University of London

Institute of Education

Dissertation

# Learning Space:

# Educating software product users

Sally Hawse

(2001)

Submitted in partial fulfilment of the requirements

for the degree of Masters of Art

in

Information Communication Technology in Education

**Abstract**

This paper has six sections. Section 1 is a brief discussion of the knowledge economy as it influences views of education. This section explores how the technology of the information age has affected economic, social and educational practices and encouraged a more communal or systemic worldview. This worldview helps create possibilities for life-long learning. Section 2 explores heterogeneous workplace teams and the importance of the theories of the zone of proximal development and communities of practice to workplace learning. This section assesses the potential impact of these theories on the learning organisations and life-long learning required by the knowledge age. Section 3 takes as its starting point technology as an 'intellectual partner'. It explores how socio-cultural features and artefacts can help direct the design of digital learning environments. Section 4 presents the results of a survey designed to leverage resource restructuring. The results were obtained from client assessments of the usability and usefulness of a software development firm's educational resources. Section 5 illustrates how the research into the design of digital learning environments was applied to an online support system for a web-based knowledge sharing application. Section 6 assesses the strengths and limitations of the online support system in assisting product learning. The paper concludes with a brief exploration of the role of this support system within the broader context of the knowledge economy and learning organisations and assesses the degree to which the resource might foster learning.

**Key terms**

communities of practice, digital learning environments, knowledge economy, learning organisations, life-long learning

**Contents**

## Introduction

The impetus for this paper derives from a commonplace and short-sighted assessment of the role of technology in workplace education. Urdan and Weggen (2000) cite The New Knowledge Economy (1999) as predicting that,

> Education is about to change. Fundamentally? Why? Because almost everything we know about education is up for grabs: the way it is funded, designed, managed, and even delivered. Around the world, wholesale efforts at education reform are already underway; and…these changes are taking place in 'Internet time'. This is the new education economy — the global education economy" (p. 2).

Urdan and Weggen employ this statement to encourage adopting corporate e-learning strategies. Their view of workplace education and learning is limited insofar as it is grounded in economic and technological determinism, cloaked as 'reform'. To propose that repackaging training and delivering it via technology will suffice as a corporate educational response to the evolution of the economy to a knowledge-based economy foreshortens the role firms might play in corporate educational initiatives. Urdan and Weggen's argument assumes that technology based training will provide corporations with a "competitive weapon" to leverage learning and they maintain this is a sufficient response to the knowledge gaps which prevent workers from meeting the requirements of a knowledge economy. Significantly while they acknowledge "academic and corporate environments must be redesigned to adequately prepare people to function in an information society" (p.2), they offer only technology as the solution.

Despite disagreeing with Urdan and Weggen, the bulk of this paper focuses on the role of technology in workplace learning. My exploration is significantly influenced by the systems thinking deriving from von Bertalanffy who argued for a scientific worldview where, rather than a Newtonian reduction

to a static framework of *Being*, the universe is perceived of as an irreversible *Becoming*. A worldview in which interrelated systems endlessly generate novelty is an appropriate construct for the information age. Educational theories incorporating this view offer potentially more viable assessments of workplace learning and the role of technology in education than do narrower transmissive models, like that of Urdan and Weggen. The systemic worldview presented by Kofman and Senge (1995), Reigeluth (1996) and Trilling and Hood (2000) and what I perceive as the allied views of Engeström (1999), Wenger (1998a; 1998b) and Zuboff (1988) thread this inquiry. This stance does not however advocate unilaterally subscribing to systems theory. A reservation is that wholesale adopting of systems paradigms will inevitably be used to legislate 'bandwagon' corporate and education policies. Despite this reservation, I believe systems thinking offers a pragmatic framework within which technology can legitimately become an intellectual partner .

The possibilities afforded by systemics relates to the context of my own work. I am employed by a software development firm which bases its practices and development cycle on Jacobson et al (1992) and Constantine's (1995) client-centric software design models. These models place the user and user workflows at the locus of the design process and support a heterogeneous or participative design cycle. The firm utilises these models to position itself as a 'learning organisation'. As a Content Developer for the Education and Consulting Products team, I help develop software support and educational resources. My purpose in this inquiry is to establish a principled rationale for the design of digital support resources. Following Agoshkova (1998, online), a systems worldview enables approaching the design of digital learning environments as a "composition of interacting elements". The elements which I explore are the knowledge economy, theories of workplace learning and analyses of digital environments.

Section 1 focuses on the 'knowledge economy'. It briefly explores the impact of information technology on economic models and the role of information technology in linking the economic,

social and technological. This section argues that the solution Urdan and Weggen promote is a stopgap, both reactionary and an industrial age response ill suited to the requirements of a knowledge economy. Zuboff (1988) and Kofman and Senge (1995) offer more multi-faceted responses to the educational requirements of workers in the knowledge age.

Section 2 is undergirded by systems thinking. It takes as its starting point the insights of Zuboff and Kofman and Senge, which enable us to depart from seeing development in terms of simple models of linear progression and instead to adopt more complex holistic notions of interaction and connection. Engeström's (1999) reinterpretation of Vygotsky's *zone of proximal development* in activity systems and Wenger's (1998a) *communities of practice* help situate this discussion within workplace learning. Engeström's *instruments* and Wenger's *reification* or 'resources' co-join with the transformative views of Jones and Mercer (1998) and Jonassen (2000) to bring technology into play as an educational or learning partner.

Design principles to integrate hypermedia into the educational 'fabric' in the role of an intellectual partner is the focus of Section 3. Kress and van Leeuwen (1990), Kress (1996) and Lohr (2000) provide a largely social basis for the principled design of digital education environments. They supply socio-cultural and metaphorical frameworks to guide the design process. This inquiry subliminally directs Section 4, for it fuelled misgivings about the effectiveness of the education resources produced by Data[1]. This section provides a brief overview of the company and my role as a Content Developer. It then presents the results of a survey to assess the usability and usefulness of client educational resources. Section 4 summarises the survey findings with a view to how they might inform reassessing and restructuring these resources.

[1] For legal reasons, company names are fictional.

Section 5 extends the research into digital learning environments to an online support system. It discusses how this research was applied to the design of a support system for an in-house web-based knowledge sharing application.

The concluding section of the paper evaluates the achievements and limitations of the web application support system. It attempts to place the support system within the broader context of the knowledge economy and learning organisations, and assesses the degree to which the resource might foster learning.

## 1. The knowledge economy: a changing corporate and educational landscape

1991 marks for Trilling and Hood (1999, p. 5) the turning point from an industrial to a knowledge age, for it benchmarks expenditure on information technology exceeding that for mining, oil fields, agriculture and construction. Bell's (1975) information or knowledge age has become a reality: in our current economic landscape the harnessing and rapid exchange of information secures economic prosperity. Gibbons et al (1997, pp. 76 - 80) and Hemingway and Gough (2000, pp. 1 - 3) assess this information age from the viewpoint that knowledge production and dissemination demonstrate increasing confluence between the knowledge based industries of manufacturing, trade and commerce and the knowledge producing or education industries. Castells (1996, p. 7) shares this view. He notes that in an informational economy, productivity and competitive advantage are leveraged through knowledge, information and the technology of their processing. Kellner (1997, online) summarises our current direction as one of evolving into a postindustrial technosociety where technology, knowledge and information are the axial or organising principles.

Kellner also believes technological advancements are utilised to reorganise and legitimate market capitalism. He argues that, "while knowledge, information and education are probably playing a more important role than ever in the organisation of contemporary society, this is because…capital is restructuring itself through the implementation of new technologies into every sphere of life". Hemingway and Gough (2000, p. 1) help substantiate Kellner's position. They state that with efficient production now the standard across many industries, new ways of establishing comparative advantage are being sought. This prevailing 'just-in-time' or post-Fordian model of market competitiveness relies upon the rapid exploitation of business intelligence and requires workers to possess information handling and decision making skills. Within this paradigm, Hemingway and Gough envisage reforms to educational and social policies will create a 'knowledge society' conducive to such economic change. E-learning advocates, Urdan and Weggen (2000) reiterate this stance. In their assessment,

the current focus on technology mediated learning derives from the evolution of the economy from industrial to knowledge based. They believe the knowledge gaps which forestall workers from meeting the requirements of this new economy is driving e-learning and that technology based training can help resolve these gaps. As a solution, they propose just-in-time corporate e-learning strategies to match a just-in-time economy.

For Urdan and Weggen (2000, p. 2), the shift to a knowledge based economy impacts on the workforce in the form of levying a premium on intellectual capital and increasing pressure to remain at the vanguard of education and training throughout one's career span. Wood et al (1998) factor in productivity. In their assessment, corporate re-engineering and downsizing have necessitated a more productive workforce and employee motivators such as education and training are foremost in creating this productive workforce. Wood et al maintain that "an individual's willingness to perform is directly related to the needs, expectations and values held by the individual, and their link to the incentives or aspirations presented by the organisational reward system" (p. 169). Such a corporate climate, as Hemingway and Gough and Urdan and Weggen imply, results in the emergence of a type of 'learning organisation'. Against this backdrop, education and training have become staff retention collateral and a means to safeguard market competitiveness.

Kellner challenges this assessment. He argues that in a *technocapitalist* society, where capital restructures itself through implementing new technologies into every facet of life, the danger exists that corporate control of technology, knowledge and information may be insufficiently moderated. Kellner's reservation is that,

> The ideologues of the technological revolution and information society are forever arguing that education is the key to future prosperity, that education must be made available to all, and that it is thus the top social priority. This would be fine if education were to be

> expanded and made accessible to more individuals and if it were able to augment the realm of knowledge and literacies, rather than just to serve as a sophisticated enhancement of job training, focusing on transmitting the skills and knowledge that capital needs to expand and multiply.

His misgiving refocuses Marx and Engles' (1952) concern that culture and education may devolve into "mere training to act as a machine" (p. 66). Kellner also undermines Urdan and Weggen's view that the role of education is chiefly to prepare individuals for employment. Against his analysis their statements that "corporations view learning increasingly as a competitive weapon rather than an annoying cost factor" and huge knowledge gaps require "a thorough re-examination of curriculum and teaching methods as they relate to labour market preparation" (p. 2) contribute to a less tenable argument.

Paralleling views outlined by Reigeluth (1996), Trilling and Hood (1999, pp. 7 - 8) assess the knowledge age with the intent of devising an educational program response to match the skills and competencies demanded of its workers. They forecast the main aims of education will focus on the engagement skills of participating in the global economy, actualising talents through technology, involvement in informed democratic decision-making and awareness and understanding of multiple cultures. Trilling and Hood outline a set of knowledge age competencies which revolve, within technologically enhanced educational and workplace environments, predominantly around holistic ideals of community, creativity and collaboration as well as the ability to manage one's own life-long learning.

Their program response incorporates issues raised by Castells (1996). He points out that although the knowledge economy is frequently extolled as a global economy, it is potentially more exclusionary than the industrial economy. Castells acknowledges that the current economic climate demonstrates

increased interplay between industry and education. He nonetheless levies concerns that the globalisation we see emerging is largely comprised of networked centres unlikely to manifest as a world economy. He contends that similar to the First and Third World divisions of the industrial age, a fourth world is emerging. This fourth world is one of exclusion — it is the product of informational capitalism and consists predominantly of those lacking access to information technology and its products. Denied access to the artefacts or resources enabling full participation these individuals will become increasingly marginalised and unempowered.

Trilling and Hood (1999, pp. 6 - 8) acknowledge the challenges facing education and society include managing technology to prevent the emergence of technology ghettos. Other challenges to be met comprise addressing technology induced personal isolation, the need for savvy information consumers able to work within the constraints of information increasingly controlled by monopolies, the ability to network across social, educational and cultural boundaries and change management skills for education and work environments perpetually in flux. With this 'curriculum' they blueprint the educational and social reform Hemingway and Gough anticipate will create a knowledge society. Trilling and Hood also provide some measure of response to Kellner and Melody (1994). Melody declaims the implications of a corporate managed information age when he alleges that ever increasing quantities of information do not necessarily correlate to more knowledge. He queries: "If the information is essentially short-term, instructional and functional, will it expand knowledge, or will it substitute for knowledge?" Education for Melody is both participatory and receptive, but "intellectual emancipation only comes with talking, writing and participation…the development and application of one's critical capabilities (pp. 270 - 271). Bigum (1987) and Apple (1992) raise similar issues. Apple believes that "the more the new technology transforms the classroom in its own image, the more a technical logic will replace critical political and ethical understanding" (p. 118). For Bigum, the use of technology for learning tends to atomise or fragment the learning process. He predicts participants will adjust their learning and cognitive styles to match the discreteness or

ahistorical mode of machine delivery. He argues that in much technology based education, reflection and praxis are forestalled, with the machine engendering a monological form of discourse in which algorithmic logic takes precedence. The danger of fostering such 'instrumental learning' is that it may result in a "type of 'means-end' rationality, whereby students learn to follow premises to their logical conclusions as expeditiously as possible" (p. 21). Inquiry is inhibited as the scope of learning becomes subsumed by machine logic.

Hemingway and Gough (2000, p. 168) support this account. They observe that an increase in demand for knowledge skills has shifted the view of education from intellectual dialogue to education as knowledge delivery. They and Gibbons et al (1997, pp. 76 - 80) also note how massification of higher education has led to shifts in both the user base and demands for academic research. Other organisations are establishing themselves as knowledge producers that complement or compete with universities.

Industry vying for a larger stake in education's role incurs sharing its responsibilities. As Kellner and Melody help illustrate, these responsibilities involve encouraging general knowledge, literacies and reflection. This responsibility also involves stimulating critical thought often at odds with economic agendas. James (1999) cites Coyle as pronouncing that the minority who have reaped the benefits of technological change "cannot be allowed to get away with presenting the economic transformation of our world as a merely technical question, a matter of hard facts and not difficult choices" (p. 3). Some of these difficult choices involve acknowledging that education is more than an engine of economic determinism; it does not reduce to industry's "competitive weapon". Gibbons et al (1997, p. 100) strengthen this position when they observe that corporate social accountability is one result of the increased reflexivity between the knowledge based and knowledge producing industries.

Galbreath (2000) borrows from the Knowledge Management industry multiple definitions of its role in an attempt to map knowledge management practices to education. One definition he tenders defines knowledge management as,

> …a discipline that promotes an integrated approach to the creation, capture, organisation, access, and use of an enterprise's information assets. These assets include structured databases, textual information such as policy and procedure documents, and, most importantly, the tacit knowledge and expertise resident in the head of the individual employee (Gartner Group, 1999).

As the Gartner Group illustrates, many of the practices and principles of knowledge management seek to quantify knowledge. Blackler (1995, pp. 1021 - 1046) provides a sample rubric of such quantification. He identifies five categories of knowledge which he outlines as the abstract and often socially prestigious *embrained knowledge* dependent on conceptual and cognitive skills, the action-oriented *embodied knowledge* of specific contexts and face-to-face transmission, the shared and socially constructed *encultured knowledge* embedded in cultural systems, the *embedded knowledge* of routines and the *encoded knowledge* residing in signs and symbols which requires tools for transmission. The simplicity of Blackler's taxonomy is enticing. Arguably this simplicity is also one of its shortcomings, for it implies that merely implementing knowledge capture and dissemination routines will effectively transmute knowledge into economic advantage.

Zuboff (1988) provides a more compelling analysis of 'knowledge management'. She suggests that "informating technology textualises the objects, events and processes that constitute an organisation's work" (p. 319) and that this textualising process engenders new possibilities for the production and distribution of knowledge. For Zuboff, the worldview afforded by technology is *panoptic*. Her assessment reworks Foucault's (1977) analysis of the Panopticon to yield a polyphonic or collective text, "a workplace in which each member is explicitly empowered as his or her fellow worker's

keeper….[T]his panopticon relies upon shared custodianship of data that reflect mutually enacted behaviour" (p. 351). With their motivational incentives Wood et al (1998) present organisational power as a seemingly vertical force. Zuboff on the other hand, perceives that a new collectivism encouraging horizontal visibility has emerged. And, with this new visibility have emerged new dilemmas.

Some of the dilemmas Zuboff (1988, pp. 358 - 359) highlights are similar to those acknowledged by Trilling and Hood. The issues she raises include egalitarian access to electronic texts, interpretative skills to access data, a more team and problem solving focus to handle ever-increasing quantities of data and "action-centred skills oriented toward nurturing reciprocity among those bound together in the mutual dependency of direction and execution" (p. 360). Like Zuboff, Davenport (1995, online) perceives that "successful knowledge transfer involves neither computers nor documents, but rather interactions between people". Hildebrand (1998) affirms this view when she notes that "organisations function courtesy of a social network of employees giving, hoarding, influencing or accumulating information". It is not Blacker's knowledge management categories but, much like Zuboff's "mutual dependency", it is interactions between people which assist Kofman and Senge (1995) in defining a learning organisation as:

> When we speak of a "learning organisation," we are not describing an external phenomenon or labelling an independent reality. We are articulating a view that involves us — the observers — as much as the observed in a common system (p. 32).

Similar to Zuboff's panopticon, for Kofman and Senge a learning organisation is a text, a horizontal transparency, a dialogue. The learning organisation which they envisage is notably different to that implied by Hemingway and Gough and Urdan and Weggen, whose workers emerge as boardpieces in Kellner's technocapitalist world. Grounded in systems theory, Kofman and Senge help redefine an industrial age understanding of 'organisation' to evolve a knowledge age cartography in which

hierarchical control is effaced by the ideals of community. In this new landscape an organisation becomes a community which incorporates the interests of business, education, government and family. For Kofman and Senge in "the new systems worldview, we move from the primacy of pieces to the primacy of the whole, from absolute truths to coherent interpretations, from self to community, from problem solving to creating" (p. 17). Defining a learning organisation as a communally enacted entity promotes communication and participation. Kofman and Senge articulate this framework as:

> Learning organisations are a space for generative conversation and concerted action. In them, language functions as a device for connection, invention, and co-ordination (p. 33).

Their definition addresses Bigum's reservation that learning in a technology influenced world constrains reflection and praxis. It also incorporates Melody's provision that intellectual emancipation arises from involvement and application of one's critical abilities. Within this framework, divisions between work space and learning space are removed and work and learning become integrated into an ongoing cycle of reflection, experimentation and action. Wood et al (1998) summarise this emerging normality. They see learning organisations as revolving around the largely social factors of,

> building a powerful shared vision of future growth which will provide the focus for learning and a benchmark for future achievements, developing strategies and action plans that will inspire the commitment of all personnel to achieve the future goals of the organisation, making extensive use of a continuous process of consultation to achieve consensus and unity of thought, encouraging continual renewal of all organisational structures and processes, employing systems thinking to ensure that the organisation focuses upon both internal and external factors that are driving the change, creating self directed teams of employees which are supported to make decisions at appropriate levels (p. 224).

What Kofman and Senge and Wood et al outline are 'communities of commitment'. The following section discusses how these communities of commitment might arise. It also explores how continuous

processes of consultation and exchange afford possibilities for life-long learning significantly different to those envisaged by Urdan and Weggen.

## 2. Communities of practice and the zone of proximal development in workplace learning

This section takes as its starting point Zuboff's "mutual dependency" and Kofman and Senge's "common system". From this perspective, learning organisations encourage cultures of shared responsibility, reflexivity and accountability, and transformative models of learning supplant transmissive models of education. Following Casey, the concept of work as a learning site directs this part of my inquiry. The workplace is the most likely forum for the continuous learning required of knowledge age workers. In a work-as-learning-space model, theories of cross-functional or heterogeneous project teams, communities of practice and new interpretations of the zone of proximal development acquire increased resonance. These views become a means whereby the concept of 'life-long learning' can be effected. My supposition is that if, as Zuboff believes, information technology textualises the workplace, then its own role has changed accordingly, and this supposition directs my inquiry throughout Section 2. Jones and Mercer (1998) and Jonnassen (2000) suggest that through the process of textualising, new texts of engagement are created. The final paragraphs of this section briefly explore the forms these texts might take. Encouraged by Engeström's instruments or tools and Wenger's reification, one of these forms must encompasses the emerging role of technology as an intellectual partner.

For Urdan and Weggen (2000) "the mission of corporate e-learning is to supply the workforce with an up-to-date and cost-effective program that yields motivated, skilled, and loyal knowledge workers" (p. 9). Guile and Young (1998) help mitigate such a catchment view of technology based learning. They reference Casey (1995, p.74) as observing that work itself "is an educational site in which pedagogical and learning practices have always taken place" (p. 175). Casey suggests that workplace interactions offer a more feasible means of effecting corporate learning cultures than Urdan and Weggen's 'transmissive model'. This view is supported by the knowledge age landscape sketched by Zuboff

and Kofman and Senge where they present a perspective on the workplace in which reflection, experimentation and action help create and sustain life-long learning. Implicit in these analyses is that the information age has shifted the balance of learning from statutory to continual and from individual to more collective. Action-centred activities and communities of practice can help encourage the learning organisations, learning societies and life-long learning which societies of the future require if they are to remain economically competitive.

Similar to Castells' networks and workplace teams, Gibbons et al (1997) identify one feature of current organisational practice as:

> people come together in temporary work teams and networks which dissolve when a problem is solved or redefined. Members may then reassemble in different groups involving different people, often in different loci, around different problems. The experience gathered in this process creates a competence which becomes highly valued and which is transferred to new contexts. Though problems may be transient and groups short-lived, the organisation and communication pattern persists as a matrix from which further groups and networks, dedicated to different problems, will be formed (p. 6).

Castells views these work teams and networks as risking the emergence of an exclusionary world economy. The view which Gibbons et al outline however indicates that this cross-functional matrix of communication and shared problem solving is scaffolding workplace cultures of reflexivity, heterogeneity and shared learning.

Wenger (1998b, online) observes that while we recognise knowledge as a key source of competitive advantage in the business world, we have little understanding of how to create and leverage it in practice. With this, he shares with Hildebrand an acknowledgement that organisations function courtesy of a social network of employees interacting with information. Wenger notes how,

> We frequently say that people are an organisation's most important resource. Yet we seldom understand this truism in terms of the communities through which individuals develop and share the capacity to create and use knowledge. Even when people work for large organisations, they learn through their participation in more specific communities made up of people with whom they interact on a regular basis. These 'communities of practice' are mostly informal and distinct from organisational units.

For Gibbons et al the experience garnered through working in heterogeneous teams can be transferred to new contexts. Arguably this transfer constitutes a form of learning. Wenger on the other hand, believes it is the informality of communities of practice which renders them both a versatile and dynamic knowledge resource and "the basis of an organisation's ability to know and learn". Guile and Young (1998) note that "in the learning organisation, learning society and life-long learning literature, very little attention has been given to the process of learning itself" (p. 174). They suggest the theory of communities of practice provides a means of focussing on the process of vocational learning distinct from more formal skill enhancement and upgrade programmes. Following Guile and Young, communities of practice serve as a form of ongoing 'apprenticeship'.

Wenger (1998b, online) distinguishes communities of practice from the task-based networks or cross-functional teams of Castells and Gibbons et al in that they arise and are sustained by shared knowledge and interests, rather than tasks: "A community of practice exists because it produces a shared practice as members engage in a collective process of learning". He (1998a) stresses that,

> Communities of practice are about content — about learning as a living experience of negotiating meaning — not about form. In this sense, they cannot be legislated into existence or defined by decree. They can be recognised, supported, encouraged, and nurtured, but they are not reified, designable units. Practice itself is not amenable to design. In other words, one can articulate patterns or define procedures, but neither the patterns nor the procedures produce the practice as it unfolds (p. 229).

In other words, reorganising corporate policies to encourage and acknowledge communities of practice will enable firms to provide a context within which life-long learning can be sustained. Guile and Young (1998, pp. 183 - 184) support this view when they note that communities of practice can enhance personal and group learning because their culture of exchange, debate and reflexivity encourages the circulation of 'knowledgeability'. Significantly, intelligence, and by extension learning, becomes "a distributed process rather than as an attribute of individuals" (p. 182).

Miller and Boud (1996) note that "every day we are confronted with problems and challenges which we address by drawing on our experience and by using this experience to find ways of learning what to do in new circumstances" (p. 3). They articulate learning as a process which draws on the,

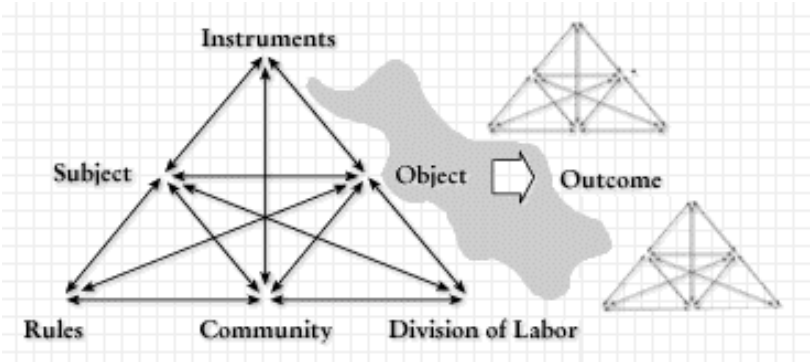
> behaviour, knowledge and skills of people around us as well as on the material and informational resources of the world….[W]e also use and build upon our own personal foundation of experience. Our learning is grounded in prior experience. It is profoundly influenced by this experience as well as the context in which we operate (p. 3).

Nardi (1996, p. 69) shares this view. She contends that a broad range of inquiry has shown it is not possible to understand fully how people learn or work if the unit of study is the individual removed from others and the artefacts utilised for accomplishing tasks. For Nardi, the context of work relationships, tools and social groups are required to achieve a comprehensive understanding of the work process. She maintains however that 'context' has a broader reference than an outer container inside of which people behave in certain ways. Rather, as people are also motivated in part through their own objectives or goals, context is "both internal to people, involving specific objects and goals and, at the same time, external to people, involving artefacts, other people [and] specific settings" (p. 76).

Engeström (1999) elaborates this understanding. He observes moreover, that while the "the socio-spatial dimension of work" has been opened through theories such as Nardi's, the "developmental dimension" (p. 64) has been neglected. To this end Engeström sketches a *zone of proximal development* for the developmental structure of communal activity. He believes this zone exists at the boundaries of all collective activity.

For Guile and Young (1998, p. 178; p. 187), reconstructions of Vygotsky's zone of proximal development (Lave and Wenger, 1991; Engeström and Cole, 1994; Engeström, 1995) are central to a series of pedagogic strategies designed to assist teachers help learners move beyond their current competence. Many of these reinterpretations have drawn attention to how the process of learning always involves changes in knowledge and action, and have been foundational in reformulating ideas about learning. Engeström for example, views the gap between a group's current position and possible future directions, goals or achievements as a zone of proximal development. This zone incorporates the views of alternate groups with divergent agendas or other constraints and influences such as rules and technologies. This zone forms part of the context of activity and must be explored before either individual or collective goals can be established.. Engeström presents in Figure 1, a conceptual model of such an activity system:

Figure 1. Engeström's ZPD in activity systems (pp. 66 - 67).



Here the zone of proximal development is the ‘gray area’ between the current, future or alternate activity systems. Engeström’s reworking of the zone of proximal development enables members of a community to learn as they take into account the goals, tools and practices of other groups. Through a process of enquiry and exchange their own goals and boundaries are continually transformed and reconstructed. Guile and Young support this assessment. They summarise Engeström’s view as ensuring “that the ‘zone of proximal development’ is collectively organised to facilitate the transformation of context, cognition and practice” (p. 186). Wells (1999, online) similarly analyses one reconstruction of Vygotsky’s zone of proximal development. This view holds that negotiating a curriculum involves accepting the most valuable learning opportunities are created in the interaction of the co-participants, tools and practices of an activity. Learning outcomes are contingent “on the nature and quality of that interaction as much as on the upper limit of the learner’s capability”. Here, much as in Wenger’s communities of practice, and in Engeström’s mediated activity system, a zone of proximal development is interstitial, a ‘moving target’.

Wells cites Lave and Wenger (1991, p. 51) as observing that:

> [G]iven a relational understanding of person, world, and activity, participation, at the core of our theory of learning, can be neither fully internalised as knowledge structures nor fully externalised as instrumental artefacts or over-arching activity structures. Participation is always based on situated negotiation and renegotiation of meaning in the world.

Engeström’s mediated activity system and Wenger’s communities of practice are workplace zones of proximal development. As with Engeström’s mediated activity system, a community of practice continually renegotiates its purpose, boundaries and practices. These models effectively function as ‘curricula’ and, through offering forums for continuous learning, reiterate Casey’s belief that the workplace is an educational site in which learning is an ongoing process.

Zuboff's textualised workplace and action-oriented skills and Kofman and Senge's common system invests technology with a participatory role. The instruments or tools of Engeström's mediated activity system and Wenger's notion of *reification* similarly include technology as an important variable. These models open the possibility for technology to take a legitimate place as a learning partner. Wenger (1998a) defines reification as "making into a thing" (p. 58):

> With the term reification I mean to cover a wide range of processes that include making, designing, representing, encoding and describing, as well as perceiving, interpreting, using, reusing, decoding, and recasting….In all these cases, aspects of human experience and practice are congealed into fixed forms and given the status of object (p. 59).

Wenger's definition acknowledges the contribution tools, technologies or 'resources' make to the learning process. Through reification, understandings and procedures are given form, are 'textualised'. This process is central to every practice. Engeström's instruments and Wenger's objects or resources are thus pivotal elements in a continuously enacted heterogeneous system.

The worldview of Kofman and Senge in which the observed and the observers participate in a common system finds corollaries in general systems theory, soft systems methodology, participative design and actor-network theory. Agoshkova (1998, online) believes the systems worldview deriving from von Bertalanffy's (1945) general systems theory presents the opportunity to refract all spheres of human activity through the systems viewing of reality. Much like Engeström's zone of proximal development and Wenger's communities of practice, for Agoshkova this paradigm encourages investigating "an object's organisation through examining systems as a composition of interacting elements". Such a perspective enables a unified basis for scientific and social inquiry.

Law (1992, online) highlights an actor-network theory affinity with systems thinking. He states that in actor-network theory the social is nothing other than patterned networks of heterogeneous materials. For Law this "effaces the analytical divisions between agency and structure, and the macro- and the micro-social, but it also asks us to treat different materials — people, machines, "ideas" and all the rest — as interactional effects rather than primitive causes. The actor-network approach is thus a theory of agency, a theory of knowledge, and a theory of machines." Likewise, Kimble and Mcloughlin (1995, p. 5) attempt to reconcile the differences between technological and social determinism. They propose an integrationist or more unified model of technological and social influences. Their model portrays the 'impacts' of these influences not as the linear outcomes of deterministic stances, but as prevailing forces influencing and shaping each other in a complex, interactive and ongoing process. This view, coupled with the collective viewpoints of Engeström, Wenger, Agoshkova and Law help substantiate the notion that technology is intrinsic to the weave of contemporary learning.

Jones and Mercer (1998) further articulate this understanding. In their assessment, there are two salient metaphors of technology in education. In one the computer system "can be viewed as an analogue to the student-teacher system with the computer replacing the teacher" (p. 23), and in the other the computer functions as a 'medium'. Urdan and Weggen promote the first or transmissive view of digital technology, as do numerous other studies including Barritt and Lewis (2000) of Cisco Systems and Wiley's (2000) and Wiley et al's (2000) learning objects, which focus on the economic and administrative expediency of technology deployed learning. For Jones and Mercer (1998, p. 23) the computer functioning as a medium does not replace people. Rather, it reorganises interactions among people and creates new educational environments. This second role emphasises the potential of computers for reorganising instruction within the classroom and for making possible the extension of education beyond the classroom. Jonassen (2000) references Pea (1994) to argue strongly in favour of adopting this second, or transformative view of digital technologies in education:

> In order to transcend the transmissive view of education, it is necessary to adopt a transformative view of technologies as resources for transforming existing practice by providing new ways of thinking, knowing and acting in education. How can that happen? Rather than transmitting information more efficiently and…effectively, and rather than controlling the thoughts and behaviour of learners, it is necessary to allow learners to reflect on and represent what they know and believe and to use technology to support and amplify those activities (pp. 23 - 24).

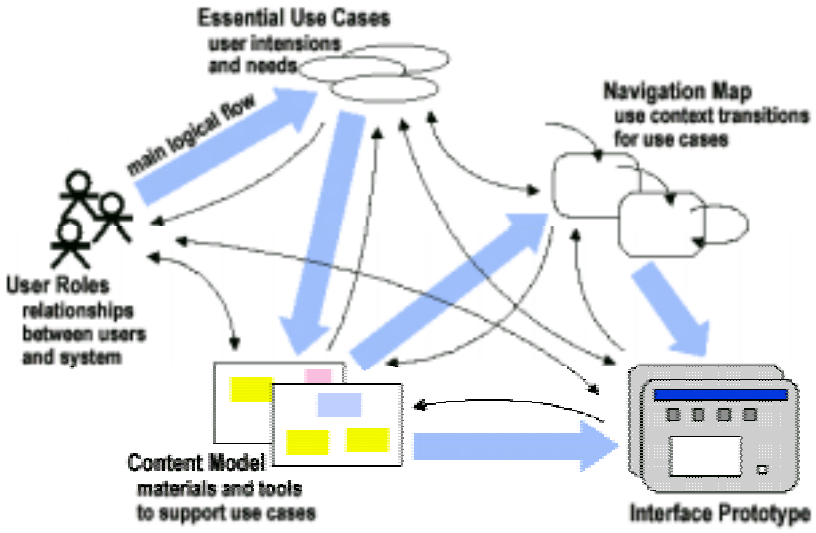
Wenger's definition of reification provides an example of technology supporting and amplifying activity. Jonassen stresses that people do not learn from technology, but rather through thinking in meaningful ways with meaningful activities. When technology enters the context of education as an intellectual partner, the learning process is transformed from receptive to participative, and to reflective and productive. This view of technology's role in education to some extent reiterates Zuboff. Jonassen summarises transformative views of education as reflecting the view that "learning as a social phenomenon constituted in the experienced, lived-in world, through legitimate peripheral participation in ongoing social practice" (Lave 1991, p. 64). When a goal is really important, people collaborate to socially co-construct shared meaning and negotiate shared responsibilities. Authority is socially mediated rather than dictated" (p. 24).

Like Jonassen, Gibbons et al believe the current focus on communication and shared problem solving is scaffolding a culture of social accountability, reflexivity and heterogeneity:

> Social accountability permeates the whole knowledge production process. It is reflected not only in interpretation and diffusion of results but also in the definition of the problem and the setting of research priorities. An expanding number of interest and so-called concerned, groups are demanding representation in the setting of the policy agenda as well as in the subsequent decision making process (p. 7).

Likewise, Engeström's zone of proximal development in activity systems highlights that one manifestation of this shared authority and social accountability is the inclusion of groups in the decision making process. From a human computer interaction perspective, Bertelsen (2000) and Bertelsen and Bødker (2000) see in actor-network theory's 'heterogeneity as a conceptual frame of analysis' a viable framework for designing technology. They believe that, "the focus on heterogeneity points to the profoundly different conditions that various groups (and individuals) have for participating in the design process" (p. 6). Similar to Gibbons et al, Bertelsen and Bødker propose a cross-functional approach to technology development. Constantine (1995) also holds this view and proposes in Figure 2, a heterogeneous process for the design and development of a software application:

Figure 2. Constantine (1995). Overview of a usage-centered concurrent modelling process (p. 12).




Constantine's model has at its centre the user or consumer. It incorporates the input of various groups, including general users, subject matter experts, computer programers and graphic designers. This heterogeneous or *participative design* process enables not only different groups to influence the design, but also to make the design process a learning activity as participants negotiate their involvement. Dix et al (1998, p. 229) summarise heterogeneous or participative design as a "a

philosophy which incorporates the whole design cycle. Participatory design is design in the workplace, incorporating the user not only as an experimental subject but as a member of the design team. Users are therefore active collaborators in the design process, rather than passive participants whose involvement is wholly governed by the designer" (p. 229).

Engeström and Constantine chart how workplace teams can encourage communication and the exchange of issues, values and expertise. Zuboff's belief that information technology textualises objects, events and processes is supported by the social theories of learning and workplace practices such as participative design. Theories of heterogeneous teams, communities of practice and the zone of proximal development underscore the increasing importance of text. These texts include the conversations we engage in, the processes we enact, the data we analyse and the artefacts we use and produce. The more textual our engagement becomes, the more we require strategies for navigating or 'renegotiating' these texts. Engeström and Constantine provide broad navigational schemas for organisational practice. However, if as Jones and Mercer, Jonassen and Law suggest, in a more systemic or heterogeneous world, technology is to play a significant role as an intellectual partner, we also require principled frameworks for designing navigable technology based educational resources. The following section explores some of the issues underpinning the design of digital learning environments. Socio-spatial metaphors, cultural artefacts and hypertext 'grammars' are factors in the effectiveness of a digital learning space. These elements are examined with a view to providing a taxonomy of learning space design.

## 3. Exploring digital environments: developing a taxonomy

Woolley (1992) observes that a host of computing developments such as digital environments and hypermedia have "opened up a new agenda for computing's research community. This agenda sees interactivity not in terms of a conversation between a natural and an artificial intelligence, but as an exploration of some form of cyberspace" (p. 154). Woolley cites Walker (1988) to support his view: "When you're interacting with a computer, you are not conversing with another person. You are exploring another world." These insights serve as a entry into an exploration of how we perceive digital environments. Crook (1994) accords with Jonassen's view that learning is a social phenomenon constituted in the experienced, lived-in world. Crook observes that socio-cultural views tend to focus "upon the manner in which environments serve to mediate cognitive activity" (p. 190). He subsequently suggests that one aspect of socio-cultural theory should be directed at "investigating options for integrating computers into this 'fabric' of the educational environment" (p. 190). This present section explores how we might design educational hypermedia to act in the capacity of an intellectual partner. Section 2 explored the role of communities of practice and the zone of proximal development in changing our perception of learning and education environments. With technology assigned a more central or legitimate role as a learning partner, the requirement for a principled awareness of the influence biological and socio-cultural factors exert on our engagement with digital technology can assist the design process. In this section the metaphorical and rhetorical underpinnings of the orientation and navigation strategies we adopt in digital environments are explored to devise a rudimentary best practices or taxonomy for the design of digital media. In contrast with the more informal processes explored in Section 2, this current section of the paper focuses on the explicit forms which might engender participation.

Kristoff and Satran (1995, p. 31) underscore the importance of design when they observe that even though users make their own choices in technological environments, information designers are

'gatekeepers' in charge of the choices they can make. Following Lakoff and Johnson (1980), metaphor is a basic cognitive principle of organisation for both language and thinking:

> Metaphor is pervasive in everyday life, not just in language, but in thought and action. Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature (p. 3).

Jonassen and Henning (1999) state the concept of 'mental models' has come out of the field of human-computer interaction as "a metaphor for describing the conceptions that humans develop for internally describing the location, function, and structure of objects and phenomena in computer systems" (p. 37). In this section of the paper, metaphor has a dual role: it both represents the artefacts embedded in digital spaces and the mental maps we create of these environments. That is, mental models represent a form of knowing. Our experience, cultural and social conventions and artefacts provide resources for the development of these mental models.

Tripp (2001) argues that "on-line learning is spatial in two senses: first there is a virtual space of online objects: text and media. Second, there is a cognitive domain that has surprising spatial qualities" (p. 41). He sources his analysis from studies examining the biological foundations of the cognitive maps we create to enable orientation and navigation in digital spaces. Allied with Wooley and Walker, he promotes the thesis that people tend to think of digital environments as "a kind of physical space in which they move" (p. 49). He believes this existing metaphor should be applied to designing digital spaces and, since people remember landmarks, routes and key nodes of information called *anchor points*, representations of these features should be included in information space design. Tripp references McCall and Benyon (1999) to derive his argument that we engage in three activities within an information space — *exploration*, *wayfinding* and *object identification*. He outlines these activities as: exploration lacks an explicit destination, wayfinding requires a specific destination and object identification is involved in understanding the structure of the information space. Wayfinding is

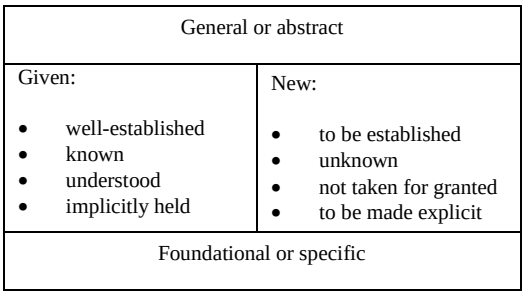
the most complex; it involves the processes of orienting oneself towards a goal, selecting a route, monitoring one's location along the selected route and recognising that the destination has been reached. Since his analysis is restricted to user strategies for developing comprehensive images of systems and spaces, Tripp does not elaborate object identification. Embedded in his analysis however is that unambiguous anchor points are precursors to understanding the information space structure. These anchor points facilitate the wayfinding which ultimately leads to the development of a cognitive or mental map. Kristoff and Satran (1995) suggest that imitating familiar cultural or anthropomorphic elements lessens the cognitive load involved in this process:

> For example, to get information about medical procedures, users might click instruments arranged in an on-screen doctor's office. This is a navigational metaphor: the doctor's office provides a familiar context to make the search for information less abstract (p. 41).

Such a metaphor streamlines the process of wayfinding. It presents the user with an immediate orientation and the ability to more readily select alternate destinations.

Kress and van Leeuwen (1990) add an ethnographic dimension to Tripp's biologically motivated appraisal of orientation and navigation in digital environments. They provide a means of making explicit the influence culture exerts on our interpretation of spatial arrangements and present a matrix to articulate how these arrangements reflect cultural metaphors in visual texts. For Kress and van Leeuwen, foundational elements are located at the bottom of a page, general or abstract notions are located at the top of a page and generally, "the meaning of the left-right structure is that the left equals the well-established, known, understood, implicitly held, the Given; and the right equals the to-be-established, presented as not yet known, not taken for granted, to be made explicit, the New" (p. 104). Figure 3 illustrates this understanding:

Figure 3. Kress and van Leeuwen's socio-spatial orientation.




Underpinning Kress and van Leeuwen's analysis is the effect of culture on *both* orientation and navigation. Kristoff and Satran (1995) amplify this understanding when they observe that, "people expect the friendly, familiar paradigms of media to guide them through uncharted territories of information….Each medium brings with it a unique language of orientation" (p. 38). While this explanation illustrates how existing cultural artefacts can be utilised to locate users in digital space, it raises the issue of cultural relevance and appropriateness. Kristoff and Satran underscore this point with their *functional metaphors*. These metaphors create "an environment in which objects perform the functions they depict. The best known example is the familiar desktop metaphor of many computer interfaces where folders are places to file documents, trash cans are places to throw things away, and an electronic address book holds names and addresses" (p. 41). Henderson (1996) also sees this familiarity as investing artefacts with cultural relevance. She however, raises the concern that "instructional design cannot and does not exist outside of a consideration of culture….When instructional design translates the topic into a tangible object…[like] software, it becomes an artefact of the culture in which it is embedded" (p. 86). This concern re-emerges in Section 6 in the influence of the workplace culture of one team on the design of a web application support system for other teams.

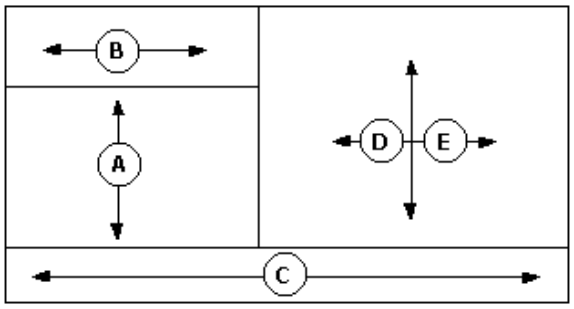
Kress and van Leeuwen's matrix and Lohr's grid for arranging digital space can be co-joined to provide general guidelines for the design of digital learning environments. Despite their visual appeal,

interface elements are not merely eyecandy. Lohr (2000) sees the interface of training and support materials as playing an important role in their effectiveness. She believes:

> The design of buttons, menus, labels, and other commonly used interface elements that direct learners to instructional information must be carefully considered. When the GUI [graphical user interface] is specifically used for instructional purposes, it can be thought of as an instructional interface — defined as the graphical elements in a computed-based training or support environment that help a learner or user go about the process of learning or performing (p. 45).

Lohr acknowledges that while training and support interfaces are different, they both fulfil an instructional function: "interfaces for both the training and support environments are designed to 'instruct' the learner on using the environment" (p. 45). She presents in Figure 4, a grid structure to guide the design of interface elements:

Figure 4. Lohr's grid structure.




While Lohr does not address the functional metaphors inherent in buttons, labels, menus and hyperlinks, her grid places information in much the same areas as Kress and van Leeuwen. Information in Zone A is reserved for body text (given or established elements). Zone B is reserved for headings (general information). Zone C is reserved for navigation (foundational or 'specific' information). Zones D and E are reserved for interaction or supplementary information (new, or information to be made explicit). Kress (1996) summarises the significance of this arrangement as:

"Display and arrangement are the fundamental features of the logic of the visual" (p. 18). He argues that salient visual elements combined with spatial relation enforce a visual logic.

Lohr (pp. 48 - 50) presents a similar analysis. She organises her grid structure around the three governing principles of the *figure/ground* principle, the *hierarchy* principle and the *gestalt* principle. The figure/ground principle requires the most important information be visually distinct. This enables users to immediately focus on key elements. The hierarchy principle prescribes organising information according to a 'visual semiotic' of stratification. That is, she suggests information be organised by degree of relatedness and then organised hierarchically according to importance. The gestalt principle prescribes organising information in such a way that users acquire a conceptual overview of the role of a piece of information in a larger or more harmonious context.

Depth is implicit in Kress and van Leeuwen's movement from general to specific. Lohr's hierarchy principle also captures the notion of depth and is analogous to the *drill down* and *drill up* of the Archival Information System (OAIS) (1995, online):

> Drilling down or up is a specific analytical technique whereby the user navigates among levels of data ranging from the most summarised (up) to the most detailed (down). The drilling paths may be defined by the hierarchies within dimensions or other relationships that may be dynamic within or between dimensions.

As Kress and van Leeuwen, Lohr and the OAIS illustrate, information in digital texts is frequently stratified or vertically organised. Horton (1994) sees this as "what you might put later in a paper document, you would put deeper in an online document" (p. 179) and Kristoff and Satran's (1995) suggestion that a good navigation design will minimise depth by creating "a hierarchy with the fewest possible levels" (p. 41) share this belief.

Lakoff and Johnson (1980 pp. 90 - 94) argue that we understand the logical structure of a text as both topographical and stratified. As their analysis is presented through overlapping syllogisms, it is useful to rework the gist of their argument as: we comprehend the over-arching structure of a text through relating it to a journey, which has a destination, direction and 'milestones'. Each of these milestones contributes to the breadth and scope of a text. Arguably, a milestone is equally a potential destination and a crossroads; we can explore each milestone or bypass it and proceed to the next. Kress (1996) presents a similar view when he argues that writing is a visual mode in which spatial logic is denoted through a metaphoric spatiality of *higher* and *lower* embedded in syntactic means of expressing subordination. He states that, "writing is thus doubly spatial: once metaphorical, through the order of syntactic hierarchy, and once actual, through the visual display on a surface" (p. 20). Kress and Lakoff and Johnson's insights can help direct the role content plays in digital environments.

Sydner (1996) defines hypertext as:

> Hypertext is an information medium that exists only on-line in a computer. A structure composed of blocks of text connected by electronic links, it offers different pathways to users. Hypertext provides a means of arranging information in a non-linear manner with the computer automating the process of connecting one piece of information to another. When the structure accommodates not only printed texts but also digitised sound, graphics, animation, video and virtual reality, it is referred to as "hypermedia" (p. ix).

Marshall and Shipman (1987, online) explore the dual role of hyperlinks. They help to augment both Kress' analysis of the logic of the visual reinforcing a syntactic hierarchy and Lohr's view of spatial arrangement. Drawing on Halasz's (1991) belief that hyperlinks can be explicitly or implicitly organised into one or more structures, Marshall and Shipman view hyperlinks as serving a two-fold function. Most commonly, "they are a mechanism that implements the rhetorical structure of a hypertext". Second, they are a representational form which can be used to "articulate specific

semantics of interconnection". They argue that while hyperlinks are mainly used to 'traverse' content, implicit hypertext structures can be realised through proximity or spatial arrangements. Such use of hyperlinks can help make explicit underlying structures and assist creation of mental models. As Kress' view of syntactic hierarchy implies, hypertext opens the possibility for entirely new representations of logical structures. Marshall and Shipman articulate this possibility as: "If hypertext can be thought of in terms of textual objects arranged in space, where a textual object can recur by appearing more than once in the same space, hypertext can have structure without conventional links". It is their capacity of signifying both boundaries and logical proximity which renders hyperlinks possible of enforcing rhetorical structure.

Borges' *Garden of the Forking Paths* (1962) is much referenced in hypermedia discourse as proposing infinite networks of possibilities, of diverse futures and times which proliferate and fork. In *Invisible Cities,* Calvino (1972) also presents a place of links:

> In Ersilia, to establish the relationships which sustain the city's life, the inhabitants stretch strings from the corners of the houses, white or black or gray or black-and-white according to whether they mark a relationship of blood, of trade, of authority, agency. When the strings become so numerous that you can no longer pass among them, the inhabitants leave: the houses are dismantled; only the strings and their supports remain….Thus, when travelling in the territory of Ersilia, you come upon the ruins of the abandoned cities…spiderwebs of intricate relationships seeking a form ( p. 76).

Calvino's Ersilia represents a powerful analogy of hypermedia and hyperlinked environments. Ersilia is a place of interconnectedness, the substance of which is the network of links comprising the city. Burdened by this network, the locus shifts, but the associations remain, perhaps themselves the authentic form of Ersilia.

The online version of Austen's *Pride and Prejudice*[2] exemplifies hyperlinking taken to extremes. This version superimposes a hypertext milieu upon a text already possessing an internal network of associations. What results is largely the inability to engage with the text. Such a hypertext construct is interrogative and, much like the inhabitants of Ersilia, encourages the reader to abandon the text and seek structure elsewhere. Conversely, a text such as Nabokov's *Pale Fire* (1962) contains networks of associations integral to its architecture, where the links themselves largely constitute the text. Ward and Bruce (2000) support this view of the interrogative nature of some hypermedia environments. They observe that navigating and making linkages may be an enervating process:

> The cognitive load posed by navigating among the various items in a hypermedia program may be so great that the user has little energy left for absorbing the content….Furthermore, users of hypermedia programs often find themselves in an aimless state, unsure what they are to do (p. 86).

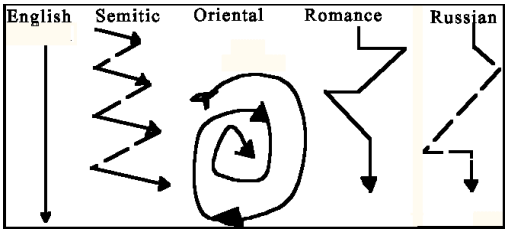
The hypertext version of *Pride and Prejudice* also helps illustrate that texts do not always readily lend themselves to alternate mediums. Miall (2000, online) notes that, "not only is the concrete form of the book supposed to drive how we read it; so too the *features* of hypertext are said to drive its *function*". To elaborate this view: Synder (1996) reports that for Ulmer (1992) *collage* is the discursive medium of hypermedia environments. In my assessment, within the visual space of digital environments, collage or verticality is one of the most powerful resources to orient users, encourage successful navigation strategies and assist semantic models. This view is contrary to the many network analogies of hypertext. It can be argued however, that perceiving of hypertext as a network constrains our understanding of hypertext to a topographical medium. Arguably, network analogies effect superficial understandings because they limit our involvement to a surface and thus do not address deeper levels of meaning. An additional shortcoming of network metaphors is that a topographical analogy assigns equal relevance to all elements of the text. It cannot therefore address what Kress (1996) considers

[2] Online at: http://www.pemberley.com/janeinfor/pridprej.html.

*syntactic subordination* (p. 20). Kress' subordination and Ulmer's *collage* become for Horton (1994) the layering or *progressive disclosure* of information. This "is the technique of successively revealing more detailed information about a subject" (p. 180) and enables the user to request the appropriate level of detail. Somewhat orthogonally, Laurillaud (1993) also provides support for adopting a drill down rather than a network view of hypertext. She alleges that hypertext is not interactive insofar as it provides no intrinsic feedback, nor moves toward a specific goal. Laurillaud sees hypertext as a connected 'database' which is neither adaptive nor reflective (p. 121). Further, she holds that the argument structure of text cannot be expressed as associative links, for these links are logical or rhetorical. The real educational benefit of hypertext is its faculty as an information retrieval tool (pp. 123 - 125).

For Whalley (1993), "a direct consequence of the fragmentation effect in hypertext is that it is likely to make it more difficult for the learner to perceive the author's intended argument structure, unless certain linearity constraints are imposed on the hypertext form" (p. 11). Structuring texts vertically helps lessen this difficulty. In Figure 5, Kaplan (1966) provides a writing analogy for Kress and van Leeuwen's socio-spatial metaphors. For Kaplan, different cultures possess distinct logical patterns and these patterns manifest themselves in the construction of written texts. In his analysis, English possesses a direct logic, Semitic languages demonstrate a staggered logic, the logic of Romance and Russian speakers is characterised by digression, and Oriental languages illustrate circular logic. Kaplan thus provides a means to relate Henderson's concern that objects become artefacts of the culture in which they are embedded to hypertext and the rhetorical structures it represents.

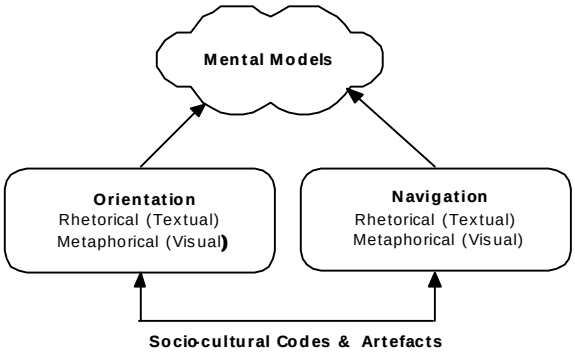
Figure 5. Kaplan's rhetorical patterns of different cultures.



Except where hyperlinks are used explicitly to confound established conventions, they should be used to assist the development of cognitive maps. For Waters (1996) this means, "your users should always know at any given moment where they've been at the site, and where they have yet to go" (p. 242). From a web developer perspective, Piperoglou (2000, online) has produced a tutorial on *The Care and Feeding of Hyperlinks*. He presents issues similar to Kristoff and Satran and Marshall and Shipman. Like Kristoff and Satran's *functional metaphor*, Piperoglou believes hyperlinks provide a useful function to the user and their function should always be obvious. Where hyperlinks are graphics, their function should be unequivocal and text links should be visually distinct, either through colour or underlining. Like Marshall and Shipman, he distinguishes between navigation and information links. Navigation links connect to structurally related pages and offer a way out of the page or back to point of origin. Information links are usually embedded in the text of a page and serve to cross-reference relevant information or access more detailed information. Analogous to Waters and to Lohr's grid, Piperoglou suggests providing 'breadcrumbs' to help locate the visitor *depth-wise* in large sites and navigation links to help locate the visitor *breadth-wise*, or link to adjacent pages.

Following Lohr, whether their overt purpose is to assist learning or performance objectives, all digital environments are to some extent learning spaces. This section has collated inquiry into visual and hypermedia environments in an attempt to establish a taxonomy for digital learning space design. Figure 6 represents such a taxonomy. In Section 5 this classification provides a framework to guide the development of a workplace software support system.

Figure 6. Possible taxonomy for learning space design.




We see digital environments as spaces or territories to explore. Biological and socio-cultural factors including tacitly accepted givens, values we take for granted, 'things' we wish to make explicit and our cultural artefacts influence information-seeking strategies. The orientational (anchor points) and navigational (goals or milestones) features present in digital spaces affect the cognitive or mental models we create. Socio-cultural codes and artefacts are often mutually influential and they are generally embedded in the visual and rhetorical components which comprise the orientational and navigational features of a digital environment. In these environments, metaphorical representations and spatial arrangements are particularly salient. Metaphor can be structural, functional, navigational or conceptual. It assists us in orienting ourselves and streamlining navigation. Since they undergird orientation and navigation, metaphors and the proximity of objects significantly influence the scope of our mental models. These models reflect learning or our knowledge of a digital environment.

Like Henderson, Jonassen and Henning (1999) argue that mental models are "also embedded in the activities engaged in by a community of practice, the social relations among members of that community, the discourse used by that community to negotiate meaning and in the artefacts that are used and produced by the community during their activity" (p. 37). Their view has considerable implications when applied to the design of digital support environments for a specific community.

The following section outlines the first steps in restructuring the educational resources for a niche market software development firm.

# 4. Leveraging change: a client survey

This section of the paper is in two parts. First, it sketches a profile of a software development organisation and my role as a member of the Education and Consulting Products team. Based on team dissatisfaction with existing education products, a client survey was undertaken to gauge the validity of restructuring these resources. The second half of this section consolidates and summarises the survey findings with a view to their role in reassessing the direction and design of the company's educational resources.

Data is a medium-sized software development company comprised of approximately two hundred employees. The company provides specialist software to the accounting industry for which it produces practice management, time management and accounting software. The firm also produces income tax return processing software compliant with Australian Taxation Office (ATO) regulations. As a niche or vertical market company, Data maintains its market position through investing in strong connections with its client base and the ATO. The company's client-centric ethos is implemented in part through subscribing to the software design principles of Jacobson et al and Constantine. Both Jacobson et al and Constantine advocate designing software around user requirements. Jacobson et al's (1992) *use case* driven approach to object oriented software engineering and Constantine's (1995) usage centered design model are employed across the firm's corporate practices.

Jacobson et al base their model for software engineering on user requirements. They maintain that "since the whole system development starts from what the users wish to do with the system, we build the system from the users' point of view" (p. 157). Such a model places the user or *actors* at the locus of the design process. Jacobson et al define actors and use cases as:

> Actors [the roles of people or things that work on the objects within the system] model the prospective users; the actor is a user type or category, and when a user does something he or

> she acts an occurrence of this type. One person can instantiate (play the roles of) several different actors. Actors thus define the roles that users can play….A use case is a specific way of using the system by performing some part of the functionality. Each use case constitutes a complete course of events initiated by an actor and it specifies the interaction that takes place between an actor and the system. A use case is thus a special sequence of related transactions performed by an actor and the system in a dialogue (pp. 157 - 158).

Constantine (1995) also places the user at the centre of the design process. He focuses on the *usability* of interfaces:

> Ultimately, usability comes from the way the architecture of the user interface fits with what users are trying to accomplish. This means that you have to understand the work that users are doing in order for your software to fit with it. It also means that you must engineer the entire architecture of the user interface, its overall organization as well as the structural details and dynamic behavior, to support that work (p. 2).

Constantine summarises the importance of usage centered design with the observation that it proceeds from the basic assumption that using a piece of software is a goal-driven activity: "Why? Why is this needed? Why would users interact with this software? What are they trying to accomplish?" (p. 3). This starting point, as shown in Section 2, encourages a participative design process. Directed by Jacobson et al, management mandates the writing of use cases to 'script' user interaction with each element of the software. Constantine's influence enforces cross-functional project teams which represent the interests of stakeholders. These teams assess the validity, direction and implementation of new products and product enhancements.

Paralleling the guidelines Wood et al (1998) outline in Section 1, Data has positioned itself as a 'learning organisation'. The firm enacts a continuous process of consultation between stakeholders — members of different departments, government and industry representatives as well as clients or

subject experts. Systems thinking is effected through participative design and the acknowledgement that external and internal factors affect the direction and implementation of product deliverables. External influences take the form of ATO legislation, market fluctuation and client requests for enhancements, while internal influences are motivated by managerial directives, technical constraints, individual team practices and team member differences of opinion and insights.

My role at Data is Content Developer for the Education and Consulting Products team. This team is primarily responsible for creating client-facing resources for the Research and Development team, but also straddles the domain of Consulting and Marketing. My role entails writing manuals, training materials, online help, knowledgebase content and client bulletins. The project which occupies the remainder of this paper is an ongoing restructure of Data's educational resources to keep pace with client learning requirements. Within the broader remit of the project, redesigning the online help or product support system was the first milestone and it is this element of the project which occupies the following sections.

On average, Education and Consulting Products team members have been with the organisation less than two years. Team dissatisfaction with the quality and usefulness of the education resources was expected to parallel client assessments. Clients were thus invited to participate in a survey of the usefulness and usability of these resources in meeting their education requirements. As it was anticipated that results would reflect the team's own assessment, the survey was largely envisaged as a tool for leveraging change. Appendix I presents this survey. Areas which were forecast to receive negative responses were the delivery medium of some resources, the general appropriateness of resource content, ease of finding the required information and [F1] or context sensitive help.

The survey was web based and distributed as a link via the *e-bulletin*, a weekly email newsletter. It was devised as a 'tick the relevant boxes' format. This format was selected to help capture entrenched opinions or more instinctive assessments of existing resources. Approximately 5% of the 1500 clients who receive the *e-bulletin* completed the survey. The survey questions encompassed general learning styles, product interaction and more general opinions of the educational role of documentation. The questions were devised to produce qualitative measurements of client satisfaction with the products, but provided scope for quantitative observations. The survey focussed on online help but also incorporated comparative reference to manuals and training materials. From the clients who identified themselves through the feedback question, results were received across a range of skill levels, from rural and urban practices and from small and large practices.

The major findings to emerge from the survey were that clients were able users of the software who required a range of supporting materials combining procedural and problem solving content relevant to their workflow. Table 1 overleaf summarises the survey results:

Table 1. Data usability and usefulness survey results.

| Survey Areas | Findings |
|---|---|
| 1. Preferred modes of learning | Modes of learning were fairly evenly distributed across the selection choices. Education resources accounted for 45% of the total. Of this percentage, 23% was use of manuals, both online and printed. [F1] help accounted for only 10%. |
| 2. Product education | Experimenting with the software, colleague assistance and training accounted for 94% of product education. Online documentation accounted for only 17% of this 94%. |
| 3. Level of comfort with product | 65% of respondents indicated they were 'comfortable' or 'competent' with the software |
| 4. Preferred accompanying support materials | There was almost equal distribution among the available options of: online and printed manuals, online tutorials and resource updates available via the website. |
| 5 & 6. Accessibility and use of support materials | Access to resources was fairly evenly distributed. Use of resources:[F1] help and the e-bulletin were both 79%, paper manuals and training course materials were 53% and 50% respectively |
| 7. Support material priorities | Respondents wanted the online help to focus on procedures and problem solving. They also wanted the educational resources to stress how procedures integrate with their workflow. |
| 8. Assessment of online help | The features of [F1] help which respondents flagged as insufficient were:<br><br>1. ability to change the level of detail available<br>2. availability of context sensitive help<br>3. accurate, complete and understandable content<br>4. ability to find information<br>5. relevance of information |
| 9. What makes a help system valuable? | At 80% and 57%, procedural and goal-oriented help were the most valued attributes. |
| 10. Suggestions and comments | Many of these suggestions enforced the need for paper manuals and more client involvement in their content. |
| 11. Usefulness of survey | Rarely answered. Some respondents suggested the survey could have been improved by providing space for commentary for each question. |

The survey results enabled the Education and Consulting Products team to make five general recommendations for restructuring the product support resources. These recommendations were:

1. Implement a more extensive [F1] or context sensitive help feature.
2. Restructure the architecture of the entire help system so the content of individual help topics include overview, procedural and problem solving information.
3. Create interactional tutorials to ship with the product or be made available from the website.
4. Increase the modularity of manuals so they can be more easily maintained and available for download from the website.

5. Restructure training sessions so they more closely reflect practice workflows and team member roles, rather than products.

Implementing more extensive context sensitive help would enable clients to bypass the process of opening the help from the Help menu. Users could more rapidly access procedural and problem solving information. This would enable issues such as: “[F1] help is rarely available on the topics that we need help on”, “answers to How To questions instead of describing what is inserted into each field on an input screen” and “the documentation needs to be more easily accessible and with clear specific instructions” to be addressed. Restructuring the general content of the online documentation to include overview, procedures and trouble-shooting areas for each topic would help lessen complaints of: “more help with common errors or problems, for example, how to exit safely when wrong selection made; what error messages mean”, “help topics could be more targeted for problem solving” and “a complete guide from start to finish would be helpful”. Creating interactive tutorials was seen as one way of addressing the issue of more continuity in education products. Tutorials could also help address comments such as: “training costs are high, especially for rural and regional practices — travel time is not warranted for half day sessions” and “well constructed online tutorials would be a boon for small practices”.

The fourth recommendation to create modular reference manuals and have individual chapters made available on the website was a response to several comments received regarding a Marketing decision not to ship printed manuals with the product. Both general survey responses and specific comments highlighted that paper-based resources overwhelmingly supported client work habits. The recommendation to provide up to date manuals which clients could download as PDF files from the website was aimed at addressing comments such as: “a printed set of up to date manuals with annual upgrade is invaluable, would like these to continue”, “I would like to see a new paper manual issued for the Desktop series as I find the online manual in the program slow and not as helpful as the paper

manuals that were issued with the old Standard series". This recommendation also addressed requests for an area for the most recent documentation updates.

The decision to restructure the training materials was based on the high percentage of clients who prefer to learn through working with the software, assistance from colleagues, and training. These figures underscored the need to tailor training to focus on practice team member roles as these roles are reflected in product use.

The survey provided a qualitative assessment across the support product range and sufficient data to leverage its restructuring. It also contained ambiguities and problematic elements. The categories of *novice*, *comfortable*, *competent* and *expert* were used to determine a respondent's degree of comfort with the software. This classification may have produced uneven results as it forced respondents to make an assessment based on often connotative values for which no key was provided. A range of dates would have been more neutral. A selection of dates would also have provided information on how far respondents had progressed with the firm's training programme. Additionally, many of the comments highlighted difficulties with Question 7. Several respondents commented Question 7 was either "vague" or that they would have liked supporting examples. Such comments indicate that the 'metalanguage' of the survey questions worked at cross purposes to its aim. This question in particular assumed familiarity with terms such as "dialog box" and "context sensitive help". Furthermore, there was confusion regarding *online* referring to resources which accompany the product, since most people understand "online" to mean the Internet. A more suitable rubric for Question 7 might have incorporated questions such as, "I can press [F1] and get help with my current task" supported by *yes/no* options.

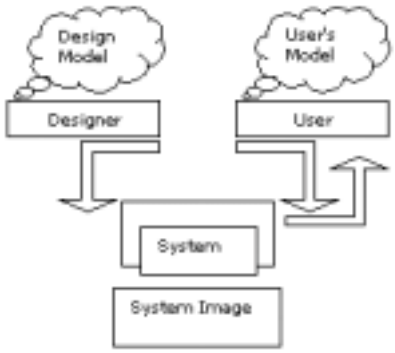
The online help is integrated with software applications. This means that every user has access to online support. Significantly however, while survey respondents indicated at 79%, high usage of online help, it does not figure prominently as a preferred mode of learning, nor in actual product education. Experimenting with the software, colleague assistance and training account for 94% of clients' learning. The Education and Consulting Products team therefore decided that upgrading the online support system in line with client recommendations would enable it to figure more prominently in this 'community of practice'. The following section of this paper provides a discussion and evaluation of the design of an online support system. The design incorporates both survey responses and the principles for the design of digital environments explored in Section 3.

## 5. Education gone to market: educating the Sales team

The analysis and evaluation of a web-based support system forms the core of this present section. It discusses how research into the design of digital environments and the survey results were applied to the development of a support system for an in-house product. This discussion includes the remit from the company for the documentation, which principles from the research into digital learning environments were applied to the support system, and the rationale for their inclusion.

Results from the Usability and Usefulness Survey highlighted that despite being competent users of the software, respondents could not access adequate online support resources. The fault, as Gaffney and Norman emphasise, lies not with the clients, but with the structure and content of these resources. For Gaffney (2000, online), "No matter how poorly [users] perform in using the site, logic dictates that if they cannot use a site designed for them, the fault therefore lies in the design". In this he echoes Norman (1988) who states that "the human mind is exquisitely tailored to make sense of the world. Give it the slightest clue and off it goes, providing explanations, rationalisation, understanding....Poorly designed objects can be difficult and frustrating to use. They provide no clues — or sometimes false clues. They trap the user and thwart the normal process of interpretation and understanding" (p. 2). Norman elaborates with reference to the *conceptual model* illustrated in Figure 7:

Figure 7. Norman's conceptual model (p. 16).



The *design model* is the designer's conceptual model. The *user's model* is the mental model developed through interaction with the system. The *system image* results from the physical structure (including documentation, instructions and labels). The designer expects the user's model to be identical to the design model. But the designer doesn't talk directly with the user — all communication takes place through the system image. If the system image does not make the design model clear and consistent, the user creates the wrong mental model.

Shortly after sending out the client survey, the company merged with an organisation producing similar software. This move necessitated the integration and rationalisation of products from both firms. As a result, much of the education resources restructure was put on hold. The insights gained from research into digital education environments and the client survey were however still used to guide the developmental direction of support resources.

During the integration and rationalisation of the desktop applications, Data diverted resources towards research and the development of web-based applications. Despite the negative connotations which infuse the term, Data is ultimately a 'technocapitalist' company, generating revenue from the creation and distribution of technology. Since online products are seen as a commercially viable yet not fully tapped product growth area, it was decided to develop and internally roll out prototype applications. This development and use cycle is seen as a valuable learning ground for assessing future development and client training requirements. One web application which has been developed is a work management system called Pulse.

Pulse enables team members to create a shared knowledgebase of client interactions. Within this space, each team member has an area where they store information on work they undertake for clients. The design philosophy undergirding Pulse is that any member of the organisation can enter client

contact details into the corporate database and have this information available for use in Pulse. Sales or Support team members will initially assume responsibility for these clients. The program enables team members to record their anticipated and actual client interactions. For Sales team members this record will take the form of recording client telephone calls, correspondence, meetings and presentations as they advance a sale. For Support team members this record will take the form of logging support queries and tracking the resolution of the problem.

The Sales team were selected for the Pulse roll out. The rationale for their selection was two-fold. First, the team maintains paper based and largely informal records of their client interactions. This system makes it both difficult for the team to share information and difficult for individual team members to maintain an 'audit trail' of client interactions. Secondly, for vertical market providers, Sales teams occupy a pivotal position in client acquisition, assessing product strengths or weaknesses against client requirements, and providing feedback on market trends. As representatives, their buy-in to the products they promote is essential. Data has recently launched the Web Cashbook, an online cashbook enabling small businesses to maintain their accounts via the Internet. Despite extensive training the Sales team were reluctant to use or actively promote the product. Following Norman, repeated requests from the Sales team to Research and Development for Web Cashbook installation information evidenced a mismatch between the developer's design model and the Sales team's mental model.

Within this context, Pulse can be assessed as a zone of proximal development. Much as in Engeström's interpretation of the zone of proximal development, Pulse has become a learning zone for both the company and individual teams. For the organisation, it helps navigate the distance between current and future products. Through adapting the product and support documentation to the needs of the Sales team, Pulse is a zone of proximal development for the Research and Development and Education and Consulting Products teams. Pulse will also become a learning zone for the Sales team

as they understand the product and its relation to the future development agenda. This is not to suggest however, that Engeström's interpretation of the zone of proximal development be recast as a panacea to valorise all areas of corporate growth. Rather, through the participative design process of inquiry and exchange, the goals, boundaries and practices of these activity systems or groups will create learning opportunities.

While they enable us to focus on the process of exchange, neither Engeström's developmental assessment of the zone of proximal development, nor Constantine's allied usage-centred concurrent modelling process explicitly address the reflective aspect of learning. Following Bigum, who challenges that much technology based learning does not enable reflection to coalesce inquiry into learning, it is possible to view Wenger's *reification* as a form of reflection. To reiterate his definition: reification covers a wide range of processes that include "making, designing, representing, encoding and describing, as well as perceiving, interpreting, using, reusing, decoding, and recasting" (p. 59). Against this background, objects and artefacts, whether tangible tools, or interpretations and understandings, represent learning coalesced into deliverables

The necessity for reflection accents shortcomings in the taxonomy for learning space design in Section 3. This taxonomy is limited in that it does not adequately capture the reflective nature of orientation and the goal-directed nature of navigation, nor the reciprocity between them. Through Wenger's reification, a mental model can be construed of as a means of making learning tangible. Tripp's analysis of *wayfinding* indicates that orientation is a necessary first step, yet is subsumed within the process of wayfinding. To understand wayfinding as a *process* helps reposition orientation and navigation within the framework of learning as a zone of proximal development. Figure 8 illustrates a possible representation of this view:

Figure 8. Orientation and navigation as a zone of proximal development.


Much like Constantine's (1995) usage centred modelling process, this model has as its premise that user interaction with software and a software support system is a purposeful or goal-directed activity. Tripp's wayfinding appears to be a largely linear process of movement towards a goal. Seeing the relationship of orientation, navigation and goal as linear does not account for the learning or internal dialogue involved in this process. The model above attempts to represent the cyclical nature of orienting oneself in digital space, navigating towards a goal and then re-orienting oneself. At the boundary of each of these actions is reflection. Learning occurs where these activities overlap and, in conjunction with the learning space taxonomy of Section 3, this revised understanding helps inform the documentation for Pulse.

A software support system can be construed of as a sort of Engeströmian zone of proximal development. That is, it mediates between a user's current position and desired task achievement. To support this role, a help system interface needs to be as transparent or as intuitive as possible. Ward and Bruce (2000) cite Elkerton (1988) in defining the purpose of online support or help systems for computer software users as: "to improve current and long-term user performance with the computer interface" (p. 85). Drawing on the research of Head (1998) they suggest that in working towards this objective users pose a number of questions which they use to form mental models of the application. Some of the questions asked include: "*conceptual* (What can I do with this program?), *descriptive* (What is this for?), *interpretive* (Why did this happen?), and *navigational* (Where am I?)" (p. 86).

Horton (1994, pp. 34 - 35) also focuses on the questions users ask as they form mental models of software applications. He divides these questions into metacognitive and goal-directed queries. Horton's metacognitive questions can be interpreted as reflective and encompass locating oneself in the software as well as assessing one's knowledge. Examples of such questions are: Where am I?; What information is here?; Can I do it on my own? and What else should I know? Navigational or goal-directed queries involve actively seeking answers. These queries include: How do I?; When do I?; What happens if? and How else do I?

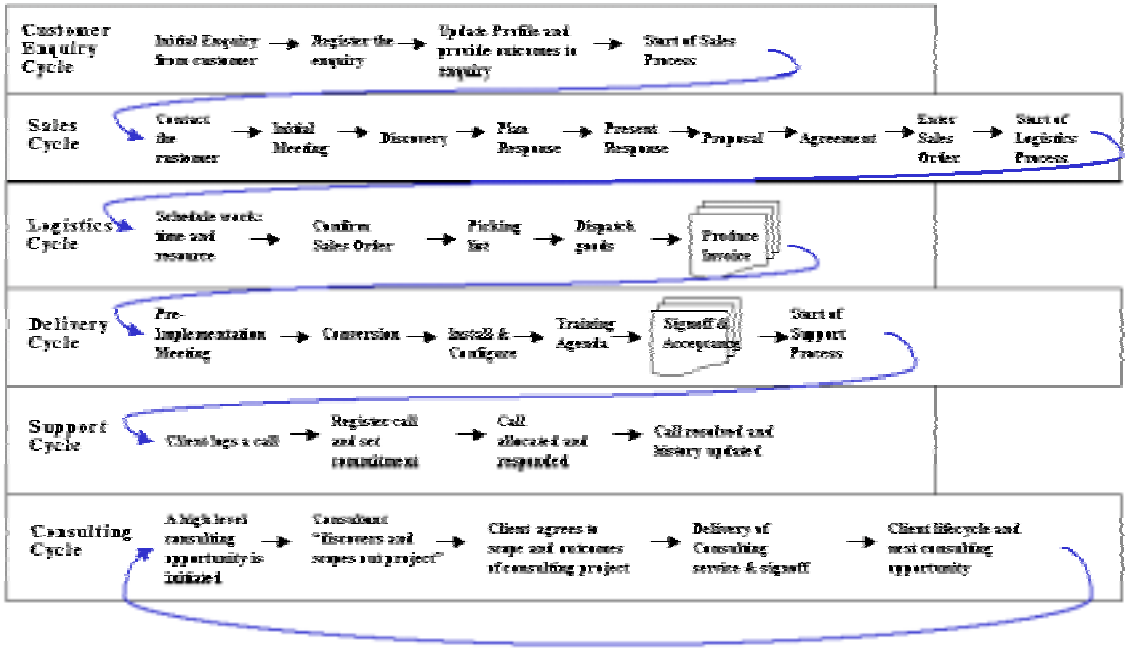
From the questions users ask when engaging with a piece of software, Ward and Bruce (2000) define the essential features of a learner support system as:

> (a) support in optimising use of the program (procedural and related help), (b) support in learning the content (context-sensitive help), and (c) support in monitoring and enhancing learning (metacognitive help). (p. 87).

For Horton (1994) this is understood as assisting the user in overcoming a problem, understanding a task or procedure, making a decision and performing a task more efficiently. He also identifies five predominant user groups ranging from novices, occasional users, transfer users, experts and rote users, all with different learning and performance requirements (p. 28). Horton's classification fulfils a dual role in that it first provides general categories within which to assign information. Secondly, as it does not presuppose a typical user, it incorporates continual modification of user types and goals. Ward and Bruce and Horton thereby provide a starting point for organising the content of a help system. To facilitate content management, Horton recommends 'engineering' a reading sequence. This is similar to Tripp's wayfinding and involves establishing a primary path directed at the largest or most important user group, then adding additional paths for other users with special needs (p. 186). For the Pulse support resource the primary path was established for novice users, but an alternate information path was created for users who quickly become comfortable with the product.

The Sales team belongs to the Customer Service division. This division provided a basic workflow for all its teams. Figure 9 illustrates how the Sales team workflow fits into a customer service cycle:

Figure 9. Data workflow and process for customer service.




Members from the Customer Services department, the Research and Development Online and User Interface teams, the Finances department and the Education and Consulting Products team were involved in the use case and design cycle meetings. Central to these meetings was the proviso that Pulse would reflect the workflow of the Sales team.

To replicate this workflow Pulse was set up to contain separate, but interrelated modules. The modules function as a means of filtering data for viewing purposes, but all modules utilise the same basic data. Table 2 illustrates these modules and a summary of their function:

Table 2. Pulse modules.

| Module | Purpose |
|---|---|
| My Stuff | Users select this module when they wish to view and work with their own client files. |
| Contacts | Selecting Contacts enables users to view or work with client files across the entire Customer Services department. |
| Matters | Selecting Matters enables users to view tasks for all team members. |
| Employees | Selecting Employees enables users to find a team member's email address and view their current workload. |
| Organisation | The Organisation area enables viewing of a hierarchically arranged list of all Sales team members, viewing and accessing of the support queue and viewing of general information relevant to the Sales team such as scheduled meetings, a history of meetings, sales forecasts and a history of all sales. |

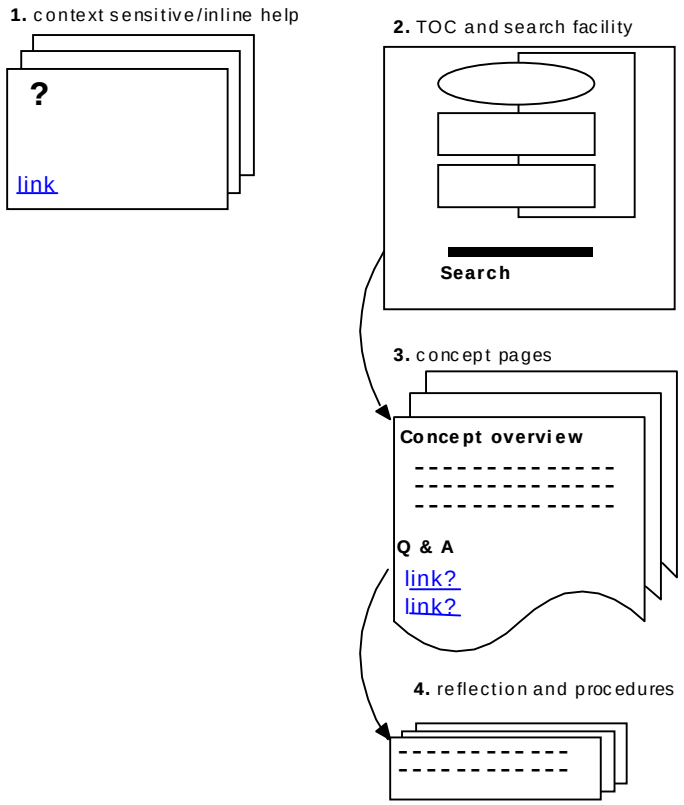
The Sales team were to be educated on Pulse via a 1 - 2 hour presentation and product walkthrough. At this session each participant would be provided with a printed copy of the online manual. The expectation however, was that most learning would occur on a need-to-know basis through the context sensitive help and online manual, as well as through the development of an informal colleague support network. Following Wenger that communities of practice are "not reified, designable units", no 'product champions' were assigned. The survey results supported this decision. Since the majority of clients learn through colleague assistance, it was believed that a support community would develop where required, of its own accord. How this community might influence educational resources has not yet been fully explored. However, an ethnographic analysis such as that shown in Appendix 2 might enable this learning to be incorporated into subsequent Pulse documentation.

The remit for the Pulse documentation was determined through cross-team consensus. The research into digital environments was collated with responses from the Usability and Usefulness Survey to provide a design framework for the support system. Tripp's (2001) anchor points, Lohr's (2000) learning space architecture, Kress and van Leeuwen's (1990) socio-spatial matrix and Kress (1996) and Horton's (1994) content layering or drill down as well as Horton's 'engineer a reading sequence' guided the development of this system. Kress and van Leeuwen and Lohr's influence is somewhat subliminal; it permeates the design principles but, because of the company remit, does not make itself felt as clearly as Kress and Horton's insights into the role of content. Consensus determined that this documentation would: (a) be brief, (b) 'map' the product architecture so that Sales team members

could very easily acquire an overview of the system logic, (c) have extensive context sensitive help available to guide new users through the system functionality, (d) provide an accompanying online manual, and (e) enable users to reflect on their knowledge of the product.

Working within these constraints, the Pulse development and Education and Consulting products teams devised a help system architecture. Figure 10 illustrates this architecture:

Figure 10. Pulse support system architecture.

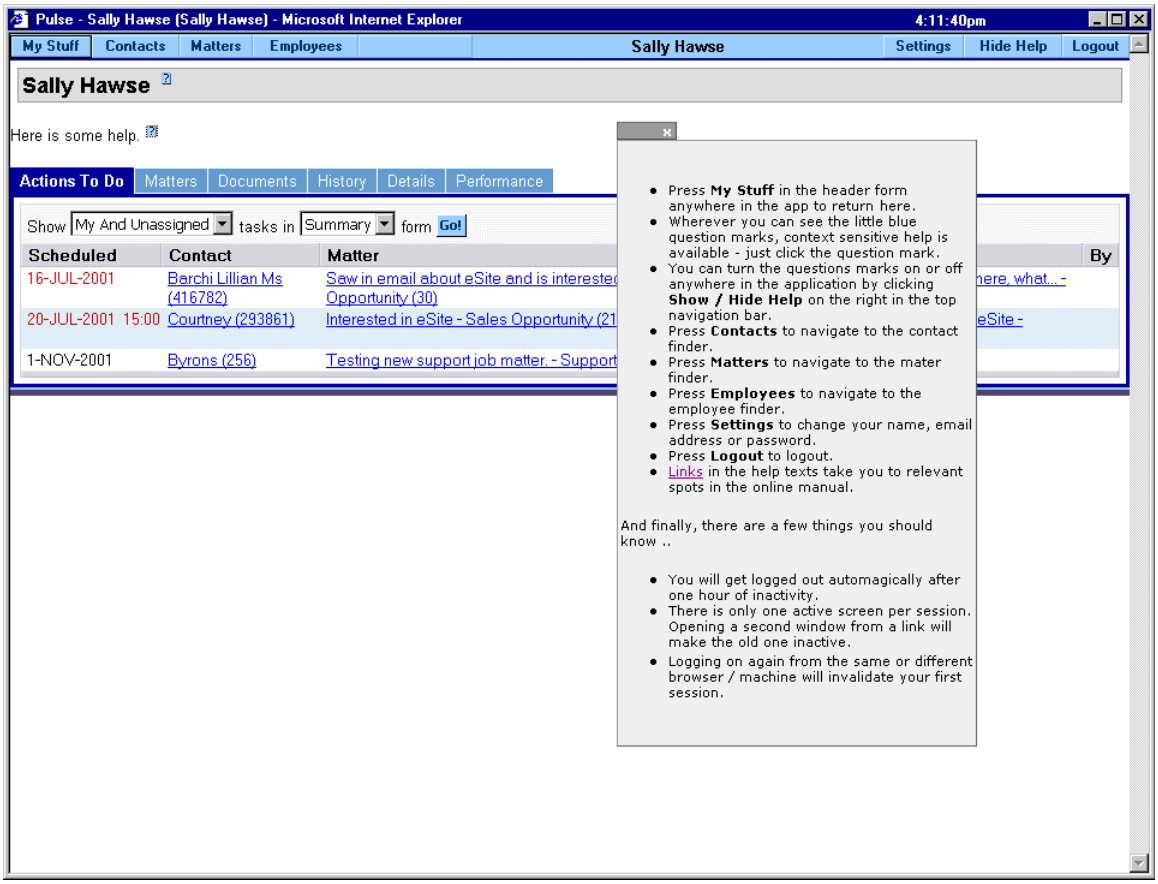



The Pulse context sensitive or inline help provides descriptions of screen functionality; it addresses Ward and Bruce's *navigational* or "Where am I?" and *descriptive* "What is this for?" questions. With the exception of the context sensitive help, the overall structure of the Pulse help system is almost exclusively vertical; it was designed to incorporate Kress and van Leeuwen's general-to-specific, Lohr's hierarchy principle, Ulmer's *collage* and Horn's "progressive disclosure of information". This

verticality is to help make explicit a semantic and navigational logic. The table of contents (TOC) is both a functional and a navigational metaphor which maps the interrelationships of the product's main features. The contents of the concept pages reflect the table of contents and enable users to drill down to procedural information. These concept and question/answer drill down pages incorporate Horton's metacognitive or reflective questions and Ward and Bruce's *conceptual* "What can I do with this program?". The following paragraphs explain these features and provide a rationale for their design.

Following client survey comments that more extensive context sensitive help would benefit their understanding of product functionality, every instance of context sensitive help was made visually explicit. The functional metaphor of a question mark icon (?) was selected as the orientational 'anchor point' to immediately identify the location and purpose of the inline or context sensitive help. These icons are seeded throughout the program, with each located where an explanation may be required. Unlike conventional desktop context sensitive help, all help items for a screen can be open at the same time, and these items can be dragged around the screen. This flexibility was devised to address client requests for more extensive context sensitive help. It was also incorporated in the belief that being able to access all the inline help for a screen would assist users in creating cognitive maps of the system. Potentially this would enable more informed navigation and goal-directed usage. Where users find the inline help icons distracting, the Settings module contains a [Show/Hide Help] option. Clicking this button enables users to toggle the display of help as required. Additionally, as the inline help content is limited to providing an overview of screen functionality, links are provided to more detailed explanations in the online manual. Figure 11 below illustrates the Pulse inline or context sensitive help:

Figure 11. A screen in Pulse.[3]

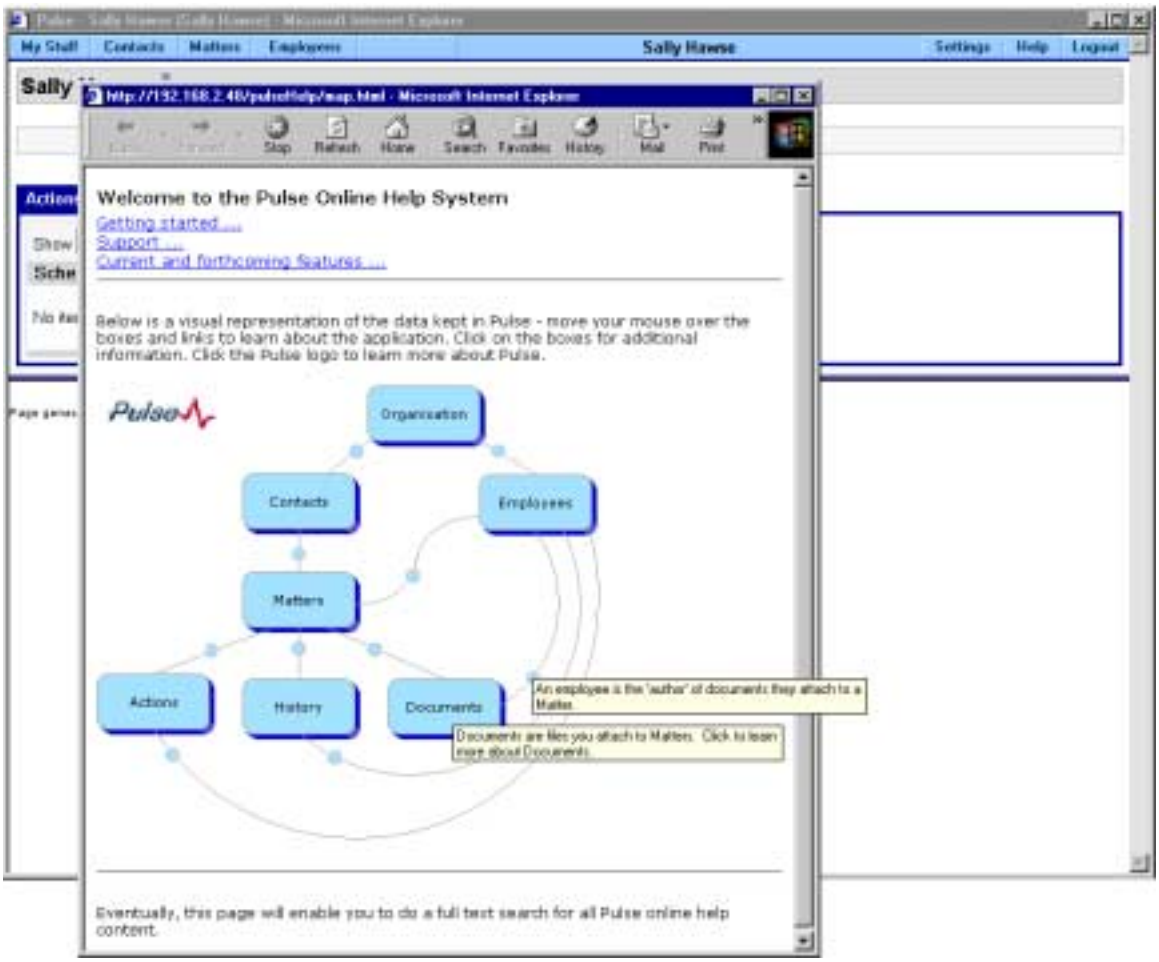



The Pulse [Help] toolbar button opens the knowledgebase in a separate window. This knowledgebase contains all online manual pages and knowledgebase articles. The index page functions as both the Pulse TOC and a search facility. Entering a search phrase in the box and clicking [Go!] replaces the contents of the index page with hyperlinked search results. The Pulse TOC is an image of the program architecture. Clicking a blue icon, such as *Contacts* replaces the TOC with the selected manual page and moving the mouse over one of the 'pulse points' (●) displays an explanation of the relationship between the main system components. Following Kristoff and Satran's (1995) *navigational* and *functional* metaphors, the dual purpose of the TOC/index page attempts to economically address the needs of novice and more experienced users. It is anticipated that new users

[3] The screenshots are representative; the Pulse support system is still in development.

will require an overview of the system architecture whereas more experienced users will be seeking specific information. Figure 12 illustrates this TOC and concept map:

Figure 12. Pulse TOC and concept map.



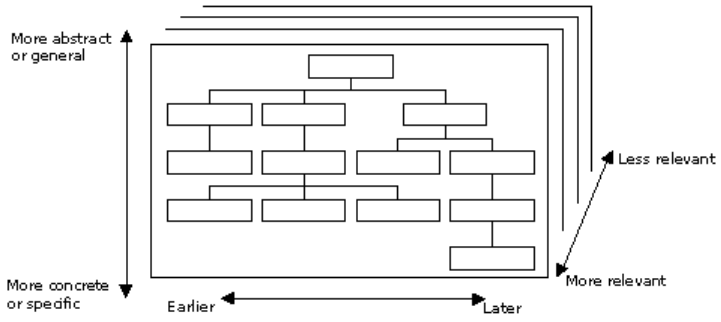

Reiterating Kristoff and Satran's belief that information designers are gatekeepers in charge of the choices users can make, Horton (1994) advises designers to consider that:

> Presenting information in the wrong order hampers learning, yet in intricately organised online documents, that order is entirely in the hands of the unguided user….[Y]ou can not anticipate all the possible ways a user can reach a given topic in an intricate document. You can, however, define a preferred reading sequence that presents information in a coherent order that ensures context….Design topics so they are understandable — or at least not

> confusing — if read out of order. At the same time, design them to encourage and support reading patterns that will help users (p. 185).

He suggests metaphor as a means of further organising information in hyperlinked environments. Mirroring Kress and van Leeuwen's socio-spatial model and Lohr's content grid, Horton recommends information be spatially organised by concept, with degree of proximity signifying conceptual distance. He suggests putting "abstractions and general concepts above concrete and specific facts. Arrange chronological events along a timeline with time flowing left to right. Show more relevant information at the surface and less relevant information on deeper layers" (p. 207). Figure 13 represents Horton's recommendations for spatially organising content:

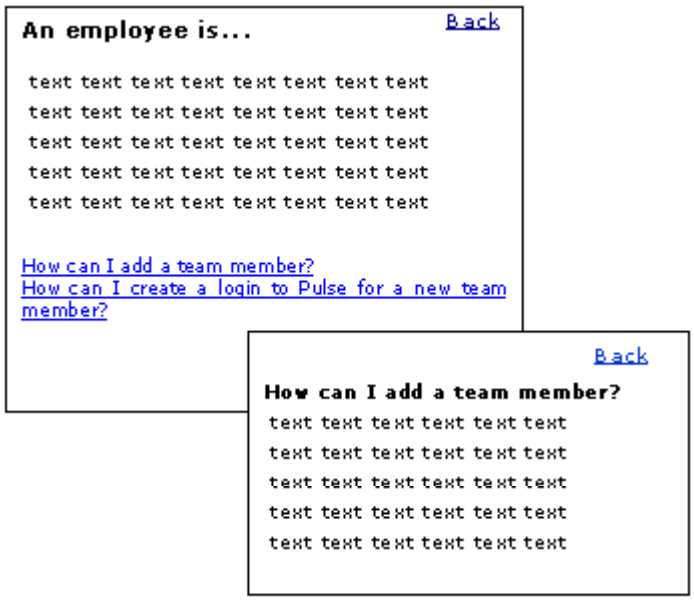
Figure 13. Spatial organisation of content.




Analogous perhaps to Kress' view that spatial arrangements afford new possibilities for the representation of logical structures and Ulmer's rhetoric of collage, 'information mapping' or structured writing is a common technique for organising the content of many software support systems. Deriving from Horn (1998, online), and implicit in Horton's 'reading path', structured writing recommends systematic analysis of content into *information blocks*. This involves deconstructing content into one of seven information types, which replace the paragraph as the basic unit of analysis and presentation. Horn outlines these seven information types as: Procedures, Processes, Concepts, Structures, Classifications, Principles and Facts. These information building blocks can then be recombined into larger elements as required.

Horn's information blocks provide a convenient framework within which to organise content. This framework was combined with Kress and van Leeuwen and Lohr's models to organise the content pages. Since brevity was the overriding constraint, the Pulse documentation content was limited to concepts and procedures. Problem solving information is expected to be included in a future release, but the extent of the problem solving information required will not be known until the Sales team provide feedback. Figure 14 illustrates a Pulse content page.

Figure 14. Main Pulse content page and drill down.




The content pages of the online manual are hyperlinked from the table of contents map. Each of these pages contains a conceptual overview of the main terms and concepts of Pulse. With the exception of the search facility, which contains occasional hyperlinks to more detailed explanations, the information blocks in the manual are organised according to a rigid hierarchy. This hierarchy follows Kress and van Leeuwen's understanding of general-to-specific. Users can drill down to more specific content, but must always drill up via the *back* link. Following Kress (1996), this constraint serves to enforce a clear awareness of the syntactic order of the information and, following Horton, this constraint functions as a clear reading path. Hyperlinks serve an exclusively navigational role in the

Pulse documentation. This restriction was imposed to alleviate the 'visual interrogation' of intricately hyperlinked texts and forestall an Ersilian abandonment of the resource. Therefore, much like Ward and Bruce (2000) who argue that hypermedia often leaves users with little energy for absorbing the content, and Laurillard (1993), who perceives the real educational benefit of hypertext is its faculty as an information retrieval tool, the role of hyperlinks in the Pulse help system is limited to information retrieval. Rather than hyperlinks, the rhetorical and stylistic similarity of each layer of information and partial overlapping or reiteration of content functions as cross-references or cognitive 'nodes'.

Laurillard has argued that hypertext is neither adaptive nor reflective. This limitation does not necessarily preclude hypertext from being utilised to simulate and possibly encourage the process of reflection. Such a possibility was forwarded in Figure 8 (page 52) of this Section: "Orientation and navigation as a zone of proximal development." This diagram attempts to represent how the iterative process of orientation, and navigation towards a goal might be construed as a learning process. At each part of the cycle one's mental map is, so to speak, redrawn. In the Pulse learner support system, further details and procedures are framed as questions. Following Ward and Bruce and Horton, the rationale for this question and answer format is to evoke a dialogue. This dialogue format anticipates conceptual and procedural queries a user might ask when working with the product. These questions and answers are employed to encourage users to reflect on their own knowledge of the product and in doing so, make their use of Pulse more goal-directed. This 'dialogue' is intended to simulate the dialogue users might engage in with themselves as they reflect on their knowledge of the product.

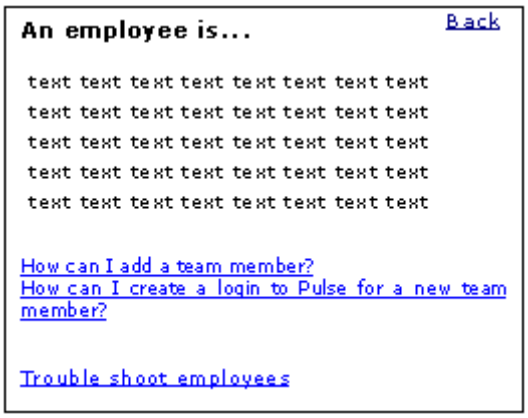
Similar to Nardi (1996), who believes people are motivated through their own goals as well as settings and artefacts, McLoughlin (1999, online) explores how learner styles might impact on instructional design. He cites Honebein, Duffy & Fishman's (1993, p. 93) assessment of the crucial role learner context plays in the design process:

> Stated simply, the context is not just an external context imposed by somebody else. It is also an internal context — the frame of reference or point of application that the learner generates (envisions). The learners (or readers) bring their own framework to the task. They have real world problems they are trying to solve and they read the text with those problems in mind. Hence the reader is cognitively problem solving in the area of application while reading the text. What information is attended to, how the information is organised and what personal knowledge is combined with the information all revolves around.... those contexts of application the reader imposes.

For workplace software in particular, users bring an existing mental model of the context of use. Here, as Miller and Boud have noted, our learning is grounded in prior experience and the context in which we operate. For Constantine this context is the rationale for participative design. The queries he asks at the outset of the development process: "Why is this needed? Why would users interact with this software? What are they trying to accomplish?" parallel Ward and Bruce's *conceptual* or "What can I do with this program?". While the question and answer format of the Pulse manual hyperlinks attempts to replicate the queries Sales team members might bring to the product in the context of use, these questions are limited to engaging with the program. More ontological information such as, "Why would I use this program?" is excluded on the assumption that in-house users will have been briefed on the rationale underlying the program. Following Norman, this omission may lead to a mismatch between the design model and the user's model. Valid questions addressing product limitations have not been included. One such question might be, "How can I secure my work area?" Queries of this nature have not been incorporated into the Pulse documentation for two reasons. First, for the development and education teams as well as for the in-house user, the application is very much a "moving target" — it is a learning zone for everyone involved in its development, and securing one's work area is tangential to its knowledge sharing remit. Second as the product exists on the assumption that knowledge sharing will unequivocally benefit users, securable areas were not envisaged.

Technical issues and context of use are the major limitations of the Pulse support system. The requirement that the documentation to be brief governed its overall design. This constraint encouraged crossing the more common documentation metaphor in which a table of contents, chapters and index simulate a paper manual with a web site metaphor. The challenge of this architecture is that while the Pulse table of contents 'concept map', hyperlinked concept pages and 'procedures as dialogue' design is well-suited to a small program with minimal features, it does not readily lend itself to scalability. When the Sales team provide feedback on the support system, content will change and problem solving information will need to be included. Ideally this problem solving information will address Ward and Bruce's *interpretive*, or "Why did this happen?" How this information might be incorporated into the present design is problematic however. Both internal hyperlinks and further content layers would enable the scope of the help available to be expanded, but this growth might necessitate revisiting the company brief. Furthermore, adding problem solving information to individual question and answer pages would detract from their original purpose. Since problem solving content is not appropriate to the question and answer or 'reflection' area, following Kress and van Leeuwen and Horton this information might be included as a hyperlink at the bottom of relevant main content pages. This placement would retain the verticality or general-to-specific arrangement of the existing pages and still provide navigational clarity. Figure 15 illustrates this option:

Figure 15. Problem solving in Pulse.




The second and potentially more untenable difficulty with Pulse is the Employees module. Because of the open nature of Pulse, anyone logged into the system can access details of all client interactions through the Employees module. This horizontal transparency has raised technical and ethical dilemmas for the Pulse development team. These dilemmas have largely revolved around issues of how to make the Pulse system an information resource for Customer Services while retaining personal privacy. The concluding section of this paper discusses these dilemmas in greater depth and explores their possible impact on the effectiveness of the support resource.

# 6. Conclusion

Recounting organisational failures in endeavours to adopt corporate wide knowledge-sharing initiatives, De Long (1997) observes:

> Leveraging knowledge is not an end in itself. Experience has shown that successful knowledge management strategies are always driven by clear links to business objectives. But simply implementing a more knowledge-oriented business focus and installing the necessary technological infrastructure will not produce the changes necessary in behaviour and culture to enable more effective knowledge use (p. 4).

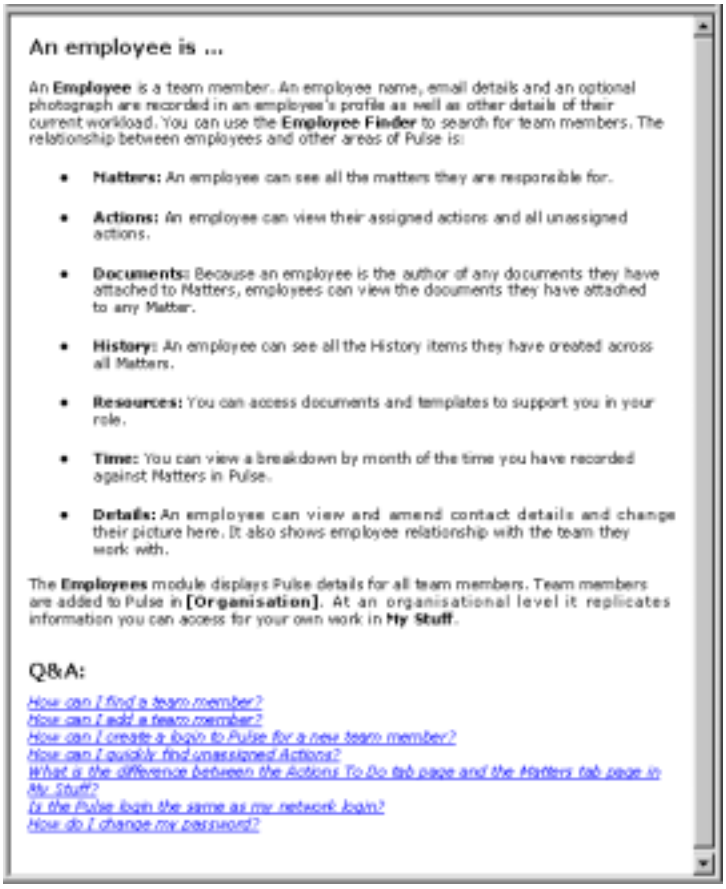
De Long cites as an example the failure of one firm to adopt a Lotus Notes implementation. He ascribes this failure in part to "the firm's rigid hierarchy and its competitive and individualistic culture" (p. 5). His example reiterates Wenger's caution that communities of practice are not about form; they are not reified, designable units. Similarly, Kofman and Senge advise that a learning organisation is not an external phenomenon or an independent reality. Following Wenger, an organisation can implement procedures, but these procedures cannot legislate practice. Knowledge sharing is ultimately about content — learning as a living experience of negotiating meaning.

Culture exists at different levels of an organisation. The systems worldview and 'learning organisation' practices of Data do not filter undiluted through the firm. Individual departments have differing values, norms and practices. The knowledge sharing and participative design ethos of management and Research and Development does not find a behavioural corollary in Sales. As opposed to Research and Development, where communal or team effort is encouraged, in Sales individual effort is rewarded. This highlights a potentially dangerous dichotomy. In the opening section of this paper, I cited Wood et al as contending that the link between their needs, expectations and values and organisational incentives bears a direct relationship to an individual's willingness to

perform. Such a link exists not only at the individual level; it can also exist at a departmental or team level. For Research and Development individual effort is largely subsumed in team endeavour. For Sales on the other hand, while team effort is tacitly enforced, individual achievement is both mandated and garners rewards. Sales team members are individually given substantial returns for the clients they secure. Such a departmental culture is at cross purposes to the architecture of Pulse, and particularly to the individual team member work displayed in the Employees module.

This dichotomy gives added significance to Wenger's *reification* and Henderson's (1996) concern that objects become artefacts of the culture in which they are embedded. Managerial knowledge exchange policies are aligned with the values, norms and practices of Research and Development and are reified through Pulse. This culture extends to its support system and is likewise embedded in the conceptual and procedural information available to users. That these values and practices are at odds with those of the Sales team is evident in the content of the documentation. As an example, the resource consistently reinforces the managerial resolve to share information across the department. Figure 16 illustrates such content:

Figure 16. A Concept page in Pulse.




At no point in the documentation are ontological or existing work practices addressed. Constantine's edict that development starts with the question: "Why is this needed?" has been for the Sales team overridden by managerial vision. Despite a participative design cycle, Blacker's algorithmic knowledge capture has been implemented. Yet, as Wenger and De Long have emphasised, technological infrastructure and tools will not alone effect behaviours and cultures of effective knowledge use or sharing. Much as with the conversational exchanges inherent in Constantine's concurrent modelling process and Engeström's zone of proximal development in activity systems, Squire and Reigeluth (2000) stress the centrality of dialogue:

> the design process begins with a visioning phase in which all stakeholders come to a shared vision of what an ideal system would be like for their community….The conversation

> represents a new form of democratic process that replaces voting as a decision-making process….[T]he conversation is a knowledge-building and consensus-building process that deepens our understanding of complex issues and helps us to evolve our thinking toward shared beliefs and vision (p. 151).

The difference is the domain of these models. Constantine's (1995) model presupposes consensual agreement of the need for the artefact has been reached. As such, the vision negotiated is the design and interface elements. Engeström's model has broader scope in that it incorporates negotiating the need for the tool or artefact. Constantine elaborates usability as:

> Ultimately, usability comes from the way the architecture of the user interface fits with what users are trying to accomplish. This means that you have to understand the work that users are doing in order for your software to fit with it. It also means that you must engineer the entire architecture of the user interface, its overall organization as well as the structural details and dynamic behavior, to support that work (p. 2).

His proviso that successful software must match and support the work users do for it to benefit this work has not, despite the consensus-building dialogue of the participative design cycle, been incorporated into the Pulse architecture. The Sales team culture of individual achievement and reward has been largely disregarded in this first implementation. That this knowledge sharing endeavour has not been matched by a reappraisal of the organisational reward system for the Sales team forecasts an unwelcome response to elements of the product. The reasons for selecting the Sales team for the Pulse roll out were valid, yet concerns with its impact on team culture and workflow were outweighed in the desire to make information around their client interactions an organisational knowledge asset. Ultimately the documentation falls short of learning objectives, for it reflects this stance and becomes another of the "competitive weapons" of Urdan and Weggen's knowledge economy. The mental model it helps create is potentially one of subordination.

Zuboff perceives that information technology textualises the objects, events and processes that constitute an organisation's work and that this textualising has created horizontal visibility — a panopticon. One effect of this visibility has been the emergence of the more action-centred skills of sharing and exchange central to Constantine and Engeström. Similarly in Squire and Reigeluth, conversation is a new form of democratic decision-making. But these texts have the potential to silence alternative voices and opinions. In *Outpost of Progress,* Conrad makes the following observation:

> The courage, the composure, the confidence; the emotions and principles; every great and every insignificant thought belongs not to the individual, but to the crowd: to the crowd that believes blindly in the irresistible force of its institutions and of its morals, in the power of its police and of its opinion (p. 58).

His view serves to emphasise that in a polyvocal text, where stakeholders come to a shared vision, the voice of dissent or difference may be suppressed by the louder voice of the group. Fullan (1993) articulates the dangers of 'groupthink' when he notes that group consensus often restrains expression of contradictory perspectives. He states: "The dark side of groupthink is not just a matter of avoiding the dangers of overconformity. Under conditions of dynamic complexity different points of view often anticipate new problems earlier than do like-minded close-knit groups" (p. 35).

The systems worldview advocated by Kofman and Senge and Agoshkova provides a means to arrest the pendulum swings of social, technological and economic agendas. Such a focus on holism however, requires that differing opinions are not silenced through systems thinking being utilised to leverage and legitimate policies of group conformity. In contrast to Conrad, Fullan quotes Stacy (1992, p. 145) as cautioning that:

> The dynamic systems perspective leads to a view of culture as emergent. What a group comes to share in the way of culture and philosophy emerges from individual personal beliefs through a learning process that builds up over years. And if the learning process is to continue, if a business is to be continually innovative, the emphasis should be on questioning the culture, not sharing it. A dynamic systems perspective points to the importance of encouraging counter cultures in order to overcome powerful tendencies to conform and share cultures strongly (p. 36).

That the Research and Development department continues to have concerns about the Pulse Employees module opens possibilities for amendments more in keeping with the culture of the Sales team. An informal working group or community of practice is becoming established as team members consider alternatives and security enhancements to the Employees module.

The role of support documentation is to capture a product ‘as is’. For Pulse this raises the issue of enforcing a type of ‘learned helplessness’ which Norman (1988, p. 42) identifies as a normal outcome of badly designed tools. While the Pulse documentation makes its own design clear and provides unambiguous orientational and navigational options, its content skirts valid questions such as “How do I keep my own work private?” Since the documentation is limited to reflecting a current state of development, all the questions it presents for reflection are closed or givens. The result is that only limited cognitive maps are encouraged, for a 360 degree view of Pulse potentially opens the product to censure and constraint by the Sales team. How the organisation addresses this censure and whether it heeds the community of practice already developing around system and documentation modifications will be a measure of its investment in its own ‘learning organisation’ infrastructure. In its current context the support system has little possibility of becoming a learning partner. Rather, it serves to encode and transmit the values of management and Research and Development.

Paralleling Zuboff's panopticon, Kofman and Senge perceive that a learning organisation involves the observers and the observed in a common system. Language is a means of negotiating our reality. They stress however, that the systems worldview, within which learning organisations can become realities is a continual process of becoming:

> The map is not the territory, but we can only guide ourselves with maps. As cartographers, however, we are far from neutral. Our perceptual apparatus, with its biological, personal, and cultural filters, is actively involved in the construction of these maps. So, where is the territory underlying the maps?….The issue is deeper than recognising that the map is not the territory. We have to face the possibility that we have no access beyond our culture to such a thing as a territory. We only have provisional maps permanently open to revision and recreation (p. 31).

The givens presented for reflection in the Pulse documentation may guide users towards a rudimentary understanding of the program, but they do not address more far-reaching questions. In this, the documentation fails its wayfinding objective. It does not encourage an adequate map of the system. The real questions involve, as Kofman and Senge point out, the territory beneath the map: "Why should the Sales team use Pulse?" "How will it actually benefit the team or individual team members?" "How open is Research and Development to modifying this system?" "To what extent is management open to amending terms and conditions for the Sales team?"

A zone of proximal development, participative design model or community of practice is by its nature an open system whose boundaries are continually renegotiated. To be otherwise negates the possibility of learning or effaces the 'territory underlying the maps'. Much like Constantine's "Why?" Postman and Weingartner (1969) offer 'open questions'. These expand the boundaries of the orientational and navigational questions Ward and Bruce and Horton provide as a means of creating cognitive maps. Like Engeström and Wenger they "make visible a strategy of inquiry". Postman and Weingartner present a series of questions to help ensure participative design and systems thinking

models do not reduce to static systems of groupthink or dictates. For Postman and Weingartner the questions in Table 3, with variations and modifications, may be used as the basis for examining any system.

Table 3. Open-ended questions (Postman and Weingartner, pp. 118 - 119).

- What are the purposes of the system?
- What roles are people assigned?
- What rules must be followed?
- What rights and restrictions are given and imposed?
- What are some of its critical, underlying assumptions?
- What are its key words?
- To what extent do the problems of the system require decisions? choices? solutions?
- To what extent is the system changing?
- What are the mechanisms for change within the system?
- To what extent is the language of the system obsolete?
- What are the critical, non-verbal symbols of the system?
- To what extent are these changing?
- What is the actual effect of the system on people?
- To what extent is this different from the ostensible purpose of the system?
- Are there alternatives to the system?
- Can we do without it?
- How is the system related to other system of knowing and behaving?

These questions comprise a checklist which can be used to inform the research, implementation, documentation and review elements of the product development cycle. Appendix 2 illustrates how these questions might guide a Pulse documentation questionnaire or form a rubric for an enthographic assessment.

In summary, the participative design and systems thinking orientation of Data enable the firm to position itself as a learning organisation. Scope was provided to research digital learning environments with a view to how this knowledge might guide the development and design of future product support systems. Principles derived from this study and a client survey were applied to the development of an online support system for an internal application. The research on digital learning environments had a secondary and far more challenging outcome in that it highlighted some of the dilemmas involved in shaping knowledge age software as learning spaces.

# Appendix 1: Data usability and usefulness survey

**Usability and usefulness survey**

The purpose of this survey is to see how Data can best match its documentation and support materials to client needs. There are 10 questions in this survey. Taking a few minutes to complete the survey will assist us in making the support resources more valuable for you.

**1. How do you learn best?**

Please select from the options below those which best reflect how you like to learn.

| | | |
|---|---|---|
| ask a colleague | consult online help [F1] | consult an online manual |
| consult a paper manual | call Data Support | email Data Support |
| check the Data website | attend training sessions | attend workshops |
| have a consultant visit | trial and error | |

**2. How did you learn to use Data software?**

Please select those that apply from the list below.

trial and error
colleague
training
Data product documentation

**3. What is your degree of comfort with Data products?**

Please select one of the options below to indicate your degree of comfort with Data products.

| | | | | |
|---|---|---|---|---|
| novice | adequate | comfortable | competent | expert |

**4. Which support material do you think Data should provide with its software?**

*User Guides* within the software
printed *User Guide*
online tutorials
updates available from the Data website

Any other? Please describe

**5. Which of these items would you find most useful?**

User Guides within the software
printed User Guide
online tutorials
updates available from the Data website

**6. Which support resources can you access and which do you use?**

Please select from the options below the Data support resources available at your office and which you use to help you work with Data products.

| | | | |
|---|---|---|---|
| Online help [F1] | use | don't use | can't access |
| Online manuals | use | don't use | can't access |
| Online release notes | use | don't use | can't access |
| Summary sheet | use | don't use | can't access |
| paper manuals | use | don't use | can't access |
| Read Me on the Data CD | use | don't use | can't access |
| E-bulletin | use | don't use | can't access |
| Data website articles | use | don't use | can't access |
| Client Services telephone support | use | don't use | can't access |
| Client Services email support | use | don't use | can't access |
| log an Data website support request | use | don't use | can't access |
| training course materials | use | don't use | can't access |
| **Help > What's new** menu | use | don't use | can't access |

**7. Things that matter to you about product documentation**

Please indicate whether the following elements of a product support system are important to you. Select all of the options you consider important.

A Table of Contents.
An Index.
A search facility.
Short topics with links to background information or product usage.
Detailed topics.
Clear graphics.
Always a clear path to where you need to go next.
Easy printing.
The documentation focuses on solving my problems as they occur, not on usage.
Pop up windows to reduce the amount of text on some screens and to define terms.
Information you can easily read on screen.

## 8. What are your views on Data's online help?

Please indicate whether you agree with these statements about Data's support material available from the **Help > Help Topics** menu. Select all statements you agree with.

Data entry screens and dialog boxes are supported by navigation and completion instructions.
There are memory aids for commands, either through online quick referencing or prompting.
The help function is visible through, for example, a key labelled HELP or a special menu or icon.
Information is easy to find.
Information is easy to find.
The visual layout well designed.
Information is accurate, complete and understandable.
Information is relevant.
Context sensitive help is available.
I can change the level of detail available.
I can easily switch between help and my work.

## 9. What makes a help system valuable?

Please indicate which of the following features of a help system address the way you like to work. Select all statements you agree with.

Help should be: **goal-oriented** (What can I do with this program?)
Help should be: **descriptive** (What is this thing for?)
Help should be: **procedural** (How do I do this task?)
Help should be: **interpretative** (Why did that happen?)
Help should be: **navigational** (Where am I?)

## 10. Suggestions and comments

Is there something more you like to see in our documentation, is there anything in particular that you find unhelpful, or something you would like to change — please tell us how we could improve.

## 11. Please rate our survey

Were the questions relevant and easy to understand? Was there anything else we should have asked? Please give us your view of how we could make the survey better.

Thank you for taking the time to complete the survey.

# Appendix 2: Review questions for Pulse documentation

**1. How long have you used Pulse? _____**

**2. Do you use the online help?**

- ☐ never
- ☐ a little
- ☐ sometimes
- ☐ quite a lot

**3. To get assistance which do you use more often?**

- ☐ [?] context sensitive help items
- ☐ [Help] access the online manual

**4. Are there:**

- ☐ too few
- ☐ enough
- ☐ too many

context sensitive help items

**5. How can we improve the content of the [?] help?**

_____
_____
_____

**6. How often do you use the links in the [?] help?**

- ☐ never
- ☐ rarely
- ☐ sometimes
- ☐ quite a lot

**7. When you access the online manual from the [Help] button, which do you use more?**

- ☐ the chart
- ☐ the search facility

**8. How well do the "An Action is…" pages help you understand the main concepts of Pulse?**

- ☐ not much
- ☐ a little
- ☐ quite a lot

**9. How can we improve these concept pages – content? layout? accessibility?**

_____
_____
_____

**10. Do the "Question & Answer" links help you solve problems with Pulse?**

- ☐ not much
- ☐ a little
- ☐ quite a lot

**11. How can we improve these "Question & Answer" pages – content? layout? accessibility?**

_____
_____
_____

**12. Overall, how would you rate the Pulse documentation:**

- ☐ poor
- ☐ satisfactory
- ☐ good

**13. How can we improve the documentation to help your understanding of Pulse (for example, shorter topics, longer topics, different types of content, more pictures, an accompanying demonstration or anything else you can think of):**

_____
_____
_____
_____

# Sources

Agoshkova, E., B. (1998). *Systems Thinking in the Twenty-First Century*. Paper presented at the Twentieth World Congress of Philosophy, Boston, Massachusetts U.S.A. 10-15 August 1998. Online at: http://www.bu.edu/wcp/Papers/TKno/TKnoAgos.htm. Accessed 31 May 2000.

Apple, M. (1992). Is the New Technology Part of the Solution or Part of the Problem? Beynon, J. and Mackay, H. (Eds). *Technology, Literacy and the Curriculum*. London: Falmer Press.

Barritt, C., and Lewis, D. (2000). *Reusable Learning Object Stategy: Definition, Creation Process, and Guidelines for Building*. Version 3.1. 22 April, 2000. Cisco Systems, Inc. (2000).

Bertelsen, O., W. (2000). Design Artefacts: Towards a design-oriented epistemology. *Scandinavian Journal of Information Systems*, Vol. 12. pp. 15 - 28.

Bertelsen, O., W. and Bødker, S. (2000). Introduction: Information Technology in Human Activity. *Scandinavian Journal of Information Systems*, Vol. 12. pp. 3 - 14.

Bigum, C. (1987). *Beyond Tools*. Geelong, Victoria: Deakin University Press.

Blackler, F. (1995). Knowledge, knowledge work and organisations: an overview and interpretation. *Organization Studies*, b, pp. 1021 - 1046.

Borges, J., L. (1962). *Labyrinths*. London: Penguin (1970).

Boud, D. and Miller, N. (1996). *Working with experience*. London: Routledge.

Calvino, I. (1972). *Invisible Cities*. English translation copyright 1974, Harcourt Brace & Company. Orlando, Florida: Harcourt Brace & Company.

Castells, M. (1996). An introduction to the information age. *City*, Vol 1. No. 7.

Cisco Systems (2000). *RIO: A Standards-based Approach for Reusable Information Objects*. Online at: http://www.coursenet.com/html/products/white_paper_RIO.htm. Accessed 8 December, 2000.

Conrad, J. An Outpost of Progress. Dolley, C. (Ed). *The Penguin Book of English Short Stories*. Harmondsworth, Middlesex: Penguin. 1967.

Constantine, L., L. (1995). What Do Users Want? Engineering Usability into Software. Reprinted and revised (June 2000) from *Windows Tech Journal*, December 1995. Online at: http://www.foruse.com/Resources.htm. Accessed 4 September, 2000.

Crook, C. (1994). Collaborative interactions around and through computers. *Computers and the Collaborative Experience of Learning*. London: Reutledge.

Davenport, T. (1995). The Future of Knowledge Management. *CIO*. December 1995. Online at: http://www.cio.com/archive/010196_davenport_content.html. Accessed 16 May 2001.

De Long, D. (1997). *Building the Knowledge-Based Organisation: How Culture Drives Knowledge Behaviours*. Working Paper. Centre for Business Innovation. © 1997 Ernst & Young LLP.

Dede, C. (1996). Emerging Technologies and Distributed Learning. *The American Journal of Distance Education*.

Dix, A., J., Finlay, J., E., Abowd, G., D., and Beale, R. (1998). *Human Computer Interaction*. London: Prentice Hall.

Engeström, Y. (1999). Expansive Visibilization of Work: An Activity-Theoretical Perspective. *Computer Supported Cooperative Work*. 8: 63-93. © 1999 Kluwer Academic Publishers.

Fullan, M. (1993). *Change Forces: Probing the Depths of Educational Reform*. London: The Falmer Press.

Gaffney, G. (2000). *The Myth of the Stupid Users*. Online at: http://www.fairfax.com.au/software/20000215/A17561-2000/Feb15.html. Accessed 17 October, 2000.

Galbreath, J. (2000). Knowledge Management Technology in Education. *Educational Technology*. September - October 2000, pp. 28 - 33.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., and Trow, M. (1997). *The New Production of Knowledge: The dynamics of science and research in contemporary societies*. Sage: London.

Guile, D. and Young, M. (1998). Apprenticeship as a Conceptual Basis for a Social Theory of Learning. *Journal of Vocational Education and Training*. Vol. 50, No 2, 1998, pp. 173 - 367.

Hemingway, C., J. and Gough, T., G. (2000). The Value of Information Systems Teaching and Research in the Knowledge Society. *Informing Science*. Vol 3 No 4, 2000.

Henderson, L. (1996). Instructional Design of Interactive Multimedia: A Cultural Critique. *Educational Technology Research and Development*, Vol 44, No 4.

Hildebrand, C. (1998). Mapping the Invisible Workplace. *CIO*, 7 (15), July 1998.

Horn, R. E. (1998). Structured Writing as a Paradigm. *Instructional Development: State of the Art*. Romiszowski, A. and Dills, C. (Eds). Englewood Cliffs, N. J.: Educational Technology Publications. Online at: http://www.stanford.edu/~rhorn/HornStWrAsParadigm.html. Accessed 5 September, 2000.

Horton, W. (1994). *Designing and Writing Online Documentation: Hypermedia for Self-Supporting Products*. New York: John Wiley &Sons, Ltd.

Jacobson et al (1992). *Object-Oriented Software Engineering: A Use Case Driven Approach*. Wokingham: Addison-Wesley.

James, D. (1999). The Latest of all Possible Worlds. *Management Today*. July 1999, p. 3.

Jonassen, D., H. (2000). Transforming learning with technology: Beyond modernism and postmodernism, or: Whoever controls the technology creates the reality. *Educational Technology*, 40 (2), 21-25.

Jonassen, D., H. and Henning, P. (1999). Mental Models: Knowledge in the Head and Knowledge in the World. *Educational Technology*, 39 (3), 37 - 42.

Jones, A. and Mercer, N. (1998). Theories of Learning and Information Technology. Scrimshaw, P. (Ed) *Language Classrooms and Computers*. London: Routledge.

Kaplan, R., B. (1966). Cultural Thought Patterns in Inter-cultural Education. *Language Learning*, Vol. 16, pp. 1-20.

Kellner, D. (1997). *New Technologies, Technocities, and the Prospects for Democratization*. Online at: http://www.gseis.ucla.edu/courses/ed253a/newDK/techcity.htm. Accessed 5 May 2001.

Kimble, C. and Mcloughlin, K. (1995). Computer based Information Systems and Mangers' Work. *New Technology, Work and Employment*. 10 (1), March, 1995, pp. 56-67.

Kofman, F. and Senge, P., M. (1995). Communities of Commitment: The Heart of Learning Organizations. Chawla, S. and Renesch, J. (Eds). *Learning Organizations: Developing Cultures for Tomorrow's Workplace*. Portland, Oregon: Productivity Press.

Kress, G. (1996). *Visual and verbal modes of representation in electronically mediated communication: the potentials of new forms of text.* © Gunther Kress. Institute of Education, University of London. November, 1996.

Kress, G. and van Leeuwen, T. (1990). *Reading Images*. Deakin University: Deakin University Press.

Kristoff, R. and Satran, A. (1995). *Interactivity by Design: Creating and Communicating with New Media*. Mountain View, CA: Adobe Press.

Lakoff, G., Johnson, M. (1980). *Metaphors We Live By*. Chicago: University of Chicago Press.

Laurillaud, D. (1993). *Rethinking University Teaching*. London: Routledge.

Law, J. (1992). *Notes on the Theory of the Actor Network: Ordering, Strategy and Heterogeneity*. Online at: http://www.comp.lancs.ac.uk/sociology/soc054jl.html. Accessed 15 January 2001.

Lohr, L. (2000). Three Principles of Perception for Instructional Interface Design. *Educational Technology*. Volume 39, Number 3. May-June 1999. pp. 45 - 52.

Marshal, C., C. and Shipman, F., M. (1987). *Searching for the Missing Link: Discovering Implicit Structure in Spatial Hypertext*. Paper presented at the AAAI 87, Seattle, WA. July 1987. Online at: http://www.csdl.tamu.edu/~shipman/ht93-paper/ht93-paper.html. Accessed 16 May 2001.

Marx, K. and Engels, F. (1952). *Manifesto of the Communist Party*. Moscow: Progress Publishers, rpt. 1965.

McLoughlin, C. (1999). The implications of the research literature on learning styles for the design of instructional material. *Australian Journal of Educational Technology* 1999, 15(3), 222-241. Online at: http://cleo.murdoch.edu.au/ajet/ajet15/mcloughlin.html. Accessed 10 January 2001.

Melody, W. (1994). Electronic Networks and Changing Knowledge. Crowley, D. and Mitchell, D. (Eds). *Communication Theory Today*. Stanford: Stanford University Press.

Nardi, B. (1996). Studying Context: A Comparison of Activity Theory, Situated Action Models, and Distributed Cognition. Nardi, B. (Ed). *Context and Consciousness: Activity Theory and Human Computer Interaction*. Cambridge, Mass: MIT Press, 1996.

Norman, D., A. (1988). *The Psychology of Everyday Things*. New York: Basic Books.

Open Archival Information System (OAIS) (1995). *OAIS Information Definition*. Online at: http://ssdoo.gsfc.nasa.gov/nost/isoas/presentations/USDA_19990219/tsld013.htm. Accessed 23 August 2000.

Piperoglou, S. (2000). *The Care and Feeding of Hyperlinks*. Online at: http://www.webreference.com/html/tutorial25. Accessed 3 November 2000.

Postman, N. and Weingartner, C. (1969). *Teaching as a Subversive Activity*. Ringwood, Victoria, Australia: Penguin Education.

Reigeluth, C., M. (1996). A new paradigm of ISD? *Educational Technology*. May 1996, 13 - 20.

Squire, K., D., and Reigeluth, C., M. (2000). The Many Faces of Systemic Change. *Educational Horizons*. Winter 2000, pp. 145 - 154.

Trilling, B. and Hood, P. (2000). Learning, Technology and Education Reform in the Knowledge Age. *Educational Technology*. January - February 2000.

Tripp, S. (2001). Cognitive Navigation: Toward a biological basis for instructional design. *Educational Technology & Society*. 4(1) 2001, pp. 41 - 49.

Urdan, T., A. and Weggen, C., C (2000). *Corporate E-Learning: Exploring A New Frontier*. © 2000, WR Hambrecht + Co. March 2000.

Ward, M., C. and Bruce, R., R. (2000). Conceptualising Learner Support Space. *Educational Technology Research and Development*. Vol 48, No 1, pp. 85 - 98.

Waters. C. (1996). *Web Concept and Design*. Indianapolis, Indiana: New Riders Publishing.

Wells, G. (1999). The Zone of Proximal Development and its Implications for Learning and Teaching. *Dialogic Inquiry: Towards a sociological practice and theory of education*. New York: Cambridge University Press. Online at: http://www.oise.utoronto.ca/~gwells/resources/ZPD.html. Accessed 15 May 2001.

Wenger, E. (1998a). *Communities of Practice: Learning, Meaning and Identity*. Cambridge: Cambridge University Press.

Wenger, E. (1998b). Communities of Practice: Learning as a Social System. *Systems Thinker*. June 1998. Online at: http://www.co-I-l.com/coil/knowledge-garden/cop/lss.shtml. Accessed 28 May 2001.

Whalley, P. (1993). An Alternative Rhetoric for Hypertext. Mcknight, C., Dillon, A and Richardson, J. (Eds). *Hypertext: A Psychological Perspective*. London: Ellis Harwood.

Wiley, D., A. (2000). *Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy*. In press. Online at: http://reusability-org/read/. Accessed 8 December, 2000.

Wiley, Gibbons, Recker (2000). *A reformulation of the issue of learning object granularity and its implications for the design of learning objects*. In press. Online at: http://reusability-org/read/. Accessed 8 December, 2000.

Wood, Wallace, Zeffane, Schermerhorn, Hunt, and Osborn. (1998). *Organisational Behaviour: An Asia-Pacific Perspective*. Brisbane: John Wiley and Sons.

Woolley, B. (1992). *Virtual Worlds*. London: Penguin.

Zuboff, S. (1988). *In the Age of the Smart Machine: The Future of Work and Power*. New York: Basic Books.