limits to what we include or exclude from our modelling?
- What parameters most influence the observed dynamic behaviour?
- Do we include all identified parameters? If not, which ones do we exclude? Which ones do we include and on what basis do we prioritise them for inclusion?
- Is it appropriate to combine variables (especially soft variables) by addition, multiplication, or other operations?
- When the model is built, how do we know that its behaviour a sufficient representation of observed real-world behaviour?
- Should we stop model development at a particular point, or continue?

Some of these choices are those of the modeller alone, but many are informed by views of the various actors. Both actors and modellers are involved in ongoing rounds of choice and decision-making. In this process the views of both are critically important.

Modelling is an iterative process (Homer, 1996) that involves building, repeatedly simulating and making adjustments to the model: choice and decision-making continue through every stage. Just how good those choices and decisions are will dictate the veracity of the modelling and, ultimately, the management intervention.

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[1] The term 'actor' is used here in the sense intended by Peter Checkland in Soft Systems

This paper looks at human cognition, cognitive limitations and failures, and organisational and cultural impacts on choice and decision making, as they affect managers and those assisting managers to develop organisational change strategies.

Fundamental Importance of Problem Conceptualisation

Every time we build a model to aid our understanding, we undertake a unique project. Success in any project is largely dependent upon the effort put into conceptualisation which, in turn, relies heavily on knowledge elicitation and systems thinking. Conceptualisation is critically important: the better we are at it the greater the rewards.

Maximum Stakeholder[2] Involvement – An Important Principle

Around fifty years ago, organisational change management pioneer Kurt Lewin was successfully employing organisational change techniques that include what we now recognise as action learning and action research. Lewin's legacies to management include *participative management* and the *learning organisation*. The latter is variously described in the systems thinking literature, with virtually no acknowledgment of Lewin's pioneering contributions.

The logical extension of participative management and group decision-making in dynamic, systemic problem settings is the group model building technique developed by Vennix (1996: 3), where the primary goal is not to build *the* model of *the* system, but rather to get a group of actors, particularly managers and key stakeholders, engaged in building a system dynamics model of a problem in order to see to what extent the process might be helpful to increase problem understanding and to devise courses of action to which team members will feel committed. Approaches such as group model building are designed to access and exploit both the tacit and explicit knowledge of actors, particularly the managers responsible for implementing change.

Getting Inside the Heads of the Actors, Managers and Key Stakeholders

To have actors, managers and key stakeholders as fully involved as their busy schedules permit is necessary but not sufficient. We also need to understand them and how they think: we need to get inside their heads. This is vitally important if we are to provide effective support to enabling shifts in thinking and development of appropriate organisational change strategies. This continual and close engagement is essential to enabling the design and building of decision-support systems that executive decision-makers, in particular, will trust and use (McLucas and Linard, 2000).

Need to Understand Managerial Cognition Before Building Decision Support Systems

Before we can build truly effective decision support systems we need to have a comprehensive understanding of managerial cognition. We need to understand what managerial cognition is, how we might strengthen it and, ultimately, how best to exploit it. We need to be able to relate to all actors, and particularly the managers and key stakeholders ultimately responsible for making change, through being able to relate to the ways they think.

Figure 1, below, depicts a number of important relationships between elements comprising managerial cognition and those tools and techniques, such as cognitive mapping and influence diagramming, that might be used to support knowledge elicitation and analysis. There is

[2] Here 'stakeholder' includes actors within an organisation as well as managers and those either within the organisation or outside it but closely involved, and who might be instrumental in any

insufficient room here to discuss all elements of managerial cognition and the full range of tools and technique that might be used to aid elicitation and analysis. So, selected elements are discussed to aid our understanding of the challenges faced when we investigate and design organisational change interventions.

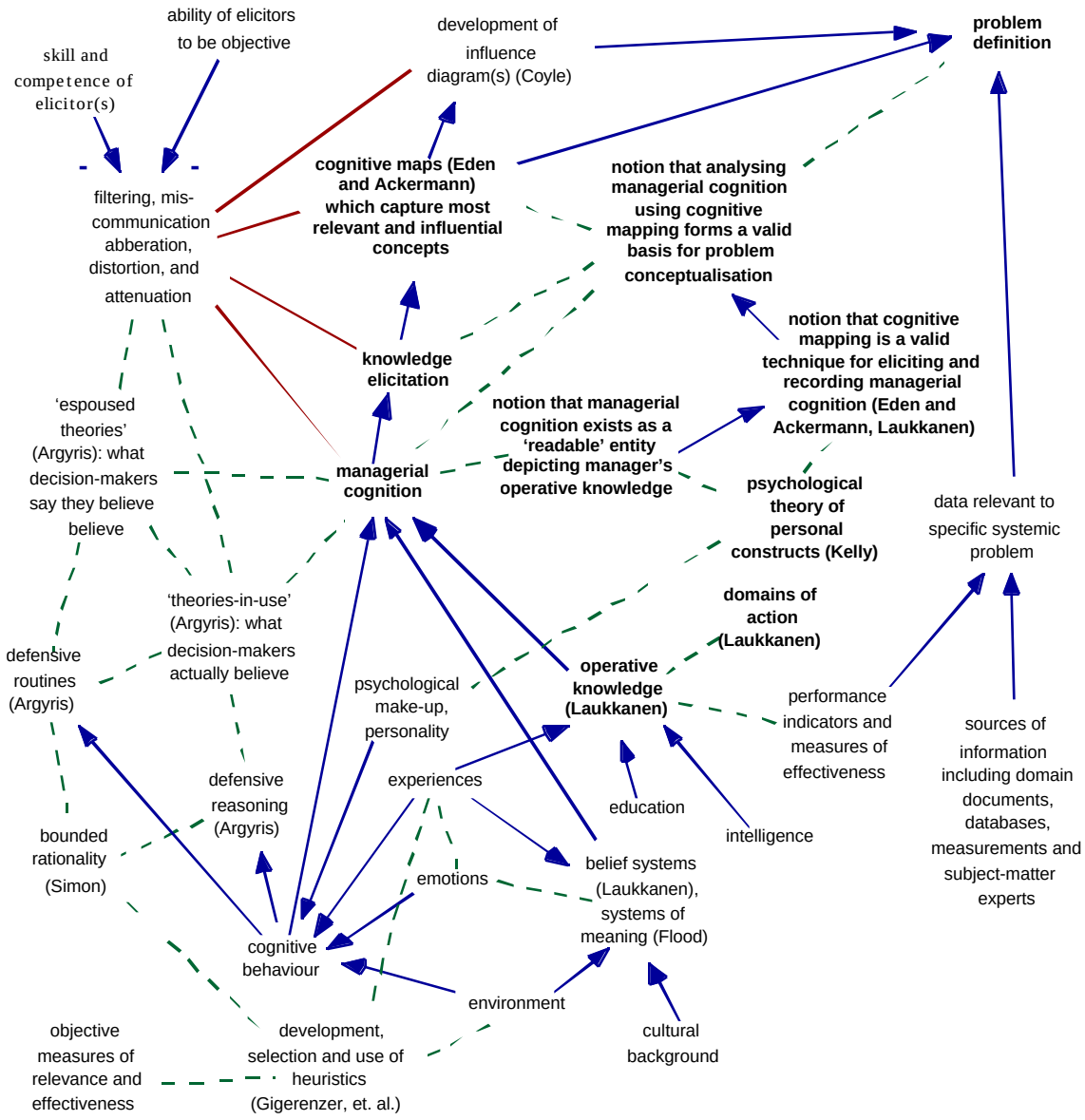

Figure 1. Relationships Between Managerial Cognition and Problem Definition [3] [4]

[3] Arrows depict causality in a 'soft' sense: an arrow means 'leads to' or 'contributes to'. Dashed lines depict connotative relationships, where causality could operate in either direction or nature of causality is ill-defined. Solid lines without arrowheads depict conflict, or potential conflict, between concepts.

[4] Linked concepts in plain text suggest there are many things to take into account in reaching

Specifically, we need to:

- know the differences between ‘espoused theories’, what managers say they think and ‘theories-in-use’, what they really think (Argyris, 1994);
- be able to identify the nature and limits to managerial ‘domains of action’ (Laukkanen, 1998: 171), that is, domains in which managers are prepared to take action or seriously influence others outside their normal domains by taking specific action;
- understand the influence that individual managers have on access, provision, and interpretation of information;
- understand impediments to both individual and organisational learning created by the ways actors, managers and key stakeholders in an organisational problem actually think;
- develop skills in eliciting, reading and analysing constituent elements and structure of managerial cognition; that which Laukkanen (1998) calls ‘cognitive content’;
- develop skills in analysing and comparing specific cognitive content, views, perspectives, underlying assumptions, dynamic hypotheses and even the hidden agenda of those involved in decision-making;
- understand which tools and techniques in our systems thinking and system dynamics toolbox that are effective in helping us analyse cognitive content; and
- overall, appreciate what might be done to improve managerial cognition, that is, to enable revision, validation and strengthening of mental models, essential to supporting and enabling managerial decision-making.

Mapping the Role of Managerial Cognition in Problem Formulation

Managerial cognition is the central focus in our tasks of understanding and clearly defining the problems that organisations face. We cannot conveniently assume that to define the problems of an organisation we simply need to talk to that actors and map out what they are thinking. In attempting to do this we, for example:

- are challenged by mis-communication, aberration, distortion and attenuation of information;
- need effective ways of uncovering the operative knowledge that managers hold;
- need to acknowledge that what we may be observing at any time could be the manifestation of an individual manager’s cognitive behaviour; and
- have to be able to differentiate between what managers actually believe and what they say they believe.

We cannot simply assume that organisational decision making is informed, rational or even appropriate to the circumstances. To explain, this paper looks at that part of human decision making which employs mental shortcuts and then links back to the central discussion about managerial cognition.

Human Decision-Making – Bounded Rationality and Heuristics in Quick Decisions

Research into human decision-making, conducted at the Max Planck Institute for Human Development in Berlin by Gigerenzer et al. (1999), revealed some interesting findings regarding

the way we use heuristics, or mental short cuts to facilitate quick decisions. How we use the short cuts in our 'adaptive toolbox' in everyday situations was put to a series of tests.

In the real world, a good decision is less about finding the best alternative than finding one that works. Our minds like our bodies have been shaped by evolution. Our decision heuristics allow us to make decisions based on very little information and using simple rules. Each heuristic is designed to resolve a certain type of dilemma under certain circumstances. Although they apply to different sorts of problems, heuristics have a common structure, which arises from the way humans make decisions. First, we search the environment for information, or cues, upon which to base a choice. A heuristic contains rules that direct the search. Next, we must stop searching. Heuristics contain a stopping rule, often ending the search after only a few cues have been considered (New Scientist, 1999: 30-35).

Some heuristics are (Gigerenzer, et al., 1999):

- *Recognition Heuristic.* This involves choosing the familiar as the only cue worth considering.
- *Minimalist Heuristic.* This involves searching through a sequence of cues until one is found which distinguishes between alternative courses of action.
- *Take the Best Heuristic.* This heuristic uses the cues in order of importance, stopping the search as soon as one cue distinguishes between the possible choices.
- *Categorisation by Elimination Heuristic*. This uses a succession of cues to whittle away the alternatives until only one remains.
- *Satisficing Heuristic*. This involves stopping and making a choice when *satisficing* occurs, that is, we set ourselves aspiration levels and stop looking once these have been achieved.

Whilst the use of heuristics does not always produce the best results, heuristics work surprisingly well in a broad range of situations. Not only do they allow us to choose between alternative courses of action, they also work when choice doesn't come with all the options up front, in which case it becomes necessary to search for all the options as well as the cues with which to distinguish between them; and heuristics come into their own when time is limited. The dividing line between deliberate decisions, involving careful consideration, and those involving judgement and intuition, where heuristics are invoked, is fuzzy (McLucas, 2001).

'Gut Feeling' in Managerial Decision-Making

Heuristics are fundamental to managerial decision-making, so much so that their use leads to decisions on the basis of 'gut feeling', intuition, where heuristics are invoked and where the choice or decision ultimately made cannot be fully explained by the person taking that choice, or making the decision. In his most recent book Klein (2002) looks at the development of skills in 'gut feeling' or intuition, and argues that it is a valid way of making many decisions. Of course managers and analysts alike need to understand the limitations of the use of intuition in decision making.

Human Decision-Making – When We Get It Wrong

Klein (1998) argues that heuristics and mental simulation of selected strategy, or strategies, play a critical role in decision-making. Whilst heuristics are generally associated with decision-making under pressure of time, there is a growing body of evidence that they are often used in

deliberate decision-making. There is a real risk that managers sometimes use heuristics in the place of deliberate decision making supported by comprehensive analysis.

The use of heuristics is not confined to situations where time and information are limited. Indeed, it seems there is surprisingly less use of detailed analysis and comparison of alternative strategies than previously thought, despite the institutionalised teaching of these approaches. Analysis of options by consideration of all relevant factors is known as *Franklin's Rule.* In many situations involving recognition, heuristics such as *Minimalist, Take The Best,* and *Take The Last* outperformed *Franklin's Rule,* and performed as well as multiple linear regression (Gigerenzer et al., 1998: 87-91). This suggests that, at least, decision makers are continually under threat of making less-than-optimum decisions as a direct result of inappropriate choice of heuristics or lack of application of more formal decision-making techniques.

Cognitive Failure

In complex environments, there is always the additional risk that decision makers hold flawed mental models about a problem situation. Decision-makers and managers, like all humans, can suffer from various forms of cognitive failure, failure to observe accurately and react appropriately to the world in which they are immersed. Bias is just one form of cognitive failure. Barnes (1984) studied cognitive bias in strategic planning and noted how the following were called into play:

- Availability. People judge an event as likely if instances of it can be recalled easily, despite evidence of occurrences being quite rare. In a sense, we are observing here that those easy to understand things are easy to remember, and things that are easy to remember are seen as occurring frequently.
- Hindsight. Knowledge of an event's occurrence increases the perception of that event's inevitability. So, we are not surprised about what happened in the past.
- Misunderstanding the Sampling Process. We tend to attach too much credibility to sparse occurrences of events, and place too much reliance when building theories on too few data points.
- Judgements of Correlation and Causality. Too often, we tend to attribute causes to un-correlated events.
- Representativeness. This failure stems from our failure to ask the question… 'how representative is this of the underlying process?

The latter two are particularly problematic in situations involving feedback (Richardson, 1991; Sterman, 1994, 2000).

Complexity

In the systems thinking and system dynamics literature there is repeated use of the term to complexity. However, there are few serious attempts to quantify the extent of such complexity. To provide the reader with a measure of complexity, this paper uses the *Complexity Index,* denoted *C,* defined by Kline (1995). *C* is defined in terms of three other quantities:

V = The number of independent *Variables* needed to describe the state of the system;

P = The number of independent *Parameters* needed to distinguish the system from other systems in the same class.

L = The number of control *feedback Loops* both within the system and connecting the system to the surroundings.

The upper and lower values of C are defined as:

$$V + P + L < C < V \,.\, P \,.\, L$$

noting that when L = 0, or V and P both have low values, *C* is taken to be V + P + L. For a particular system, the location of the value of *C* between these upper and lower bounds will depend on the degree of 'connectedness' within the structure of the system and between the system and its surroundings (Kline, 1995: 49-51).

Rather than attempting to make exact estimates of *C*, Kline makes rather crude one-sided estimates using inequalities. For example, the typical systems analysed in classes in physics, chemistry, and in analytic problems in beginning engineering classes have no control theory feedback loops; so L = 0. Initially, in such beginning problems we fix the values of the parameters and study a particular case. For these systems, typically V = 1, 2, or 3; thus we can write:

$C_A < 5$, where subscript $_A$ denotes the class of systems under consideration.

Class A systems include, for example, deflection of simple structural members or the motion of pieces of matter under prescribed forces (Kline, 1995: 52).

Desire to Keep it Simple

Many senior managers ask for, indeed demand, simplicity even when it is not possible to avoid inherent complexity. Simplicity, here, would be characterised by $C < 5$, which corresponds to a simple system described by a first order differential equation, which also corresponds to the upper limit of complexity we can cope with using mental simulation. As far as the number of concepts we can consider simultaneously, it also correlates well with the magic number seven, that is 7 ± 2 (Miller, 1956). Meadows (1989) observes that many people faced with complex problems look for 'gold nuggets' – fix the one single thing that is wrong and fix the problem. Unfortunately, it is rare for complex problems do not have simple answers.

Human Decision-Making – Belief and Learning

Heuristics are not the only devices that inform our decision-making. Kline (1995) explains we have the ability to rapidly recall schemata, that is, all the ideas in a person's head which are used to represent and interact with the world. Senge (1990) calls these 'mental models' whilst Kelly (1955) calls them 'personal constructs'. Some of our human schemata are simple, some moderately complex and some relatively very complex. Complex schemata are learned: complex schemata constitute the basis for a doctor in diagnosing illness, for a musician in playing his or her instrument, for an engineer designing a device, and so forth. These more complex schemata are not merely strings of information but, rather, form complex relational networks that are acquired by and only by long experience and usually focused study: all disciplinary knowledge is based on relatively complex, learned schemata (Kline, 1995: 31-32).

In our minds, schemata are broken down into chunks. Our working memory can hold about four chunks, or about seven bits ['bits of information', not to be confused with digital bits], whilst our long-term memory can hold about 50,000 bits of information for a single area, and around 100,000 bits in total. These can be rapidly recalled using the brain's multiple, parallel processing capability.

The relationship between working and long-term memory and schemata may be as depicted by Figure 2. Whilst we all have limited capacity in our working memory, we have enormous capacity to rapidly recall relevant, interlinked chunks of information in the form of schemata from our long-term memory. Schemata, sysreps, mental models or personal constructs are only really valuable as bases for understanding and learning if they have been developed from valid and relevant experiences, and reinforced through equally valid and relevant experiences.

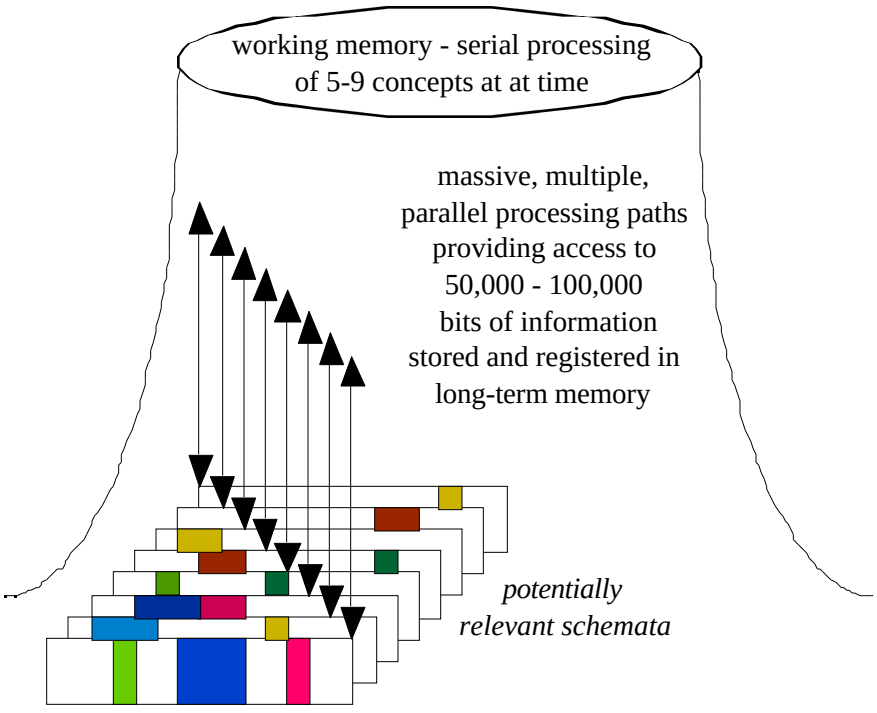

Figure 2. Relationship Between Memory and Schemata

Dynamic Environments – Misperceptions of the Implications of Feedback

Klein (1998) suggests decision-makers firstly invoke recognition to determine that a problem is typical of something seen before then, through combination of schemata recalled from long-term memory and cues from the current situation, build mental simulations of strategies. Even though this is the primary means of making decisions under constrained time and when there is limited information, a growing number of researchers argue such methods also used frequently for decisions where no such time constraints apply.

This type of thinking is problematic in dynamic situations, especially where cause and effect are not proximate, either temporally or spatially. Such is the case where feedback and delay mechanisms exist. We are in danger of failing dismally to either understand or predict the manifestations of systemic behaviour. Kleinmuntz (1993) warns that much of the research in the field of behavioural decision-making has been undertaken in situations suffering one unfortunate limitation, that is the tasks studied are almost exclusively static, discrete instances of judgement or choice. Decision researchers have overlooked the complex, time-dependent nature of many real decision environments, particularly the feedback structure linking previous decisions to changes in the decision environment (Hogarth, 1981). Decision makers have exhibited systematic patterns of poor performance that suggest that they are insensitive to the implications of feedback in these dynamic environments (Kleinmuntz, 1993: 223).

In an attempt to answer questions regarding the types of decision support we might provide to decision makers, it is necessary to look at the most problematic aspects of decision-making in dynamic environments. Of particular interest are misperceptions that are associated with feedback, regardless of decision-making being deliberate or intuitive.

The important implication is not so much that managers fail to see the relevant information and fail to develop 'situation awareness'. Situation awareness can be formed rapidly, through intuitive matching of features [either in the actual environment or a model of it], or through mental simulation. Sometimes a situation reminds the manager of a previous event, and the manager will then try to use analogy to make sense of what is happening. At times there are several competing explanations and the manager may have to compare them. Usually the manager will scan each explanation to see if there are elements that do not seem plausible, so we can reject the less likely ones and keep the best. But, by taking this approach, and without realising it) the manager is choosing not to explore how feedback and delay mechanisms operate to produce observed dynamic behaviour.

Relationship Between Metacognition and Parameters for Design of Decision Support Systems

In our research task, we need to be able to determine when the type of intuitive thinking described may be appropriate and when it is not. Klein defines the situation where we are aware of how we are thinking as metacognition (Klein, 1998: 158). Both we, and those managers facing 'wicked' complex and dynamic problems (Rittel, 1972), need metacognitive skills. In a consultancy or research situation we need ways of eliciting, surfacing, and testing how individual actors actually think. We need to have effective means of determining that the way managers are thinking about the problem really is appropriate. This was recognised by Mason and Mitroff (1981) and led them to develop their Strategic Assumptions Surfacing and Testing (SAST) intervention. A co-requisite, here, is a detailed appreciation of the nature of

complexity. For descriptions and characterisation of complex, dynamic, systemic problems, see McLucas (2003a).

Human Decision-Making – Different Perspectives on The Same Problem

Actors in a problem situation all have different perspectives – one will view a glass of water as half full, whilst another views it as half empty. Kosko (1993) observes that this demands a different way of viewing problems, a way that accommodates 'fuzzy logic', where there are many shades of grey.

The need to accommodate perspectives of actors was recognised by Vickers (1970). Klein (1998) suggests actor relates to a different set of cues and builds on his or her own situation awareness, or perspective. Checkland's Soft Systems Methodology (SSM), for example, acknowledges the importance of actor perspectives and the contribution to richness in problem conceptualisation made through accommodating varying perspectives. What SSM takes into account in helping actors find out about their particular problem situation, rather than how SSM is applied, is described later in this paper under the heading 'Finding Out About a Problem Situation – The Soft Systems Methodology.

Building Understanding Relevant to the Problem at Hand

Generally speaking, system dynamics practice seeks to build understanding about what underlies the behaviour of complex problems. When deciding how best to support managers through design of decision-support systems, we need to determine:

- what domain knowledge, knowledge relevant to their *domains of action* (Laukkanen, 1998), decision-makers have;
- what relevant expertise they possess;
- how well they appreciate the underlying dynamics; and
- how they believe reference modes of behaviour are produced.

Systems of Meaning

Heuristics, schemata, sysreps and mental models may be the building blocks of understanding and learning, but they are only part of cognisance of an individual actor or manager. An individual's cognisance fits within systems of meaning. The relationship between cognisance and meaning is depicted diagrammatically at Figure 3.

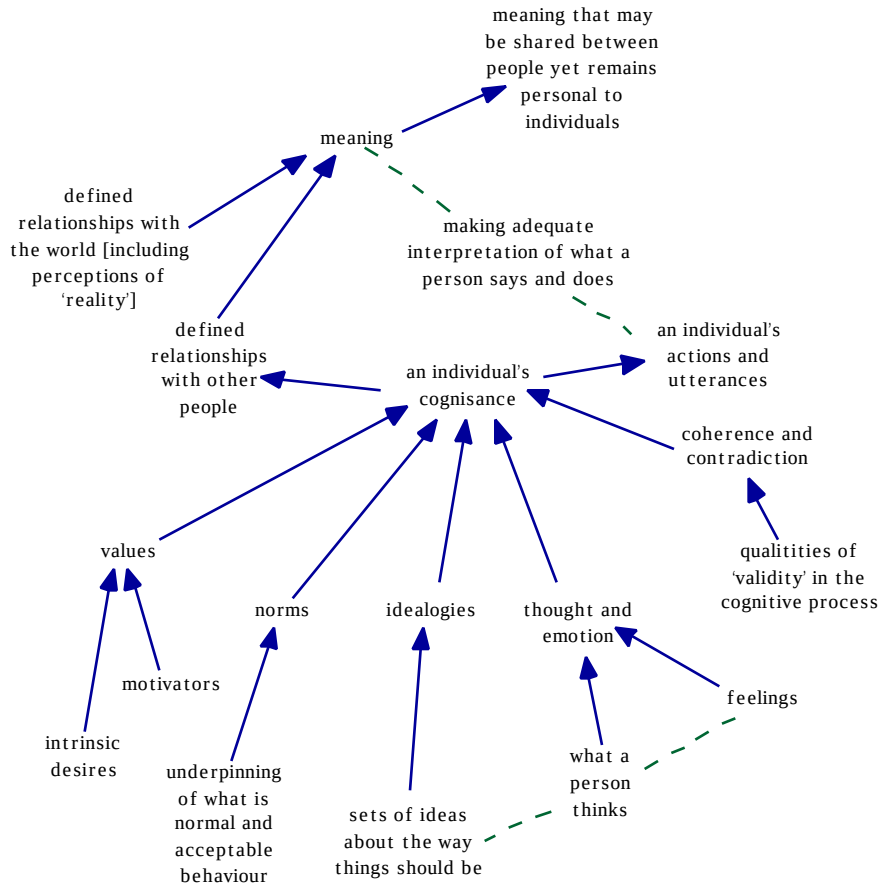

Figure 3. An Individual's Cognisance Within Systems of Meaning

Flood (1999) explains that meaning arises from people's cognitive processes and the way that, for each person, their cognisance defines their relationship with other people and the world. Cognitive processes might be conceived of in terms of values, norms, ideologies, thought and emotion, coherence and contradiction. A person's actions and utterances cannot be made sense of without reference to this texture of what they think. *Values* are intrinsic desires and motivators. *Norms* underpin what is considered to be normal and acceptable behaviour. *Ideologies* are sets of ideas about how things should be. *Thought and emotion* refer to what a person thinks and how they feel about that, as well as the impact that feelings have on what a person thinks. *Coherence and contradiction* are qualities of 'validity' in cognitive processes. All of these things are key in making an adequate interpretation of what a person says and does.

Cognitive processes constitute meaning that may be shared in some way between people and yet remains somehow personal to individuals. Systems of meaning that people employ may coexist and adapt in relative harmony and/or degrees of conflict. That is, systems of meaning may yield cohesion in cultural ways of living and/or tension arising from disagreement, perhaps leading to coalition building and political interaction. Appreciation of what people mean and the temperament of their coexistence are therefore of central interest when seeking 'agreement' on improvement strategies.

Amongst other things, this means choices or decisions we might make cannot be divorced from feelings. Alternatively stated, there are links between cognition, emotion and cognitive behaviour: choices and decisions are rarely made on purely logical and rational bases. We need to recognise that decision-makers have feelings when we design decision-support systems for

them. Further, they will only act when they feel strongly enough about a problem to do something meaningful about it (Forrester, 1985: 133-4; Checkland and Scholes, 1999).

Human Cognitive Limitations

When we do not have convenient and trusted analytical tools to help us deal with systemic behaviour, we revert to using judgement and intuition. Judgement and intuition can be quite inappropriate in situations where complex systemic problems are involved. Noting the earlier discussion and Kline's observation that human ability to reliably solve problems is limited to those characterised by $C < 5$. Sterman (1994: 309) makes a similar observation that people cannot simulate mentally even the simplest possible feedback system, the first order positive feedback loop. Such positive feedback processes are commonplace, from compounding of interest to the growth of populations. Yet people significantly underestimate exponential growth, tending to extrapolate linearly rather than exponentially.

Kline goes on to describe the problems executive decision-makers may be called upon to solve and characterises them by $C > 10^n$ where n can range from 6 -13 (Kline, 1995: 49-68). The gap between our cognitive capability in dealing with complexity and the complexity we face is enormous. This alone suggests that using judgement and intuition in complex environments can be inappropriate. Various researchers have commented on cognitive limitations of managers:

- The concept of feedback is generally not well understood. Feedback manifests itself almost everywhere and our ability to understand it is poor (Richardson, 1991).
- Our decision-making is seriously challenged when it comes to complex and dynamic systems where feedback and delay mechanisms exist. Human ability to predict dynamic behaviour of complex systems involving feedback and delay mechanisms, is poor (Sterman, 1989a; 1989b).
- Feedback dynamics easily elude human intuition and judgement (Sterman 1989c; Kleinmuntz, 1993; Diehl and Sterman, 1995: 198-215).
- Dynamic complexity is not interpreted well by those who are responsible for managing it (Forrester, 1971; 1975: 54). Behaviour can be quite counter-intuitive. Consequently, there is an ever-present risk that remedial strategies and policies created by managers will be based on flawed or erroneous assumptions and mental models.
- Further to our cognitive shortcomings in dealing with complexity, we are inhibited by our inability to correctly conceptualise problems when our assumptions may be inappropriate (Meadows, 1989).
- Complex problems are difficult enough for us to address without being further handicapped by analysis that starts from conflicting, hidden or fallacious assumptions (Mason and Mitroff; 1981).

Recognition in Analysis of Complex Problems

Recognition is the key to harnessing human intellect in dealing with complexity. In a series of studies of decision-making under time-pressure, Klein (1998: 23-4) and his team of researchers observed and classified 156 decisions and found 127 involved 'recognitional decisions'. Figure 4 depicts graphically Kline's model for recognition-primed decision making.

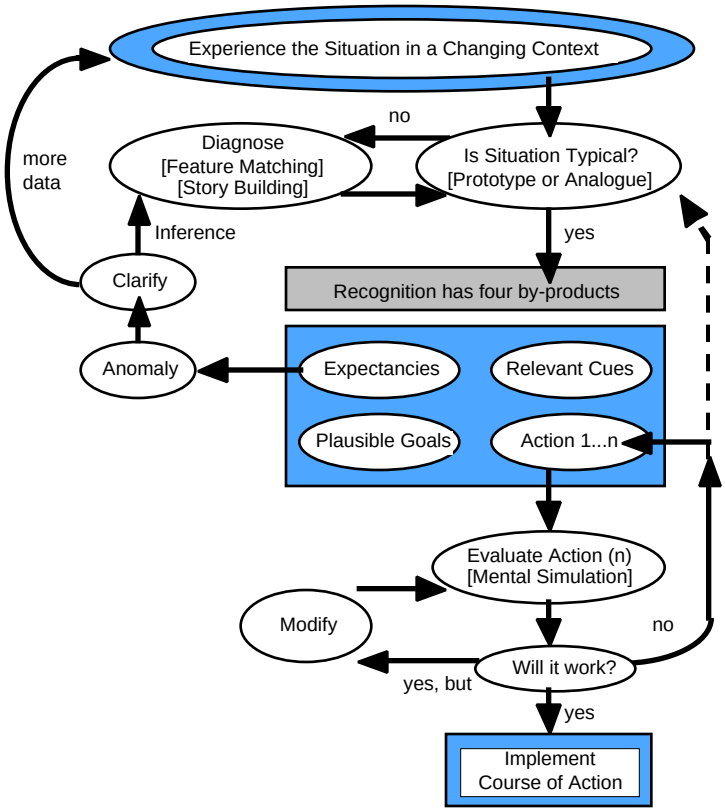

Figure 4. Integrated Version of Recognition-Primed Decision-Model

Kline's team observed that when more time was available, decision makers deliberated about options and this became a substitute for recognising a situation as 'typical'. As a result of separate decision research, Carroll and Johnson (1990) also conclude human intellect is best applied to recognitional tasks.

Using System Dynamics Modelling and Simulation to aid Recognition

With the advent of accessible and powerful desktop computing, it is now a relatively easy system dynamics task to model the systemic structures that underlie quite complex patterns of dynamic behaviour. Generally speaking, this is achieved through capturing business rules and building them into the structure and associate controlling algebra of models then simulating as an aid to 'recognising' how changes over time are produced.

System dynamics modellers have identified the importance of 'mental simulation' Klein (1998: 17-30) suggests in his *Integrated Version of Recognition-Primed Decision-Model.* Through 'modelling as learning' they are mimicking the processes using a mix of qualitative and quantitative system dynamics modelling and simulation. Of course, we cannot hope to achieve this in quick time such as the decision-making situations Klein and his team studied. Any decision-support system we might design to help us deal with the dynamics of 'wicked' (Rittel, 1972; Mason and Mitroff, 1981) or 'messy' problems (Vennix, 1996) must remove the human decision-maker from the process-intensive task of calculating complex dynamics. The human decision-maker is best involved by using his or her powers of pattern recognition to spot changes in a problem's dynamic behaviour: taking a helicopter view (Eden and Ackermann, 1998) or a world view *weltanschauung* (Checkland, 1990; 1999), rather than becoming embroiled in complicated calculations.

Importance of Communications in Decision Cycles

The interdependence of the various activities in decision-making is shown in the Decision Cycle at Figure 5. This diagram emphasises the requirement for effective communication.

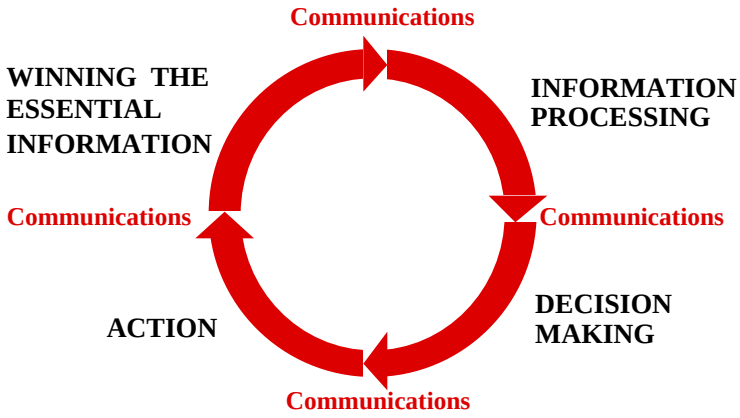

Figure 5. The Decision Cycle [5] [6]

Back in Figure 1, mis-communication is shown to threaten, or conflict with, managerial cognition, knowledge elicitation activities, cognitive mapping and influence diagramming. Mis-communication is generally possible at four separate points encountered as we negotiate the Decision Cycle. Mis-communication may come about for many reasons including:

- errors occur in the transmission process because we are unable to express perfectly, through verbal or non-verbal communication, exactly what we are thinking;
- errors occur in the reception process because we are unable to interpret perfectly what is transmitted, either as verbal or non-verbal communication;
- noise levels being high relative to the signals, that is, the really valuable information can be difficult to find among the large volumes available;
- misuse or imprecision in the use of language; or
- confusion in the use of terminology.

The decision cycle must be negotiated repeatedly. Facilitating effective communications at each of the points identified in the Decision Cycle is important to assuring understanding, and to avoid the introduction of errors.

A Fundamental Proposition – Superior Insights Lead to Superior Learning

A proposition fundamental to systems thinking and learning is that superior insights lead to superior learning outcomes. When supported by appropriate and timely validation, this learning informs cycles of revision and development of our mental models, making them more robust. Invoking these mental models, appropriately supported by analytical tools and data

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[5] Originally the Boyd Cycle, after Colonel Boyd USAF, a fighter pilot in the Korean War. This is also known as the OODA Loop, involving cycles of Observing the changing situation, Orienting to what is occurring, Deciding what action to take and Acting.

should lead to development of more effective policies, strategies, and decisions.

Organisational learning comes about only after learning of individual actors is enabled. Unfortunately, there can be many barriers to achieving this.

Barriers to Learning and Effective Decision-Making in Dynamically Complex Environments

Barriers to learning and effective decision-making arise for a combination of reasons:

- Many 'successful' senior executives have surprisingly poorly developed decision-making skills: rapid promotions distance them from the legacies of their earlier decisions (Argyris, 1994).
- We have limited ability to deal with dynamic complexity where feedback and delay occur (Sterman, 1989a; 1989b; 1989c).
- Frequently there are disjoints between strategic decision-makers who choose to distance themselves from high levels of complexity and those at lower decision-making levels where managers have to deal with massive complexity.
- Socio-technical organisations are massively complex (Kline, 1995).
- Executive decision-makers, who are amongst the busiest in the organisation, would prefer to avoid the impositions on their time, and the extensive delays that often accompany the application of analytical techniques: for them, the true nature of complexity remains undiscovered. When this understanding is absent or deficient, over-simplification can result, leading to perpetuation of the simplistic notion that one cause produces one effect, find the cause and fix the problem.
- Decision support is often untimely. Winning the essential information from actors, managers and influential stakeholders takes time and effort, as does information processing.
- Executive decision-makers are often intimidated by the complicated appearance of analytical methods and fail to appreciate their value (Nutt, 1989: 32-33). Many managers would prefer to, and do, dismiss them: they see them as threatening or time wasting.
- There is a strong aversion by decision-makers to have their deeply ingrained assumptions, their mental models tested or made public. The same applies to having 'systems of meaning' uncovered and critically analysed.
- The transformation of tacit information into explicit sysreps brings the possibility of imperfectly mirroring the systems concerned and making outright errors. This is the reason why such close attention needs to be paid to how we form sysreps, how we use them and how they are influenced by the limitations of the human mind (Kline, 1995: 55). Further, aversion is likely to be increased when a decision-maker's knowledge-power base is threatened.
- Strategic decision-makers are also political players concerned primarily with the impact individual decisions may have on their future careers.
- The structure of many large organisations and the nature of their business activities have the natural effect of shifting the management of complexity to lower organisational levels.

- Information can be compartmentalised within organisations. The existence and protection of these compartments by members of the organisation militates against the best intentions of the designers of information systems and decision support systems alike.
- Knowledge markets exist and market forces dictate the extent to which knowledge is traded. Understanding that there are knowledge markets and that they operate similarly to other markets is essential to managing knowledge successfully in organisations. Many knowledge initiatives have been based on the Utopian assumption that knowledge moves without friction or motivating force, that people will share knowledge with no concern for what they may gain or lose by doing so People rarely give away valuable possessions (including knowledge) without expecting something in return (Davenport and Prusak, 1988: 26).
- The 'need to know' principle also militates against sharing information. Decision-makers who are not granted the need to know are not only denied information but are denied opportunities to be involved in strategy development except in a controlled and limited sense.
- Reward systems in organisations, particularly public sector ones, are rarely centred on rewarding the sharing of information for long-term gains.

Systems of Knowledge-Power and Shared Reality in Organisations

Flood (1999) explains knowledge-power derives from the idea that people in positions of power determine what is considered to be valid knowledge and consequently valid action. 'Systems of knowledge - power', in which executive decision-makers are central players, militate against the sharing and flow of information (Flood, 1999: 116-122). How systems of knowledge-power operate in organisations is depicted diagrammatically at Figure 6.

Reality in organisations evolves through ongoing processes in which people negotiate with each other. Whilst they do not necessarily engage in these processes with the same negotiating power, they influence others to accept their organisational constructs and thereby constitute shared reality in organisations. Participants generate distinctions of their own, which they use to coordinate their actions, and through recurrent coordination of actions, and through the use of language they create a consensual domain of action, or shared reality (Espejo, 1994: 204).

Systems of knowledge-power depicted graphically at Figure 6 militate against natural evolution of shared reality in organisations. Failure to acknowledge the pervasive nature of systems of knowledge-power can seriously damage a manager's understanding of organisational dynamics. This creates further problems for those charged with the task of designing decision-support systems.

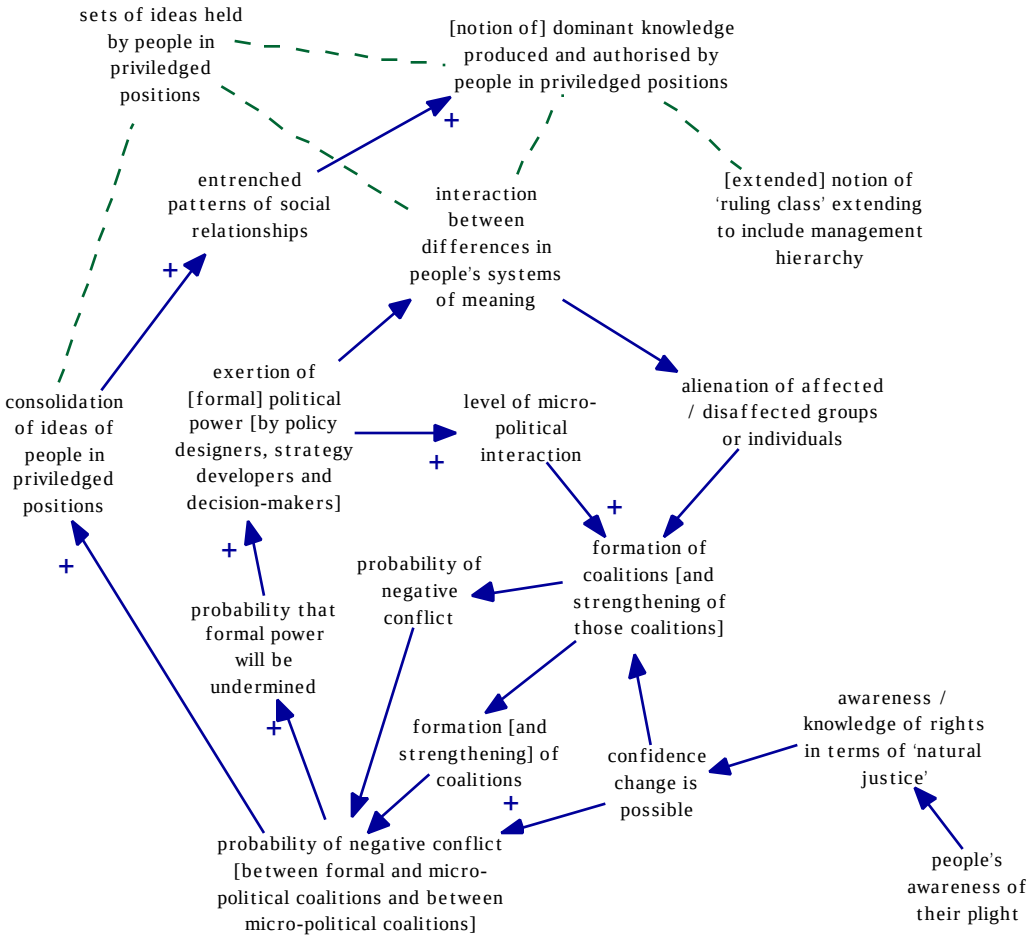

Figure 6. Concept Map – Systems of Knowledge-Power [7]

Finding Out About A Problem Situation – The Soft Systems Methodology

To enable understanding and analysis of the complex, dynamic interactions within organisations undertaking meaningful human activities, we need techniques such as Soft Systems Methodology (SSM). In this paper SSM is used as and example. Rather than describing the application of SSM, which is covered by Rosenhead (1989), Checkland (1990), Checkland and Scholes (1999), and ITSM 2000, and Wilson (2001), this paper analyses the component parts of the methodology, why they are needed and how they fit together. How they fit together is depicted in Figure 7.

The strength of SSM is that it acknowledges the complexity of human affairs. How to apply SSM is described by. SSM was developed by Checkland and has been in use, and continually evolving, for over 30 years. SSM exploits the following intellectual devices:

- *Rich Pictures*. Rich pictures, are used in SSM to convey ideas, and to facilitate dialogue. SSM exploits *semiotics*, that is, the use of icons and symbols in verbal and non-verbal communications.
- *Weltanschauung*. This German word stresses the importance of accommodating varying perspectives about a problem.

- *Systemicity*. This describes the complex, dynamic behaviour exhibited by systems, or systems-of-systems. The notion of *weltanschauung* is both important and complementary to *systemicity*.

Figure 7. Finding Out About a Problem Situation [8] [9]

Figure 7, is a concept map, which depicts diagrammatically how SSM is intended to assist actors, managers, key stakeholders and analysts, working together, find out about a problem situation. This does not describe how SSM is applied: this paper does not attempt to describe

[8] This depiction of SSM has been derived primarily from the textual description contained in the 30-year retrospective in SSM (Checkland and Scholes, 1999: A15-A17), as interpreted by the author of this paper.

[9] Detail shown in normal text is derived from the work of Checkland and Scholes. Augmentation,

SSM in detail. An excellent review is contained in the 30-year retrospective (Checkland and Scholes, 1999: A3-A61). Rather, the map concentrates on the relationships and interaction between concepts upon which SSM has been developed, or has evolved over many years. For a more recent and comprehensive treatment of SSM and its application, see Wilson (2001).

Like Mason and Mitroff's Strategic Assumptions Surfacing and Testing (SAST) (Mason and Mitroff, 1981), SSM sets out to foster, through the systematic use of such intellectual devices, the surfacing of assumptions and mental models, and development of exploratory discourse among people who are grappling with a problem situation.

Checkland is emphatic that learning is central to SSM (Checkland and Scholes, 1999: A40): SSM is a process of social inquiry that aims to bring about improvement in areas of concern by articulating a learning cycle (based on systems concepts) which can lead to action.

Unfortunately many who perceive SSM simply as a step-by-step process miss this important point. SSM is not a one-shot methodology. It is intended for iterative use, providing a vehicle for dialogue and discourse even as more and more becomes known about the problem at hand.

SSM is but one approach to finding out about a problem situation. It may be used on its own to inform the development of strategy or may be used to inform quantitative analysis.

Checkland admits that some people have difficulty with 'rich pictures' and training might be needed to develop their rich picture communications skills in a way with which they are comfortable. There are alternatives to rich pictures as vehicles to facilitating communications, knowledge elicitation and surfacing assumptions. Systems thinkers use various methodologies employ devices to assist thinking and communication about systemic issues. These include hexagons (Hodgson, 1992; Lane, 1993), rich pictures (Checkland, 1990; Wilson, 2001) and oval mapping (Eden and Ackermann, 1998).

Churchman (1971) and Mason and Mitroff (1973) identify preferred modes of gathering and processing information generally used by decision-makers. Choice of which intellectual, semiotic devices to use and how to communicate should be informed by client preferences regarding gathering and processing of information. Further, communications must be facilitated in a non-threatening way. Knowledge elicitation, assumption surfacing and testing can be threatening to individuals. These activities demand highly effective communications.

Managerial Decision-Making and Decision Support - Summary

Greatest gains accrue from careful attention to knowledge elicitation and problem conceptualisation. Action research suggests involvement of actors, managers and key stakeholders is essential from the very outset, and this involvement should continue throughout model building, strategy development and implementation. Engagement of actors, managers and key stakeholders will enhance development of understanding of the problem situation and subsequent commitment to strategy implementation.

There are many occasions when need to seek out views and perspectives of actors, managers and key stakeholders. We need to understand when these, and associated ingrained assumptions, might be flawed. Such awareness only comes from an understanding of complexity itself and a working knowledge of managerial cognition. This means we must be aware of how all actors might use mental shortcuts in both quick and deliberate decision making, and the difference between quick and deliberate decision making.

It also means we need to understand how various forms of cognitive behaviour may affect choices, decision and the way managers act. We need to know how and when prejudice, bias and politics and systems of knowledge-power might come into play. Given that these influences exist and come into play from time-to-time, we cannot trivialise problem conceptualisation without risk of basing model-building activities on invalid, biased assumptions or inappropriate choices and decisions. Any successful problem-solving methodology we might like to devise cannot be divorced from considerations of the way people think and feel, culture, their prior experiences, and their deeply ingrained assumptions. We need to appreciate this before we apply system dynamics modelling or any other methodology designed to enable an organisational change intervention or provide decision-support that managers will accept and trust, and use to enable their understanding and to facilitate the formulation of management strategies.

Understanding how actors, generally, and managers, specifically, think and why they think the way they do are not trivial issues: they can prove to be significant challenges. Eliciting and analysing what the various actors and managers know involves much more than simply asking them. Whilst they may have valuable operative knowledge, held either tacitly or explicitly, we need to be able to draw upon that knowledge to build qualitative and quantitative system dynamics models.

We also need to be able to engage them in ways that enhance their commitment to being involved in or taking specific action to change an organisation. New ways of thinking come about through modification of the mental models of actors and stakeholders involved in a problem situation, noting that those mental models may have been formulated years before and remain ingrained and personal. Commitment to act only comes about when actors, managers and key stakeholders have actually gone through a paradigm shift in their thinking.

This paper has revealed a number of these issues and has shown how certain elements of methodology are essential to assisting managers and analysts through processes of finding out about complex problem situations they are facing so they may better understand and manage them.

References:

Andersen, D.F. and Richardson, G.P., 1997, 'Scripts for group model building', in: *System Dynamics Review,* Vol. 13, No. 2, Summer 1997.

Argyris, C., 1994, 'On Organisational Learning.' Blackwell, Cambridge, Massachusetts.

Barnes, J.H., 1984, 'Cognitive biases and their impact on strategic planning', in: *Strategic Management Journal.* (5): 129-137.

Carroll, J.S. and Johnson, E.J., 1990, 'Decision Research: A Field Guide', Sage Publications, Newbury Park, California.

Checkland, P.B., 1990, 'Systems Thinking, Systems Practice', John Wiley & Sons Chichester UK.

Checkland, P.B. and Scholes, J., 1999, 'Soft Systems Methodology In Action', John Wiley and Sons, Chichester, UK.

Churchman, C.W., 1971, 'On the Design of Inquiring System: Basic Concepts in Systems and Organisation', Basic Books, New York.

Coyle, R.G., 2000, 'Qualitative and quantitative modelling in system dynamics: some research questions,' in: *System Dynamics Review* Vol. 16, No. 3, Fall 2000, System Dynamics Society, Wiley.

Davenport, T. H. and Prusak, L., 1984, 'Working Knowledge.' Harvard Business School Press: 26.

Diehl, E. and Sterman, J., 1995, 'Effects of feedback complexity on dynamic decision making', in: *Organisational Behaviour and Human Decision Processes*, 62, 2.

Doyle, J.K. and Ford, D.N., 1998, 'Mental models concepts for system dynamics research', in: *System Dynamics Review*, vol. 14, no. 1, Spring 1998: 3-29.

Eden, C. and Ackermann, F. 1998, 'Making Strategy: The Journey of Strategic Management.' Sage, London.

Espejo, R., 1994, 'What is systems thinking', in: *System Dynamics Review,* vol. 10, no. 2-3, Summer-Fall: 199-212.

Flood, R.L. 1999, 'Rethinking the Fifth Discipline: Learning Within the Unknowable.' Routledge, London.

Forrester, J.W. 1971, 'The impact of feedback control concepts on the management sciences, in: *Collected Papers of Jay W. Forrester*, Productivity Press, Portland Oregon.

Forrester, J.W. 1975, 'Counter intuitive behaviour of social systems', in: *Technology Review* no. 73, January: 52-68.

Forrester, J.W., 1985, 'The 'model' versus the modeling 'process'', in: *System Dynamics Review*, vol. 1, no. 1, Summer 1985. Originally System Dynamics Group Working Paper D-1621, Sloan School of Management, MIT, Cambridge Massachusetts, 1971.

Gigerenzer, G., Todd, P., and ABC Research Group, 1999, 'Simple Heuristics that Make Us Smart', Oxford University Press.

Hodgson, A.M., 1992, 'Hexagons for Systems Thinking', in: *European Journal of Operational Research* 59 (1) 64-84.

Hogarth, R.M., 1981, 'Beyond discrete biases: Functional and dysfunctional aspects of judgemental heuristics,' in: *Psychological Bulletin* 90: 197-217.

Homer, J.B., 1996, 'Why we iterate: Scientific modeling in theory and practice', in: *System Dynamics Review*, Vol. 12, No.1: 1-19, Spring 1996.

ITSM, 2000, Proceedings: International Conference on Systems Thinking in Management.' Deakin University, Geelong, Australia, 8-10 November 2000.

Kelly, G.A., 1955, 'The psychology of personal constructs: A theory of personality', Norton, New York.

Klein, G., 1998, 'Sources of Power: How People Make Decisions. MIT Press.

Klein, G., 2002, 'Intuition at Work,' Random House.

Kleinmuntz, D.N., 1993, 'Information processing and misperceptions of the implications of feedback on dynamic decision making,' in: System Dynamics Review, Vol. 9, No. 3 (Fall 1993): 223-237.

Kline, S.J. 1995, 'Conceptual Foundations for Multidisciplinary Thinking', Stanford University Press, Stanford, California.

Kosko, B. 1993, 'Fuzzy Thinking: The New Science of Fuzzy Logic', Harper Collins, London.

Lane, D.C., 1993, 'The road not taken: observing a process of issue selection and model conceptualisation', in: System Dynamics Review, Vol. 9, No. 3 (Fall 1993): 239-264.

Laukkanen, M. 1998, 'Conducting causal mapping research: Opportunities and challenges', in: Eden, C. and Spender, C. –J. (eds) *Managerial and Organisational Cognition*, Sage, London.

MacIntyre, A. 1981, 'After Virtue', Duckworth, London.

McKinnon, A.J. and Wearing, A.J., 1985, 'Systems analysis and dynamic decision making', in: *Acta Psychologica* 58: 159-172.

McLucas, A.C. and Linard K.T., 2000, 'System dynamics practice in a non-ideal world: modelling Defence preparedness', in: *Proceedings of System Dynamics 2000, International System Dynamics Conference,* The System Dynamics Society, Bergen, Norway, August 2000.

McLucas, A.C., 2001, 'An Investigation into the Integration of Qualitative and Quantitative Techniques for Addressing Systemic Complexity in the Context of Organisational Strategic Decision-Making.' PhD Dissertation, University of New South Wales, February 2001.

McLucas, A.C., 2003, 'Decision Making: Risk Management, Systems Thinking and Situation Awareness', Argos Press, Canberra.

McLucas, A.C., 2003, ' Incorporating Soft Variables Into System Dynamics Models: A Suggested Method and Basis for Ongoing Research', in: *Proceedings of 21st International System Dynamics Society Conference*, New York, July 2003.

Mason, R.O. and Mitroff, I.I., 1973, 'A program for research on management information systems', in *Management Science,* Vol. 19, No. 5: 475-487.

Mason, R.O. and Mitroff, I.I., 1981, 'Challenging Strategic Assumptions: Theory, Cases and Techniques', Wiley-Interscience, New York.

Meadows, D.L., 1989, 'System dynamics meets the press', in: *System Dynamics Review,* vol. 5, no. 1, Winter, 1989.

Miller, G.A., 1956, 'The magical number seven, plus or minus two: Some limits on our capacity for processing information.' In: *The Psychological Review*, vol. 63, no. 2: 81-97.

New Scientist Magazine, 1999, 'Decisions decisions.' September.

Nutt, P.C., 1989, 'Making tough decisions: Tactics for improving managerial decision making', Jossey-Bass, San Francisco.

Richardson. G.P., 1991, 'Feedback thought in social science and systems theory', University of Pennsylvania Press, Philadelphia.

Rittel, H., 1972, 'On the planning crisis: Systems analysis of the 'first and second generations'', *Bedriftsokonomen,* NR8: 390-396.

Rosenhead, J. (ed), 1989, 'Rational analysis for a problematic world: Problem structuring methods for complexity, uncertainty and conflict', John Wiley & Sons, Chichester.

Ryan, M.J., 1997, 'An introduction to battlefield command systems,' in: *Australian Defence Force Journal,* No. 124, May/June, 1997: 7-15.

Senge, P., 1990, 'The fifth discipline: The art and practice of the learning organisation', Doubleday, New York.

Sterman, J.D. 1989a, 'Misconceptions of feedback in dynamic decision making', in: *Organisational and Human Decision Processes,* no. 43: 301-335.

Sterman, J.D. 1989b, 'Modeling managerial behavior: Misperceptions of feedback in a dynamic decision making Experiment', in: *Management Science,* vol. 35, no. 3: 321-339.

Sterman, J.D. 1989c, 'Misperceptions of feedback in dynamic decision making', in: Milling, P.M. and Zahn E.O.K. (eds), *International System Dynamics Conference: Computer-Based*

Management of Complex Systems. International System Dynamics Society, Stuttgart: 21-31.

Sterman, J.D., 1994, 'Learning in and about complex systems', in: *System Dynamics Review,* vol. 10, no. 2-3, Summer-Fall: 291-330.

Sterman, J.D., 2000, 'Business Dynamics: Systems Thinking and Modelling for a Complex World' McGraw-Hill.

Vennix, J.A.M., 1996, 'Group model building: Facilitating team learning using system dynamics', John Wiley and Sons, Chichester, UK.

Vickers, G., 1970, 'Freedom in a rocking boat.' Pelican, London.

Weisbord, M.R., 1987, 'Productive workplaces.' Jossey-Bass, San Francisco.

Wilson, B., 2001, 'Soft Systems Methodology: Conceptual Model Building and its Contribution,' John Wiley & Sons, Chichester, UK.