The worst failure: repeated failure to learn

Alan. C. McLucas

Principal Consultant Codarra Advanced Systems, Canberra, ACT Australia.
E-mail: alan.mclucas@codarra.com.au
Doctoral Candidate, School of Civil Engineering, University College, Australian Defence Force Academy

ABSTRACT: *Research into integration of hard and soft systems methodologies for solving messy problems highlighted the need for an in-depth understanding not evident in systems thinking and system dynamics literature. The search for better insights was built around concept (cognitive) mapping of reports of Boards of Inquiry, Royal Commissions and Coronial Inquests. It was found that surrounding each accident were myriad factors and high levels of interconnectedness. Common to all cases were failures by almost everybody to recognise emergent patterns of events. There was repeated failure to understand, and to learn. This paper demonstrates that the key to correcting repeated failure to learn starts with recognising these recurring patterns.*

Keywords: Concept / cognitive mapping, systemic structure, systemicity, understanding, learning, risk management.

INTRODUCTION

A BHP-owned coal mine at Moura in central Queensland in 1994 was the scene of an explosion in which 11 men lost their lives. A build up of heat and methane in the mine had been detected weeks beforehand: seemingly, this was ignored. The consequence of ignoring this and other indicators was disastrous (Hopkins 1999).

On the evening of 12 June 1996, during a routine training exercise near Townsville in Queensland, two Army Black Hawk helicopters collided and crashed to the ground in a massive fireball. 18 soldiers died and 12 were injured (Australian Army 1996). Many similar exercises had been practiced, why did this one go horribly wrong?

One quiet Sunday afternoon in July 1997, a young girl Katie Bender died when she was struck in the head by a fragment of steel having 100 times the energy of a bullet fired at point blank range. She, her family, and thousands of spectators had come to witness a highly publicised spectacle, the demolition of a community hospital in the centre of Canberra (ACT Magistrates Court 1999). The shot-firer who laid the explosives was charged with manslaughter, but was he really responsible? Some wanted the Chief Minister of the Australian Capital Territory to resign, arguing she interfered and was responsible through her unwelcome involvement.

On 5 May 1998, a fire in the engine room of HMAS WESTRALIA resulted in the deaths of four Naval personnel. The fire was caused by diesel fuel from a burst flexible hose spraying onto a hot engine component. Flexible hoses of an unapproved type had been recently fitted to replace rigid metal ones which continually weeped small amounts of fuel (Department of Defence 1998). A minor problem was fixed only to replace it with a much more serious one, with death being the consequence.

At about lunchtime on 25 September 1998, a heat exchanger in Esso's Longford Gas Plant No.1 fractured, releasing hydrocarbon gases and liquid. The resulting explosions and fire killed two workers and injured eight others (Parliament of Victoria, 1999). Gas supplies to millions of customers in the State of Victoria were disrupted for months. A safety audit conducted by the parent company Exxon only months before had given the plant a clean bill of health.

The Reports of the Royal Commissions, Boards of Inquiry and Coroner's Inquests each identify a series of factors combining at a single culminating point, with catastrophic results. The naive might argue that each 'accident' was the product of serendipitous events which could not have been predicted. Chance certainly played a critical part, but only in the terminal stages. First, the circumstances had to be created by man: only then could chance play its final tragic role.

The research described in this paper sought to identify pre-conditions for accidents, not by looking at what existed immediately before but by looking at what was lurking in the weeks, months, or years beforehand. The common threads found were:

a. A litany of systemic failures existed at all levels in organisations involved.
b. Breakdowns in communication existed.

c. Existence of type of organisational culture best described as a 'culture of denial', denial that there were problems.
d. Failure to understand and to learn.
e. Failure to manage risks.
f. Each accident was avoidable, though not predictable in terms of exactly where, or when, or in what form.

It is most disturbing that the worst failure, the failure to learn, lay at the heart of each precursor situation.

RESEARCH FOCUS

The background to this paper lies in a quest to design powerful problem-solving techniques which integrate soft and hard systems analysis (McLucas, 2000). As this research progressed there came a growing realisation that insufficient was known about the nature of 'messy' (Vennix, 1996) problems. Accident cases proved to be an ideal source of the required insights. In particular, except that in the accident cases the sequences of events resulted in death, the precursor situations, what occurred some time beforehand, were strikingly similar to problems we face daily.

By focusing on what was occurring in those weeks, months or years beforehand, it was possible to build a picture of what was considered 'normal'. With 20/20 hindsight we recognise the scene was being set for disaster to occur. Research found that the 'normal' situations existing before each of these accidents involved detail complexity, dynamism, feedback, and delay mechanisms. That is worrying given known human limitations in predicting behaviour under such conditions (Sterman, 1989a., b., and c.).

Many 'failures' occur in dealing with problems under these 'messy' conditions. The explanation offered for this is a failure to appreciate the nature of the complex problems at hand. Perhaps this should galvanise us to forearm ourselves with tools for analysing detail and dynamic complexity, as outlined in this paper.

Selection of Case Studies

Cases for study:
a. had to be drawn from real life: they had to be 'messy' problems (Vennix 1996, 13);
b. had to be extensively documented;
c. needed to be reported with high levels of objectivity and reliability; and
d. had to withstand scrutiny.

Investigations conducted by the judiciary in the wake of serious accidents involving death were found to fit these requirements. They are frequently subjected to critical review by the legal profession, researchers and litigants alike. This ensures they are robust, objective and reliable.

RESEARCH METHODOLOGY - USING CONCEPT MAPPING

Concept mapping was used to graphically depict important elements of the evidence, the relationships between those elements, and thoughts behind legal deliberations. Maps summarised what the judiciary took months, or in some cases years, of investigation and deliberation to conclude.

Ackermann, Eden, and Williams, 1997, used concept mapping (they prefer 'cognitive mapping') to build compelling arguments to defend a case in litigation over the management of the Channel Tunnel Project. A similar technique was used, but rather than building the maps *ab initio*, the maps were developed from source material in the form of the various Reports. This technique was used to analyse each of the cases. In this paper the Black Hawk helicopter crash is used to demonstrate how mapping was done.

In outline, concepts were first identified. A concept is a notion, idea or action expressed as a call to action in positive terms, that is affecting connected concepts in a positive way (Eden and Ackermann, 1998.a.: 160). Then, the logic of the links between them was determined, recorded and analysed. Banxia© *Decision Explorer* software was used to facilitate building concept maps depicting the cognitive structure of primary interest here.

Fuzzy Logic Links Between Concepts

Unlike digital computers which are programmed to operate using classical logic, human brains operate on 'fuzzy logic'. In many domains people do not have all-or-none convictions about whether something is true (Pinker, 1997, 101; Kosko, 1993). Three types of 'fuzzy logic' links were needed:
a. Causal. Causal relationships are represented by arrows, where each arrow means 'leads to … , such as is expressed in the statement 'smoking *leads to* heart disease. This does not mean all smokers will suffer from heart disease but suggests there is strong evidence to this effect, noting all people who smoke will be

affected, at least, to some extent. 'Fuzzy logic' underlies the 'leads to' causality. A delayed effect on a causal link may be marked by a 'T', signifying a temporal qualification.

b. Connotative. Connotative relationships are depicted by lines without arrowheads. Here causality may act in either direction at different times or under varying circumstances. This type of link suggests causality is ill defined, open to interpretation, or requires further investigation.

c. Conflict. Conflicting relationships are a special case of a connotative relationship, but where the concepts at the ends of the arrow cannot co-exist without conflict or a state of stress being created.

How maps were developed and interpreted is explained below in the context of the Black Hawk Helicopter Crash case study.

Black Hawk Helicopter Crash - Case Study Overview

On that fateful day in June 1996, at the High Range Training Area near Townsville in Queensland, during training to build individual and team skills required for Counter Terrorist (CT) and Special Recovery Operations (SRO), there was a catastrophic training accident. It occurred on the second day of a series of training activities designed to develop and retain high readiness on the part of the Special Air Service Regiment and the 5th Aviation Regiment. These soldiers were training to undertake operations to recover Australian citizens should they become the victims of a hostage situation, such as has occurred in many parts of the World.

After the accident, an extensive and thorough Inquiry was conducted. It lasted three months. The Board of Inquiry Report and related proceedings comprise 17 volumes. The following reviews the Chief of Army's Report to the Minister for Defence.

Mapping of Factors Contributing to the Accident

Individual concepts are numbered for identification purposes only. Numbering is not intended to suggest importance or priority. Where a choice exists for placement of concepts on a map, more important ones are placed towards the top. Placement of concepts is balanced against the need for overall compactness of the map. The latter requires concepts to be positioned adjacent. Maps are easier to understand when read from the bottom up. Pairs of concepts linked by unambiguous causality can be progressively built into chains. In the first pass, these do not have to be complete. However, the critical requirement is to check that every link can withstand scrutiny of validation that one concept 'leads to …' the connected concept as shown by the direction of the arrow.

As the map develops it might appear as depicted at Figure 1, noting that the diagram may have to be re-drawn several times to tidy it. An alternative is to write concepts on individual Post-it® Notes. These can be placed on a whiteboard, firstly in clusters, then connected by arrows to depict causality. This technique works well in a group setting, or workshop. Eden and Ackermann, 1998, use a variation on this they call the Oval Mapping Technique.

Concept maps serve to present concepts graphically and to facilitate detailed step-by-step analysis. Individual maps accommodate differing points of view. Used carefully and consistently they are also very useful in highlighting omissions and errors in logic.

Figure 1, below summarises Chief of Army's Report to the Minister for Defence on the findings of the Board of Inquiry. It should be noted that this Figure depicts on a single sheet of paper, months of detailed investigation and deliberation. It warrants close scrutiny. Reading the map can start at any point, although starting from the bottom is recommended. Causal links should be read first. Follow each series of links through until each has been read and understood. The next step involves considering the relevance of individual concepts. Whilst, for example, it may be readily accepted that Concept No 23, *high pilot separation rates for pilots* led to *loss of experience base,* there is little information about the extent of the problem.

When the whole map has been read and understood, the overall structure should be viewed by standing back from the detail, taking a world view or *weltanschauung*, and contemplating the systemicity [that is, the system-like behaviour exhibited by complex systems-of-systems] (Checkland 1990; Checkland and Scholes 1999).

This facilitates thinking about:

a. concepts connected in causal loops, such as 22 – 23 – 25 – 27 – 22, 22 – 24 – 25 – 27 – 22 , and 22 – 24 – 26 – 22;

b. nodes where several arrows enter or leave, such as 4, 33, 22, 14 with nine, six, six and six link arrows or lines respectively; and concepts connected in loops involving a mix of causal and connotative links, where the latter are considered as bi-directional causal links following direction of the loop at least some of the time, such as 4 – 3 – 13 – 2 – 4 and 4 – 30 – 31 – 4.

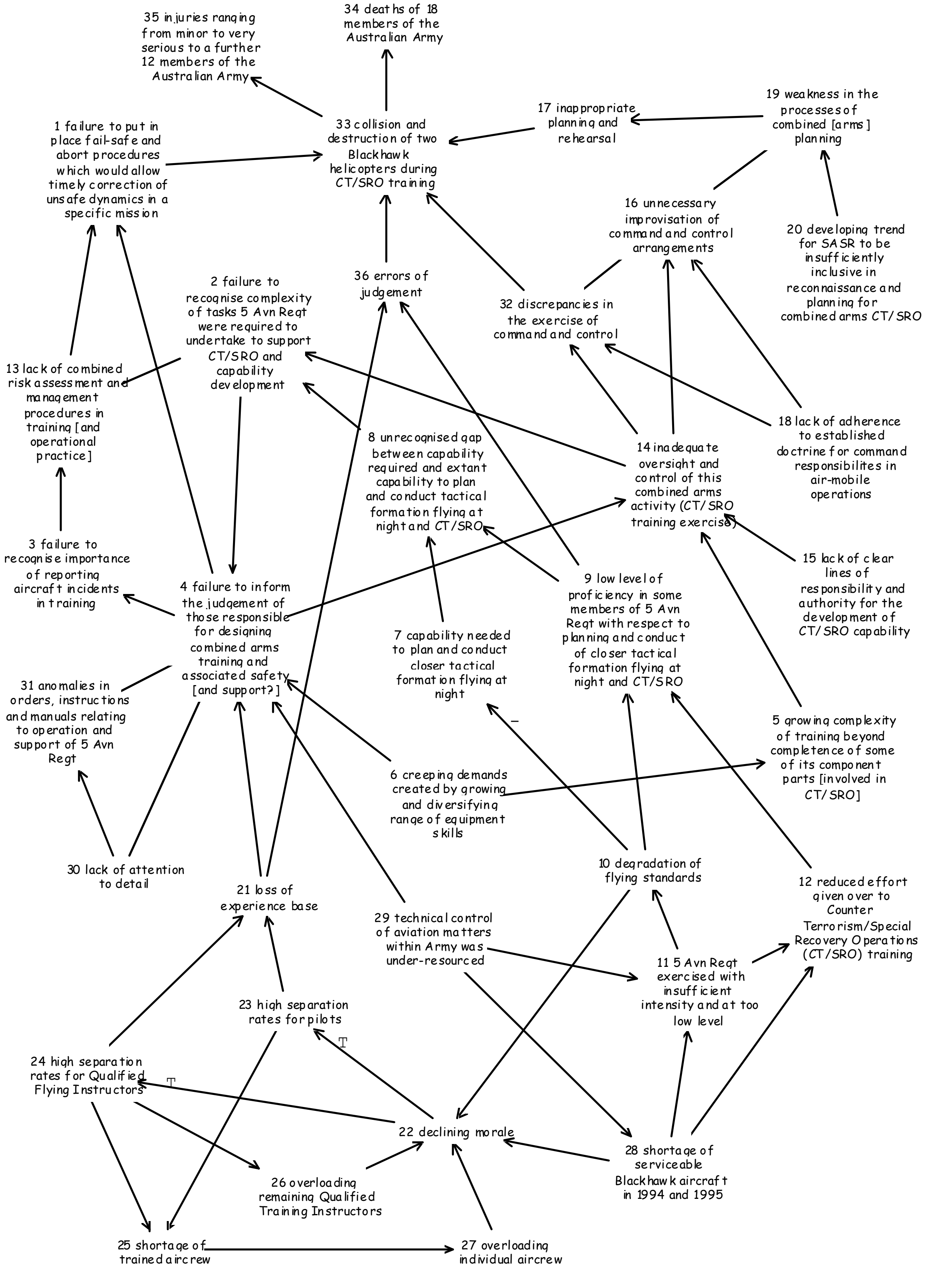

Figure 1. Concepts Included in Chief of Army's Report to the Minister for Defence

A *shortage in serviceable aircraft in 1994 and 1995*, noting that the crash occurred in June 1996, contributed to *declining morale*, as did *a degradation of flying standards*. Those responsible for managing *declining morale* did not have a holistic view. In addition to aircrew matters, such a view might have included factors impacting on pilot training and aircraft availability, for example. If they had, they would have realised that the problem was more complex and highly influenced by organisational politics, resource availability and funding issues.

Declining morale was an issue in itself. It was symptomatic of more deeply rooted problems, some going back several years. It was a critical indicator of a set of highly interconnected problems. *Declining morale* could not be rectified overnight. For example, it would take several years to recruit and train pilots and a longer time for qualified flying instructors. This was a complex, dynamic problem exhibiting classical counter-intuitive response to strategies designed to fix it. It was never addressed effectively.

Concept 4 is critical when considered in the light of the feedback loops, 4 – 14 – 2 – 4, 4 – 3 – 13 – 2 – 4, and 4 – 30 – 31 – 4. Note should be taken of the connotative links 4 – 30, 31 – 4, and 13 – 2 in the latter two feedback loops. These links are open to interpretation. They are considered to be pseudo-feedback loops because for at least part of the time their influence is in the same direction as the causal links.

Concept 4 is critically important. It is what Coyle (1996, 222) calls a 'pressure point' and Senge (1990, 64) calls a 'leverage point'. Changing Concept No 4 or the nature of the links to or from it, that is the extent to which it affects other concepts or the influence it has, may have significant influence on the likelihood or consequence of possible outcomes. Managing Concept No 4 is very likely to produce enduring improvements. Both Senge and Coyle agree that tackling a difficult problem is often a matter of seeing where the leverage lies.

Indeed, it is suggested that any strategy to avoid training incidents or accidents in the future would be directed at correcting critical Concepts such as those identified by our analysis, especially concepts 22, 4 and 14. The Board of Inquiry's observation that *failure to inform the judgement of those responsible for designing combined arms training and associated safety* … suggests the worst failure, the failure to learn.

Breakdown in Management of Risks

Before the Black Hawk helicopter crash occurred, there was a breakdown in the understanding of complexity involved, failure to learn, and a breakdown in risk management. This was brought about, at least in part, by:

a. misunderstandings of risks, their likelihood and consequences;
b. a lack of appreciation of mechanisms and systemic structures, feedback and delay, that underlie dynamic complexity, and contribute to dynamically changing risk; and
c. 'systems of knowledge-power' and 'systems of meaning' (Flood, 1999) issues which militated against effective risk management.

Winding the Clock Back

In each of these case studies, the clock was wound back as follows:

a. Once the complete map was developed, concepts that could not have existed before a selected point in time were removed (Banxia© *Decision Explorer* has the facility to allow concepts to be hidden from view).
b. The resultant map, depicting circumstances that existed well before the final tragic events, was analysed. Analysis then took the form of determining what would have been reasonably known at the time. [Note: A concept taken from British Law is that of a 'reasonable man'. A reasonable man confronted with the circumstances suggested in the evidence might be expected to act in a way seen under law to be 'reasonable'. This legal device is designed to facilitate legal argument or judicial rationale.] The resultant map is a revelation of what might be reasonably considered to exist to have existed or to have been known at the chosen point in time.
c. Systemic structures were identified and analysed as in the Black Hawk helicopter case.

Once having developed an understanding how these messy problems, viewed as one might view the map of a large city, utilises one of the strongest attributes of the human mind, the ability to recognise patterns (Carroll and Johnson 1990).

CONCLUSIONS

Maps for each case study, some containing 200-300 concepts (McLucas, 2000), exhibited characteristics patterns and underlying structure :

a. a single central business district (one main node, or a small number of critical and highly influential nodes);
b. a number of highly interconnected business districts - choke points which might be likened to 'pressure points' (Coyle 1996, 222) or 'leverage points' (Senge 1990, 64); and

c. distribution systems (causality, connotation or conflict) linking the business districts.

In these cases there is a common node which we could describe as *failure to understand, failure to learn and [as a result] failure to manage risk*.

There is strong evidence that managers and strategic decision-makers alike have underdeveloped appreciation of the nature of complexity with which they must deal. They are often unaware of emergent patterns of events and behaviour that suggest underlying systemic structures.

Politics, systems of knowledge-power, compartmentalisation of information, incompetence, ignorance, resistance to having ingrained and potentially erroneous assumptions surfaced, mistrust of analytical methods, bounded rationality and defensive routines are all part of the organisational decision-making environment. They militate against the recognition of the emergent patterns and understanding of underlying structures.

Our prime objective should be to use techniques such as that demonstrated here to develop enhanced understanding and learning. This must be the highest priority: to correct the worst failure, repeated failure to learn. This is where the greatest gains are to be made.

REFERENCES

Ackermann, F., Eden, C. and Williams, T. 1997, 'Modelling for litigation: Mixing qualitative and quantitative approaches' *Interfaces*, 27, pp. 48-65.

ACT Magistrates Court, 1999, 'Inquest Findings, Comments and Recommendations into the death of Katie Bender on Sunday 13th July 1997 on the Demolition of the Royal Canberra Hospital Acton Peninsula, ACT'

Australian Army, 1996, 'Report of the Board of Inquiry into the Mid-Air Collision of Army Black Hawk Helicopters A25-209 (Black 1) and A25-113 (Black 2) at Fire Support Base Barbara High Range Training Area, North Queensland on 12 June 1996'.

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.

Coyle, R. G. 1996, 'System dynamics modelling: A practical approach', Chapman and Hall, London.

Department of Defence, Australia DPUBS: 32871/98 1998, 'Report of the Board of Inquiry into the Fire in HMAS WESTRALIA on 5 May 1998'.

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

Eden, C. and Ackermann, F., 1998.b., 'Analysing and comparing idiographic causal maps' in *Managerial and organisational cognition: Theory methods and research*, Eden, C. and Spender, J.-C. (eds), Sage, London.

Flood, R.L., 1999. 'Rethinking the fifth discipline: Learning within the unknowable' Routledge, London.

Hopkins, A., 1999, 'Managing major hazards: the lessons of the Moura mine disaster'
Allen and Unwin, Sydney.

Kosko, B. 1993, 'Fuzzy thinking: The new science of fuzzy logic', Harper Collins, London.

McLucas A.C., 2000. PhD Dissertation. 'An Investigation Into the Integration of Qualitative and Quantitative Techniques for Addressing Systemic Complexity in the Context of Organisational Decision-Making.' University of New South Wales. November, 2000.

Parliament of Victoria, 1999, 'The Esso Longford Gas Plant Accident Report of the Longford Royal Commission', No. 61 - Session 1998-99, June 1999.

Pinker, S. 1997, 'How the mind works', Penguin.

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, pp. 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, pp. 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.* pp. 21-31, International System Dynamics Society, Stuttgart.

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

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