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# Exploring experiences of learning and knowing at work: Findings from a public sector case study

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## Abstract

*Organisational theorists have been using complexity theory for some years now to provide new perspectives on productivity and performance in organisational systems. While much of the work involves investigation through computational modelling (Holland 1995; Morel and Ramanujam 1999), some theorists and researchers are applying conceptual models of complex adaptive systems theory to provide new insights on organisational process, behaviour and outcomes (see, for example, Anderson 1999; Stacey 2001; 2003b; 2003a). This paper describes the findings of research investigating organisational members' experience through conceptual models provided by complex adaptive systems theory.*

*In this study participants' narratives about learning and organisational knowledge in a public sector organisation were collected and analysed in groups. Participants developed categories of themes that mirrored those of complex adaptive systems (Holland 1995), focusing on the dynamic of localised groups and their outcomes (aggregation), identification of others from whom to learn or with whom to solve problems and share knowledge (tagging), the impact of the unanticipated on process (non-linearity), the paths for information flow and knowledge sharing (flows), diversity, assumptions about the organisation and its processes and rules (internal models) and repetition and recombination (building blocks).*

*The findings offer novel insights into the structures, dynamics, practices and processes that influence (both positively and negatively) participants' learning and their use and development of organisational knowledge. Themes that emerged around organisational members' struggles to perform in increasingly complex environments and their strategies for improving 'fitness' (Holland 1995) within organisational structures are especially interesting in this forum on knowledge, productivity and performance in organisations.*

## Introduction

A convergence of themes in organisational learning, knowledge management and workplace learning leads to opportunities for their integrated investigation in support of more holistic approaches to learning and knowing in organisations.

Complexity theory is used as an integrating device in a variety of contexts (McElroy 2000; Thompson Klein 2004). In the study described here complexity theory was used as a sensitising device in development of methodology and as an heuristic tool in the analysis of data.

The findings of the study illustrate patterns of behaviour within a public sector organisation that reflect those of complex adaptive systems. Participants' narratives about learning and knowing in and with their organisation provide enormous insight into the relationship between the two. The findings illustrate the value of metaphors arising from complexity theory in making sense of knowledge within this organisational context.

## **The study**

This study arose from a nagging discomfort with the theoretical and practical separation of knowledge and learning within organisations. In traditional settings, knowledge management 'sits with' the information systems section of organisations and focuses on capture and dissemination of explicit knowledge. Workplace learning, on the other hand, 'sits with' human resources and focuses on transfer of primarily stable and explicit knowledge from expert to novice.

Theory, however, has progressed over the past decade or so to reveal a close relationship between the two fields as well as a clear resonance with organisational learning theory. Convergence of concepts, particularly in relation to the elusiveness of knowledge, its construction within and between individuals, its emergence through individual and collective engagement with the workplace, the role of sense- or meaning-making, a focus on the process rather than the content of learning, the role of the social in knowledge development and insights gained through post Cartesian perspectives on organisations leads to more holistic understandings of learning and knowing in organisations.

This study builds from this convergent theoretical base to explore the experiences of public sector employees. It endeavours to discover the ways in which these organisational members learn in their organisation and how this learning is related to the knowledge of the organisation.

## **Method**

This research was designed to explore the experience of individuals and collectives. Complexity theory suggested methods that aimed to maximise interaction, allow for emergence of the novel as a result of the interaction, accommodate self-organisation, and value diversity. As a result, the research followed a grounded theory approach in which naturalistic groups engaged in narrative circles and then later analysed the narratives in a sense-making workshop. This method conforms to a 'theory elaboration' (Vaughan 1992) model of grounded theory and accommodates small deviations from a standard grounded theory approach (Strauss and Corbin 1998) in its use of group coding (sense-making).

## **Data collection and analysis**

Narratives were collected in three narrative workshops each of which involved between six and eight participants. In these workshops participants were provided with very little direction, the researcher beginning each session by informing participants that the words 'learning' and 'knowing' should be used in their broadest sense, allowing narratives to illustrate the meanings constructed from these terms both individually and within the group. The group was then encouraged to share stories about their learning experiences and how these related to the knowledge that the organisation holds.

Each narrative workshop ran for two to three hours and after transcription a metanarrative was developed from the three workshops. This metanarrative was then taken to a workshop where the group comprised members of each of the three narrative groups. After some coaching on the process of coding (again, following Strauss and Corbin 1998) the group worked with the narrative to develop coding terms against the narratives.

After exhausting the metanarrative, the group had developed nearly one hundred codes which they then clustered into themes. The researcher then worked with the codes, the clusters and

the entire data set (including the recorded sense-making session) analysing the pattern of codes that emerged.

## Findings

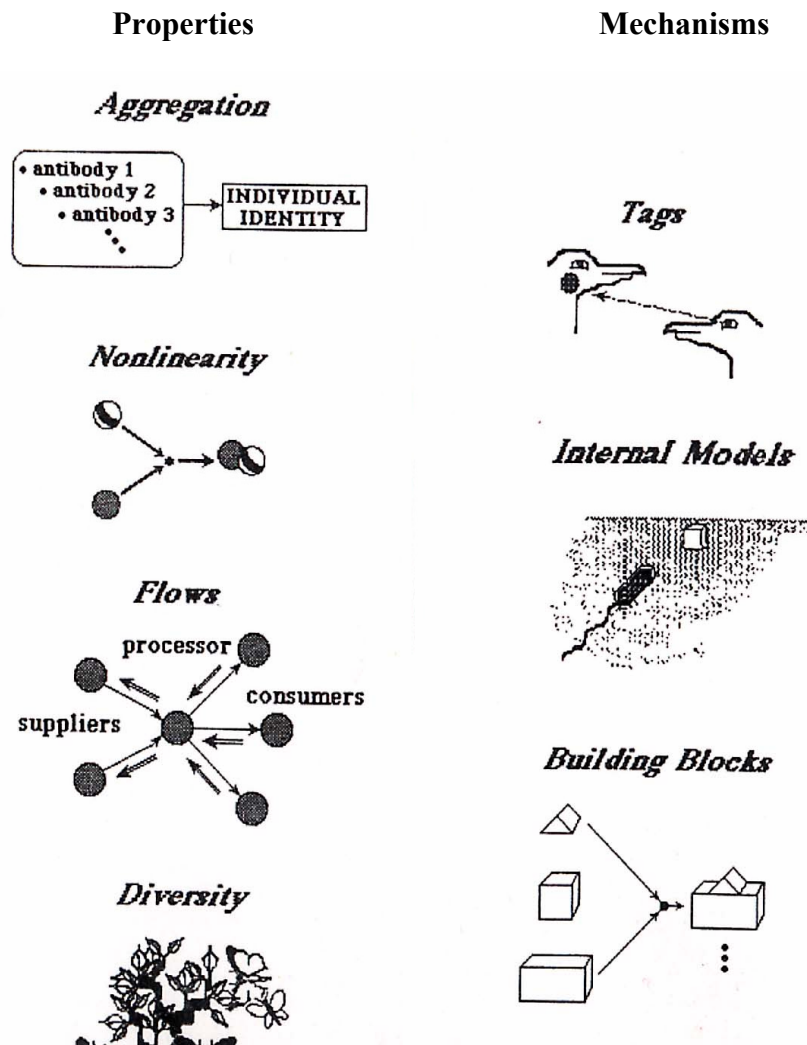
Categories emerged through group analysis that broadly reflected the properties and mechanisms of complex adaptive systems (Holland 1995) and provided a framework for analysis of data. The framework was used as a heuristic device, the categories used broadly as metaphors rather than specifically as prescriptors. These categories served as 'building blocks' for combination and recombination in relation to other theories of complexity and complex adaptive systems.

As with any model, the complex adaptive system model provides a framework for focusing attention on some aspects of the data, while blinding the research to others, in Holland's words, 'We decide which details are irrelevant for the questions of interest and ignore them' (1995: 11). In using the metaphors provided by Holland the researcher recognises that frameworks and models constrain discussion, focusing it only on those characteristics provided by the model. This effect can be moderated by attempts to critique thoroughly the model's application in this field and the data itself. As Vaughan stresses, 'It is the "loose ends," the stuff we neither expect nor can explain, that pushes us toward theoretical breakthroughs. If the guiding theoretical notion truly is used heuristically, case analyses should raise additional questions relevant to understanding the concept, model, and/or the theory being considered' (Vaughan 1992: 176). For this researcher, analysis is undertaken in the hope of providing new insights on organisation through the application of theory as well as new insights into the theory itself.

Holland (1995) describes complex adaptive systems in terms of their properties (or characteristics)<sup>1</sup> and mechanisms. His model includes seven basics of complex adaptive systems.

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<sup>1</sup> While Holland (1995) uses the term 'property' to describe the basic of attributes of complex adaptive systems, this researcher uses the term 'characteristic' to eliminate confusion resulting from Strauss and Corbin's (1998) use of the term in describing themes in grounded theory processes.



**Figure 1: Holland's (1995: 38) properties and mechanisms of complex adaptive systems**

In this study, the properties as described by Holland prompt the question, 'What are the characteristics of organisational members' experiences of learning and knowledge development?' Mechanisms prompt the question, 'What are the mechanisms by which organisational members learn and develop organisational knowledge?' While these dimensions are represented separately, the properties and mechanisms work together in a system of learning, knowledge development, sharing and institutionalisation.

### **Aggregation**

Individuals work within organisations through 'Different patterns of relationships [that] constitute ways of coping with informational complexity' (Rhodes and MacKechnie 2003 citing Boisot and Child 1999: 64). In this study, the ways in which aggregates of these individual, adaptive agents combine to deal with the complexity of their context is fascinating. The property *aggregation* focuses attention on features of the group that relate to the responses of groups to their environment, the nature and form of that grouping and to the outcomes of aggregation.

Organisational members' narratives feature *aggregation* as a primary theme. In this study, and in in vivo terms, *aggregation* includes a set of concepts about a group's ability to *find its own order* (its self-organising capacity (Stacey 2001), in *meeting the need* (or fitness function Holland 1995) of the environment, and adaptive responses through *work around* (outcomes of aggregate behaviour). This cluster of themes reflects the experience of learning and novelty that arises from group (aggregate) behaviour.

This code *aggregation* provides a descriptor, which allows for consideration of groups as interacting, connected collection of agents which are self-organising and focuses attention of the outcomes of the dynamic group in broader, complex and coherent learning and knowledge outcomes.

<p>Participants spoke of their experiences in groups that came together to solve a problem and developed through interaction with each other within their environment.</p>	<p><i>'I worked in another team ... that was self-empowered like that, and was able to find its own order... because people felt so comfortable, and because it sort of was like its own little hothouse, if you like, and it was able to generate all sorts of innovative and different approaches to different things'</i> (Participant 3.1)</p>
<p>Similarly, individuals talked about the performance level of such groups, 'high performing' aligning with 'self organising', as in this vignette from 3.4, an individual working within head office developing learning products for customer service staff.</p>	<p><i>'It was just one of those circumstances where, everything had to, was under review if you like, and so, and not necessarily from a point of view of that management had said, "It's time to look at everything", but other outside influences, ...the people who made up the team were all relatively new, but from a huge diverse range of backgrounds... You know, we had what appeared to be a huge amount of work to do, and lots, I guess, lots of different people and a lot of very different dynamics. And one of the interesting dynamics we had was that a lot of us were, ... we were operating off very high stress levels and so it was almost like our work was our outlet, and we just did some absolutely amazing things, and I think it's because we were all complementary skills, I suppose and that we were working off these very high energy levels...so we were able to really revolutionise, it's a big word, but in [that part of the organisation] it's pretty much what happened'</i> (Participant 3.1).</p>

The second important theme within the aggregate category, *improving fitness*, grew from the gathering of themes around individual and collective attempts to *meet the need* of the organisation's environment, *find solutions* to problems encountered and *cut it* as an effective organisational member.

<p>In complex adaptive systems, ‘...agents are presumed unable to forecast the system-level consequences of their individual choices, and so they optimise their own fitness, not that of the organisation’ (Anderson 1999: 220). Examples of this phenomena abound in the narratives and participants appear aware of the interaction of the aggregate in their individual pursuit of fitness.</p>	<p><i>‘... but we’ve pushed them out of the mix now because they’re not useful’</i> (Participant 1.2).  <i>‘... more of a hindrance than a help’</i> (Participant 1.3).  <i>‘exactly’</i>(Participant 1.2).</p>
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Similarly, participants were aware of their use of others within the aggregate, their payoff related to the behaviour of other agents within the agent’s ‘adaptive landscape’ (Anderson 1999: 200). Overwhelmingly, though, participants talked about the impact of other individuals on the adaptation of the aggregate to its environment.

<p>In contrast to the assumptions of linear and formal interaction, these participants talked about their reliance on interaction with other agents within their environment for improving their own individual fitness.</p>	<p><i>‘But it’s always been a case of, you know, to be professional, you have to keep a distance. And that’s not necessarily true in this type of environment. In fact, to actually get to the end result quicker, to have a good relationship with people who you’re working with ...’</i> (Participant 1.1).</p>
<p>Participants told of their struggles to increase their fitness within constantly shifting local environment through interaction with it and aggregate members. They were aware, too of their reliance on the behaviour of other member is the ability to succeed within the environment. Examples of problem solving within the ‘frantic palaver’ (Participant 1.2) that is the everyday environment of organisational members were offered most frequently through ‘workarounds’. Participants described workarounds as a vital source of learning for operational staff and the outcomes valuable organisational knowledge.</p>	<p><i>‘[this organisation] is better than any organisation I’ve been a part of, or read about. Anyone. They’re the best at workarounds. They are the best. [General laughter] We have such a capability within the organisation to be responsive to workarounds’</i> (Participant 1.2).  In clarifying this term, the researcher asked,  <i>‘Someone talk me through an example of a workaround’</i> (Researcher).  <i>‘Every day’</i> (Participant 1.2).  [Energetic laughter]  <i>‘An example, OK. And this is at ground level again. People who would [detail of complex problem that customers have with a particular service and the face-to-face worker ‘fiddling’ the system to make sure that the customer receives the correct service] At the same time, we’ve got KPIs, we’ve got key performance indicators that these staff have to be meeting so what they were doing is [detail of the ‘fiddle’] ...so the system won’t have a conniption [deleted detail] and then another team, they’ll just say, ‘let’s just stockpile, and when we get to</i></p>

	<i>this point, we'll work around again'</i> (Participant 1.3).
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So, workarounds are innovations designed at the local level to deal with the conflict between the struggle for the organisational member to maintain effectiveness in their environment and the rules of the organisation.

Participants had a keen sense of belonging to small, localised, problem-focused groups and discussion around interrupts or disconnects between levels of aggregation were associated with this.	<i>'Well, if you're in the local office, then, then, your whole experience with [this organisation] is what happens in that office, pretty much, if you've never been outside ... unless, unless it's got connections to real people and relationships and, and what you sort of perceive as relating to your work. It's not, there's nothing very real about it'</i> (Participant 3.4)
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### Tagging

Related to aggregation is the category *tagging* which gathers together themes around the ways in which organisational members identify others with whom to develop solutions to workplace problems, increase *fitness function* (payoff (Anderson 1999) or value (Rhodes and MacKechnie 2003), and *shift the outcome* for the organisation in facilitating continuing change. This category includes narrative and discussion about how organisational members find each other, what foci attract them and how they create boundaries around their aggregate through selection of agents with whom to interact and how these aggregates build hierarchies.

Holland (1995: 12) describes *tagging* as a '... mechanism that consistently facilitates the formation of aggregates ... and boundary formation in *cas* [complex adaptive systems]'. Because tags facilitate selective interaction they are important to agents in establishing groups for specialisation, cooperation and, ultimately, the formation of hierarchies.

In this study, participants spoke about tags in relation to aggregation and their stories showed the characteristics of other organisational members (or tags) that they selected in forming problem-solving groups. Overwhelmingly, agents were identified by *localisation* – agents with local knowledge, local experience and who were locally accessible. Participants also told stories that illustrated their selection of others with whom to interact based on their perceptions of role, commitment to the organisation, commitment to role and opportunities for knowledge sharing.

Participants were aware of and reflected on the tags they use for useful interaction	<i>'You know, fit for purpose. You know, you can engage in an appropriate level of interaction, according to the circumstances'</i> (Participant 1.2)
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An important theme within *tagging* for these participants gathered around the in vivo term *sphere of inclusion*. This code was developed after a lengthy discussion which attempted to clarify the ways in which participants' stories told of boundaries around dynamic groups. This phrase became an important one in the group's development of understanding about the ways that participants selected others with whom to interact. The term was intertwined with that of

self-organisation, and participants used it to describe the boundaries to the aggregate and provided a frame through which the aggregate could allocate inclusion and exclusion based on useful or unhelpful interaction.

<p>A customer service employee commented on the reasons why people in head office are not useful to the aggregate in solving problems that emerge in day-to-day interaction.</p>	<p><i>'They know the technicalities of it, but when it comes to implementing it, the group of people sitting around this table are the people who have to punch the keys and discuss it with the customer.'</i> (Participant 2.1).</p>
<p>The <i>sphere of inclusion</i> most often forms around a particular issue or problem or, in Snowden's (2003) use of the word, 'attractant'. Participants provide many and varied examples of their gathering in an organic way around a problem.</p>	<p><i>'... the problem was very complicated, but the bottom line was, we thought, well why don't we ... and we had [clients] complaining, significant numbers of [clients] complaining...so we thought we could look at a number of ways</i> (Participant 2.4).  <i>'When you say "we" ... I'm sorry to interrupt... (Researcher).</i>  <i>'Oh, me and my team ... we did it as a meeting, you know we set up, we said well, OK what are some of the things that we can do, lets set up some hair-brained ideas ... (Participant 2.4).</i></p>
<p>Indeed, some stories suggest that the greater the need, the more urgent and pressing the problem, in this case a very difficult and conflict-ridden environment, the increase in concentration of tags for selective coordination. In other words, this example demonstrates the tighter definition of the aggregate as a function of the difficulty of the environment.</p>	<p><i>'... but it is probably one of the better environments to work in. It's the most teamwork, the most people tend to pull together</i> (Participant 2.4).  <i>'... The feeling when you walk in just different</i> (Participant 2.1).  <i>'... It's different to every other site'</i> (Participant 2.2).</p>
<p>In contrast, one manager's attempts to form a group to facilitate knowledge sharing was difficult to instigate, the group having no need, no pressing concern around which to form and respond.</p>	<p><i>'Well, it wasn't, it wasn't bad, but it was just the first meeting and I think there was that, you know, all right, well what are we all here for, we've got nothing in common</i> (Participant 3.2).  <i>'And it didn't go anywhere, did it?'</i> (Participant 3.3).</p>

Participants at the customer service level of the organisation described their aggregation as occurring in response to broad issues emerging from interaction with the *real world*, the tags they use for selective interaction based on accessing a broad range of aptitudes for dealing with a diverse environment.

These participants contrasted their experience of selecting for tags that mediate useful interaction (that is diverse experience) with that of groups in head office which they see as aggregating along a narrower range of tags.	<i>'The interdependency we have at the [customer service] level is not mirrored, it is only at the ground that it's mirrored. It's not mirrored further up the organisation, it then very quickly silos, with business'</i> (Participant 2.4).
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Thinking about identifiers for selective interaction highlights issues of priority for different aggregates within the organisation. Some of the frustration experienced at the operational level with head office assistance in the solution of local problems can be considered issues of tagging. If head office selects for tags that facilitate its adaptive process it may well be that these tags are not those represented in members at operational levels of the organisation.

### Non-linearity

Interactions within complex systems produce outcomes which do not result in 'a sum of the parts', complex outcomes which cannot be predicted and which cannot be anticipated from individual behaviour (Waldrop 1994; Holland 1995; Kauffman 1995). In non-linear systems agents interacting with each other interfere with the outputs of the system, and as a result the system must be approached holistically – an analysis of each part will not provide a picture of the whole.

As a result of interaction between members, and between members and others in the organisation's environment, the relationship between inputs and outputs in this organisation can be seen as non-linear. This non-linearity relates to flows through connections among members, whether through information exchange, learning and sharing, innovation and knowledge development or access.

A strong theme in narrative and discussion revolved around the tension for participants between the non-linearity of their experience and the processes of delivering service (and maintaining effectiveness), the formal structure and linear processes defined by the organisation. Almost every tale gathered about the interaction of organisational members within their organisation and with the external environment included a reference to nonlinear phenomena. In many cases, too, this experience of dealing with non-linear dynamics was contrasted with the organisation's assumption of linearity and the expectation of the organisation that staff act in line with prescribed linear processes.

The property of non-linearity in this learning and knowledge sharing system relates to the in vivo terms *real-world* and *interdependency* and associated themes resulting from the disconnection between participants' experience of *real-world* and the organisation's need for consistency.

That complex adaptive systems are inherently non-linear is illustrated clearly within this case study. That this organisation structures itself as a linear system is similarly clear. The disparity between the formal organisational system and the lived experience of organisational members highlights critical features of the learning and knowledge landscape.	<i>'You can't just tie it in a neat little package and say, "this is what you will do. For every single person that you come across"'</i> (Participant 2.6).
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Participants equated the <i>real world</i> with their lived experience in a non-linear dynamic.	'...there is no way to prepare yourself for the whole, because you get told a lot of things, and you see things on telly but these things are real. And they're real people.' (Participant 2.4).
The individuality of the customer emerged as an important feature of the non-linear dynamics of the customer service employee experience. There appears to be little evidence of repeatable, clear and linear connections between cause and effect in terms of applying organisational rules to individual customer problems. Participants talk of the discretion they use in solving problems based on this lack of causal relationship and the diversity of problems resulting from the non-linear effects on customer variables.	'... you have to make a lot of discretionary decisions based on, it's almost the right thing... (Participant 2.4). 'What you know to be happening ... (Participant 2.6). 'As opposed to what might happen tomorrow! (2.1).
The disproportionate effect that one variable may have on another as a result of non-linear dynamics meant that participants were dealing continually with novel problems and, as most frequently described, novel problems in interaction with individual customers.	'They're all different, and as [7] said, every single customer is going to be different from the one you had two hours ago, even though they present with the same look and feel and everything ... (Participant 2.8). '... And they all tick the same boxes and [deleted], but they're not the same' (Participant 2.4).

The organisation's assumption of clear and linear relationships between cause and effect leads to a collision between the formal (linear) and lived (non-linear) and impacts sharply on the development and sharing of knowledge developed through adaptive learning within the complex system.

### Flows

Flows, in Holland's work, refers to the movement over a network through nodes (agents) and connectors. Examples of flows in organisations may be flows of information, physical resources, or sentiment. In complex adaptive systems these flows change in response to the success or failure of agents, their role as nodes and possible connections shifting with the adapting system.

The nature of flows of information through the organisation and the paths for knowledge sharing through interaction are represented by themes in narrative around *structure*, *direction*, *permission* and *what we do with information*. The characteristic *flows* represents participants' experiences that relate to sources of knowledge or opportunities for innovation and learning and the points at which transfer was facilitated or inhibited.

Through non-linearity the distance between the perceived experience and understanding of operational members of the organisation and their policy developing counterparts in head office was highlighted. While each group saw themselves operating within complex

environments, those dealing with customers on a daily basis were adamant that the organisation's requirements of them in maintaining consistency and control was untenable.

Participants described the impact of power relationships on their ability to flex to their environment, to learn in interaction with it, their customers and colleagues. They talked about the ways in which they learnt through exploration when given permission to fail and the impact of fear of the repercussions of exploration when permission was not given. Participants also described the rhetoric around freedom to explore and contrasted it with examples of criticism and blame for negative outcomes and lack of recognition for positive ones.

Participants' perceived a lack of understanding across aggregate groups and levels that limited the effectiveness of planned learning interventions, serendipitous learning opportunities, knowledge passage into the organisation and knowledge sharing outside of the aggregate.

<p>Permission to innovate and use discretion in solving problems was an important theme in discussion of learning opportunities. Participants at all levels identified permission in their stories of informal learning and development within the organisation. For those in customer service, the stories tended to be about the relationship between a customer service employee and their local supervisor or manager.</p>	<p><i>'And then as soon as he knew he had that permission to do that, that's fine, off he goes, fine, no issues. And the fact is, you've actually increased his compliments and it improves the way we do business, and it makes people willing to learn. They want to learn, if they've got permission to make mistakes'</i> (Participant 2.4.)</p>
<p>Similarly, in stories of attempts to share knowledge, permission was highlighted as an important factor. Endorsement of knowledge sharing activities by those in power within the organisation was described, and the limitations of requiring permission to share lamented, both at the operational level of the organisation and within head office. In the following excerpt a manager from head office tells of her experience attempting to share some knowledge she believed to be important to other members of the organisation.</p>	<p><i>'And that happened to me last week with something that I was trying to put up to help people as a resource and within two hours of having that put on the website the heavies came straight down and said, 'You'd better remove it because I haven't approved it'</i> (Participant 3.2).</p>
<p>The same need to be given permission by head office to share new knowledge is experienced by people working in customer service offices. While they learn in interaction with their environment and share the knowledge locally, as we saw in 'aggregation', they hesitate to share outside of the aggregate. Occasionally the opportunity arises for these aggregates to share their knowledge</p>	<p><i>'...we know that from the conference where they stand up and tell everyone what they've done, and you just stand there and think, "This is great!" and we're still in here trying to pump it out, and they're out there doing it. So I think that they do. And I think that a lot of the time they sit and wait for us to say it's OK'</i> (Participant 1.5).</p>

more broadly, and it seems that one thing preventing the sharing is permission.	
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The impact of the perceived tension between policy and practice in this organisation and organisational members' understandings of the gaps in organisational knowledge sharing resulting from this tension are explored through this characteristic 'flows'.

### Diversity

*Diversity* arises from ongoing adaptation, and each adaptation gives rise to the opportunity for further change through new interactions and new niches in the system. A single agent will not have the aggregate properties or capabilities of a complex adaptive system, but the aggregation of diverse agents provides a distributed base. As a result of diversity and the filling of niches within the system, complex adaptive systems are '... characterised by perpetual novelty' (Waldrop 1994: 147).

Diversity emerged in participants' stories about the makeup of aggregates and the impact on organisational outcomes, especially in relation to the survival of the group in its environment and in the novelty of solutions it develops in improving effectiveness. Participants' stories highlighted the range of individuals working in the organisation and the ways in which they fill niches within aggregates. The stories also highlighted the dynamic resulting from the interaction of these diverse members, and the impact of the context provided by other members on individual members (Holland 1995).

Through narratives, participants described the role of diversity in the survival of aggregates within the organisation as well as on the emergence of novelty. In particular, the ability of members to adjust within aggregate, assume roles or take on new characteristics to improve the aggregate's fitness was highlighted	<i>'Yeah, most of our group who were there, well, not most, maybe half of our group had come from an IT background, systems support groups, and system testing areas and those sorts of things, and then there was two or three of us who came from a learning background. So, yeah, it had a strong IT focus and that's where, I guess, that's where we, all our original directions had gone, that's where we were going to be heading until we sat down and had this discussion and sort of challenged, well, why wouldn't we do these other things' (Participant 3.5).</i>
Importantly, too, participants told of innovation occurring through interaction of diverse agents, the diversity of the group seen as critical to the emergence of new and substantially different knowledge outcomes. Participants saw their access to knowledge within the local aggregate as enhanced by the diversity of the group. They described the range of knowledge sources as contributing to their ability to learn from their experience in their role.	<i>'I ask a question, and there's five people behind me, "Yeah, what do you need?" and it's not only where in other places people go, "Well, you just do this" and sit at their desk and don't answer, or don't share, it's not just the technical stuff that they share, but they also go, "Oh, well, I would do this" and someone else will go, "Well, no, I would do this" and then another person say, "I would do this". So you can then base it on, they all just share their knowledge so well' (Participant 2.2).</i>

The diversity of the organisation is both a function and a product of the complex adaptive system. Not only does the diversity of the population contribute to the continuity and coherence of the organisation, but diversity contributes to adaptation that opens up possibility for further diversity.

### Internal models and building blocks

Participants spoke about the ways in which individual and aggregate learning was influenced by set *internal models* – in in vivo terms *the normal confines, the right thing and what I know*. Narrative that related to assumptions about dealing with organisational problems and rules for anticipating appropriate behaviour was coded to this node. In many instances discussion coded to this node related to inhibitors of innovation and learning, participants claiming that the *memory of the organisation*, held within individuals' and aggregates' internal models restricted the flexibility of the organisation in meeting changing environmental needs.

Built to form filtering rules that agents apply in decision-making, *internal models* are a mechanism of complex adaptive systems otherwise known as schema or schemata and are used as an anticipatory device; these *internal models* comprise a set of inputs which includes: all possible action/decisions that agents are capable of taking, combined with all possible pairings of current and future states, and the concept of desired outcome or *fitness function* (Rhodes and MacKechnie 2003). *Internal models* provide the complex adaptive system with an active ability to continually make predictions about its environment and act on that prediction. Indeed, Holland assures us that every complex adaptive system builds models to anticipate the world.

In this study, narrative and discussion revealed *building blocks of internal models* through themes around repetition and recombination, reflected in participants' reflections on shifts in understandings resulting from *real learning needs*. There were few excerpts coded to this mechanism directly, rather the theme was inherent in participants' discussion of internal models. For this reason, *building blocks* is represented with *internal models*.

For Holland *building blocks* are continuously revised and rearranged as complex adaptive systems gain experience. At one level, *building blocks* are the component parts of which internal models are built. Internal models may be deconstructed and its building blocks recombined to apply to new situations. At another level internal models become the building blocks of behaviour (Waldrop 1994), and so on, so that each level of organisation becomes the building block of the next, ready to be tested, refined, and rearranged. This nesting hierarchy feature of complex adaptive systems was not identified clearly in narratives, although the influence of internal models on learning and knowledge in the organisation was discussed quite broadly.

<p>In discussing limitations to learning and the sharing of knowledge through the organisation, participants told of their frustrations in attempting to innovate. In the following example the participant describes a time that was ripe for learning with and through the work and the production of new knowledge that may have contributed to the organisation's knowledge but for the schema of a person in a position of power.</p>	<p><i>'There was no room for anything else. So, he couldn't understand, didn't matter what we did, he couldn't understand what was being proposed, and he didn't see the value of it, and that makes life quite difficult ...'</i> (Participant 3.1).</p>
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<p>Participants spoke, too, about their own internal models and the ones that existed within their aggregate. Stories, though, did not separate the internal model from the whole - shifts in internal models were described as <i>reconceptualising</i>, a <i>new way of thinking</i>, and <i>letting go</i> and were spoken of within broader experiences of the individual and collective in maximising their fit with their work environment.</p>	<p><i>'... and it was a real, like, Bam!' That thing that I've been looking for, ... Like I hadn't asked the right questions, or we'd been looking way too narrow, so yeah, that was a real, OK, now I can see that's the missing piece of the jigsaw puzzle'</i> (Participant 2.3).</p>
<p>Opportunities for collective learning were perceived to be related to the absence of restrictive internal models within aggregate members and the aggregate itself.</p>	<p><i>'And because the blockers weren't there, there was no, "Well, because we've always done it this way", it was just that open opportunity for people to just have a good look at something in a different way, because they weren't wedded to the past, and they weren't restrained by anyone else, it was just that free environment they were learning in'</i> (Participant 3.2).</p>

Internal models were shown to exist within collectives and the organisation as well as within individuals.

<p>Participants describe the rigidity of organisational structures and processes, which may be seen as the organisation's internal models, as contrary to learning.</p>	<p><i>'... one of the problems that 3.4 and I often talk about is how many ideas we actually have and how great things could be ... but, because we're so busy, you know, trying to keep up with all the processes and you know, sign the right forms and you know have the right reports in on time and all that processy type stuff, we never have that brain space we keep talking about to actually do the innovative stuff, even though we probably are well positioned where we sit to actually be able to do that, so we never get to it, so it's one of those things that's almost a luxury, that it, you know, I'd really like to do that but I can't because this finance report's due or whatever'</i> (Participant 3.2).</p>
<p>Similarly, the culture of the organisation is described as an inhibitor, characteristics of the culture ranging from blame to stealing others' ideas.</p>	<p><i>'We just don't invest in solutions'</i> (Participant 3.4).  <i>'We don't ever see any surprises'</i> (Participant 3.2).  <i>'It almost comes back to that, what I said before, about, we've made a mistake and'</i> (Participant 1.1).</p>

	<p><i>'and blame someone else (Participant 3.2).</i></p> <p><i>'We can't fix it so we won't worry. Ignore it and it might go away. (Participant 3.4).</i></p> <p><i>'that sounds like putting your head in the sand (Participant 1.1).</i></p> <p><i>'or, or, the blame culture thing - find someone to pin it on ... Or you might suggest an idea, or whatever, and put it in someone's mind and then they run with it, and get the recognition, which then, you think, I'm not going to bother any more' (Participant 3.4).</i></p>
<p>Internal models assist the organisation to replicate outcomes, and in this organisation, the replication maintains priority over new learning and innovation.</p>	<p><i>'... we don't actually focus on innovation and that's picked up in a number of these other stories, too, that we tend to do more of the same rather than to look at innovative or different ways of doing things to achieve the outcome (Participant 3.2).</i></p>

The seven properties and mechanisms of complex adaptive systems emerged from narratives of learning and knowledge development in this organisational context. The use of the complex adaptive system heuristic has focused attention on aspects of organisation, learning and knowing that allow for new insights into their understanding.

### Implications

Recognising organisations as complex adaptive systems allows for fresh perspectives on learning and knowing and opportunities for their consideration within a single theoretical model. The broad implications for practice in organisations from a complexivist perspective hover around the futility of fixed plans and goals, the emergence of surprise outcomes resulting from the interaction of individuals, the self-organising capacity of groups and the concerning limitations of attempting to direct groups, the system as less rational (Frank and Fahrback 1999) than traditional perspectives on organisation suggest, the influence of exogenous impacts on individuals and their interaction within the organisation, and the impact of the context or landscape within which individuals attempt to improve their fitness (Anderson 1999).

The value of the metaphor to learning relates to adaptation of individuals and collectives as a result of interaction with each other and their environment. It recognises the role of mental models and their restructuring in individuals and collectives and the influence of localised learning on this adjustment. The metaphor also focuses attention on the patterns of interaction around 'attractors' and the selection of others with whom to learn and share knowledge.

This study highlights the tension between the organisation's assumption of Cartesian mechanics, focusing on linearity, measurement and control, and the experience of organisational members experiencing non-linear dynamics in their interaction with each other and their work environment. This tension plays itself out in interruptions of flows between

aggregates and levels of aggregation and results in limitations to learning and knowledge sharing.

The study also points to the learning that occurs at the edges of the organisation within local aggregates solving immediate and pressing problems in order to improve individual and collective 'fitness' within an environment of ubiquitous novelty. That organisational members should develop knowledge that is important to the organisation's adaptation and competitiveness through engagement with their work is not surprising, it is, however, often unsupported and (in this case) seen as deviant. Organisational structures which demand consistency in a consistently novel environment limit the opportunity for the organisation more broadly to profit from the innovation that occurs and is held at the boundaries of the organisation.

The disconnection between the local aggregate and the organisation as an aggregate is in conflict with Holland's illustration of aggregates 'nesting', so that local aggregates are the building blocks of the organisational aggregate. In this study, nested hierarchies did not emerge from the interaction of aggregates. Participant stories revealed organisational members' perception of the organisation's rules and structures as the cause of the disconnect, members' preference for keeping local knowledge local perceived as resulting from the distance between levels imposed by the formal hierarchy of the organisation.

The implications of this lack of nesting are lack of knowledge sharing across organisational levels and between aggregates. A somewhat cyclic issue is uncovered here - in order for the organisation to learn from its members, it must reconsider these structural restraints, but in order for the structure of the organisation to change, it must respond to exogenous shocks which are sensed and responded to through organisational members. The organisation can learn as structures change in response to these shocks, but only when it allows itself to be responsive (Frank and Fahrback 1999). 'Exogenous shocks cause learning at two levels. First, individuals learn as they are exposed to new information. In turn, this changes their sentiments and interactions. Second, changes in the overall distribution of sentiment and pattern of interaction constitute learning at the organisational level (Hedberg 1981)' (Frank and Fahrback 1999: 269).

Challenging of internal models is a well-worn theme in organisational learning literature (Argyris and Schon 1996; Schein 1999) as well as in cognitive learning approaches to workplace learning (Mezirow 1990; Karakowsky and McBey 1999) and recent knowledge management discourse (Snowden 2002; Kurtz and Snowden 2003; Snowden 2003). While this study shows the complexity of knowledge, its development within social contexts, through the interactivity of organisational members (Stacey 2001) and its collective nature, internal models and their impact on development of organisational knowledge are highlighted. Organisational members' ability to challenge individual, collective and organisational internal models appears an important skill in the development of new knowledge and its benefit to the organisation. From a complexity point of view, agents and aggregates who use overt internal models for explicit explorations of alternatives have 'lookahead' skills, the progressive adaptation of these internal models resulting in opportunities for the agent and aggregate to be actively influenced by the environment.

The role of the environment in shaping knowledge is another important theme in this study, its implications far-reaching. Organisational members told of the impact of their environment on their behaviour and learning, their attempts to improve fitness within the work landscape

their main priority. These narratives illustrated members' secondary interest in considering the impact of their work any further than in the advantage to their local aggregate. Individuals and collectives focused first on meeting the need of their immediate problem solving context, protected others within that context and held knowledge close, preferring to learn from and share knowledge with those in the aggregate. This preference for local interaction led to knowledge developed to respond to environmental conditions. The implication for the organisation is that valuable knowledge is held at the edges of the organisation, the implication for individuals and collectives is that this knowledge is not recognised, valued or endorsed by the organisation.

## Conclusion

If learning is simply '... the process of acquiring knowledge' (Easterby-Smith, Antonacopoulou et al. 2004: 3) then knowledge management and learning must 'sit' together. Insights from learning literature and practice and those from knowledge management are mutually supporting and may be understood in more holistic ways through complexity theory.

This study illustrates the nature of knowledge as activity, problem solving, a thing, a flow (Snowden 2002), personal, individual, collective, socially constructed, owned and protected, localised, valuable only in its application, complex and elusive.

The findings of this study illustrate the ways in which organisational members learn and knowledge emerges within a complex adaptive system. This perspective allows for consideration of knowledge and learning within one theoretical frame and points to the importance of more holistic understandings and practice in improving knowledge productivity and performance.

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