An Information Systems Design Theory
for E-learning

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February 2011

A thesis submitted for the degree of Doctor of Philosophy of The
Australian National University
Declaration

I certify that this thesis is my own original work. It does not contain any material previously published or written by another person without due reference in the text.

David Jones
Acknowledgments

The work described here has been made possible by thousands of people, literally. A number far too large to personally acknowledge within the space allowed here. Consequently, I start by offering gratitude to all, especially those that I have not mentioned below.

Perhaps most importantly are the tens of thousands of people who made use of the services provided by Webfuse. Thank you for your patience and suggestions. It was your diversity that drove home the importance of emergence and just how inflexible most institutional IT systems actually are.

Thanks also to those who disagreed with the ideas expressed here and embodied by the Webfuse information system. The difficulties you had with understanding these ideas provided the impetus to further understand, refine, and explain the ideas. On reflection, the fact that so many of you filled management or senior information technology positions within the organisation remains somewhat troubling. But this work would not be without you, thank you.

Also essential were those who helped enable the emergence of Webfuse. The project students and institutional IT staff who worked on or in support of Webfuse. There were many of you and you rarely received the recognition due. In no particular order, thank you: Andrew Newman, Andrew Whyte, Matthew Aldous, Arthur Watts, Bret Carter, Chriss Lenz, Adrian Yarrow, Russell Gibbings-Johns, Zhijie Lu, Paul Wilton, David Binney, Chris Richter, Shawn Dollin, Paula Turnbull, Damien Clark, Scott Bytheway, Matthew Walker, Stephen Jeffries and many more I have almost certainly forgotten. Special mention should
be made of Derek Jones, the last man standing in terms of Webfuse and a major influence on its latter development.

Special thanks must go to Mary Cranston. Her contributions were as important and immeasurable as they were generally unrecognised and self-effacing. That lack of recognition was by far the largest shortcoming of the organisation we worked for. I cannot thank Mary enough.

Webfuse and the work described here would not have happened without Stewart Marshall. Stewart was the Foundation Dean of the Faculty of Informatics and Communication and, as described in Chapter 5, remains the only senior manager in my experience to not only understand ateleological development but also publicly embrace it as a strategy for the organisation he was responsible. Without Stewart, Chapter 5 would never have happened.

From the research perspective, I am deeply indebted to the Very Respectable Professor Gregor. Without Shirley’s knowledge, connections, influence and most especially patience this work would have been much less than it is. Perhaps my largest regret from this thesis is that I was not in a position to do more with Shirley’s contribution. The same might be said about the folk I have co-written with over recent years. I would like to make special mention of Kieren Jamieson as someone who made significant and under utilised contributions to this and related work.

Lastly, I would like to thank my family and ask forgiveness for all the time I spent on Webfuse, related work, and this thesis. That is time we’ll never get back. A special thanks to Sandy for starting her own PhD. Thereby, providing the
motivation necessary for me to complete this thesis, before she completed hers.

But more than that, thank you for all that is good in my life.
Abstract

This thesis seeks to offer an answer to the problem of how to design, implement and support information systems that effectively and efficiently support e-learning within universities. This problem is increasingly prevalent and important to the operation of universities. It is also a problem where existing solutions are limited in terms of variety, quality and explicit theoretical guidance. This thesis formulates a specific Information Systems Design Theory (ISDT) – An Information Systems Design Theory for Emergent University E-learning Systems – as one answer to this problem.

The ISDT is formulated using an iterative action research cycle that encompasses the design, support and evolution of the Webfuse information system at Central Queensland University (CQU) from 1996 through 2009. The Webfuse system was used by tens of thousands of staff and students. It is the knowledge gained through this experience that, in two separate stages, is used to formulate design theory.

The final ISDT recognises that diversity and rapid on-going change are for a number of reasons, the key characteristics of e-learning within universities. Consequently, the ISDT specifies both process and product models that aim to enable the e-learning information systems to be emergent. In particular the ISDT proposes that emergent e-learning information systems will encourage and enable greater levels of e-learning adoption in terms of quantity, quality and diversity; as well as providing a level of differentiation and competitive advantage for the institution.
This thesis makes two additional contributions. First, the *Ps Framework* is developed and used to analyse the current, dominant practice of providing e-learning information systems within universities. The resulting analysis reveals a significant mismatch between the requirements of e-learning within universities and the characteristics of the product and process models used by the dominant approach to supporting e-learning within universities. It is this mismatch that the ISDT seeks to address. Second, is the formulation of an alternate method for specifying the components of an ISDT. This alternate specification arose from difficulties faced with using existing ISDT specifications.
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Chapter 1 - Overview

Theory without practice leads to an empty idealism, and action without philosophical reflection leads to mindless activism. (Elias & Merriam, 1980)

1.1. Introduction

This thesis describes the formulation and testing, over an extended period, of an Information Systems Design Theory (ISDT) (Walls, Widmeyer, & El Sawy, 1992; Gregor & Jones, 2007) for e-learning. In this thesis e-learning is defined as the use of information and communications technology to support and enhance learning and teaching in higher education institutions (HEIs) (OECD, 2005c). The proposed ISDT developed in this thesis is titled: An ISDT for emergent university e-learning systems. The ISDT provides guidance to practitioners and institutions on how to design and develop an e-learning information system that offers several key advantages over current approaches. These advantages include greater variety of features, flexibility in the choice of applications, integration with the organisation, and staff and student usage (Jones & Gregor, 2004).

Unlike much design-science research where constructed artefacts are rarely full-grown information systems that are used in practice (Hevner, March, Park, & Ram, 2004), this e-learning ISDT is based on the design, development and support of Webfuse (Jones, 1999b). Thousands of students and academic staff have used Webfuse for e-learning. Work on Webfuse commenced in 1996 with the intent to develop an integrated information system to enable use of Web-based learning and provide a distinct advantage over competitors (Jones & Buchanan,
In the years since 1996, an iterative, action-research process has been used to evolve the system. Commencing in 2003, additional work was undertaken to reflect upon and abstract the insights gained from Webfuse into an ISDT, which is the focus of the thesis.

This chapter provides an overview and background to this thesis. It starts by providing a brief background to the research (Section 1.2) including a justification of the importance and relevance for the research. Drawing on this background the chapter then outlines the particular research problem the thesis seeks to address and the contribution it offers (Section 1.3). From there the research method is described (Section 0), along with the significance of the problem and approach (Section 1.5), and the limitations of the study (Section 1.6). The chapter closes with a description of the structure of the thesis (Section 1.7) and a summary (Section 1.8).

1.2. Background to the research

Advanced industrial societies are currently undergoing a fundamental transformation from capital- and labour-based economies into knowledge economies (Burton-Jones, 2001). In such economies knowledge, education, people and their ideas become the key strategic resource necessary for prosperity (Duderstadt, Atkins, & Houweling, 2002, p. 7). This transition to a knowledge economy is characterised by factors including globalisation, increasing competition, knowledge sharing and transfer, and an information technology revolution (Zhang & Nunamaker, 2003). This transition raises a number of issues for education systems, in particular how best to adapt such systems to the changes.
in the socio-economic landscape and provide the best educational opportunities and outcomes (Knight, Knight, & Teghe, 2006).

Schools and universities will play increasingly important roles as society enters this new age of knowledge and becomes increasingly dependent upon the social institutions that create knowledge and educate people (Duderstadt et al., 2002, p. 7). Some believe that the university will be the central institution in post-industrial society (Bok, 1990). A 2002 survey of 30 Organisation for Economic Co-operation and Development (OECD) countries indicated that more people than ever are completing tertiary education and that 1.9% of the combined GDP of these countries was devoted to higher education (OECD, 2005b). A report on education in the Group of Eight (G8) countries shows those countries spending between 1% and 2.7% of gross-domestic product (GDP) on higher education during the year 2000 (Sen, Partelow, Miller, & Owen, 2005, p. 17).

The dominant model of the University in use today continues to be the traditional combination of teaching and academic research suggested by Wilhelm von Humboldt in the 19th century (Tsichritzis, 1999). Universities are one of a very few institutions that have maintained their existence since the 1500s (Kerr, 1994, pp. 45–46). Such consistency and longevity is often attributed to the ability of universities to be change resistant (Green & Hayward, 1997, p. 4). Change arising from e-learning is particularly difficult because, as the OECD (2005a) observes, the nature of e-learning to some extent conflicts with the academic culture based on autonomy and a reward system based on research. Subsequently, the growth of e-learning has been incremental and has not fundamentally challenged the primacy of the face-to-face classroom.
The emergence of the knowledge economy and the increasing influence of technology are not the only factors requiring change within higher education. Indeed the last 30 years have seen a period of unprecedented change as higher education institutions across the world are being shaped by similar problems and forces (Green & Hayward, 1997, p. 3). These forces include: increased access and growth in participation; reduction in public funding; increased costs; increased calls for accountability in outcomes and subsequent arguments around autonomy; the changing nature and growth of knowledge and disciplines; industrialisation and industrial relations policy; and, internationalisation (Coaldrake & Stedman, 1999; Cunningham et al., 2000; Green & Hayward, 1997). The uncertainty about the future generated by these changes highlights the importance of building institutions that are responsive to change (CRHEFP, 1997). It is the institutions that are able to continually adapt to these changes that will be successful (Huynh, Umesh, & Valacich, 2003) and survive (Klor de Alva, 2000).

The increasing importance and impact of information and communication technologies is seen as one of the major drivers behind the need for adaptability. Zhang et al. (2004) observe that the knowledge economy shows a pervasive and ever-increasing demand for innovative delivery of education, which has led to dramatic changes in learning technology and organisations. The new technological possibilities as well as the new learning environments they enable are contributing to an unavoidable pressure for change (Tsichritzis, 1999). The advancement of computer and networking technologies are providing the means to support changes to learning that make it more personalised, flexible, portable and on-demand (Zhang et al., 2004). These new technologies have become a major force for change in higher education institutions and will have potentially
profound effects on the structure of higher education (Green & Hayward, 1997). Some suggest that the rapidly evolving technology and emerging competition puts the very survival of the current form of the university at risk (Duderstadt et al., 2002, p. viii). For example, Peter Drucker suggests (Lenzer & Johnson, 1997) Thirty years from now the big university campuses will be relics. Universities won’t survive. It is as large a change as when we first got the printed book.

Unlike previous periods of technology-driven social change the impact of information technology affects the basic activities of a university – creating, preserving, integrating, transmitting and applying knowledge – and more fundamentally changing the relationship between people and knowledge (Duderstadt et al., 2002, p. 8). The importance of e-learning in contemporary universities cannot be denied (deFreitas & Oliver, 2005). Allen and Seaman (2008) report on a 2007 survey of US higher education institutions that shows a 12.9% growth rate for online enrollments compared with 1.2% growth in the overall student population. The questions about e-learning have moved from a focus on use versus non-use to how, why and with what outcomes (Hitt & Hartman, 2002).

Most universities are currently answering the “How to implement e-learning?” question through the adoption of a Learning Management System (LMS). Other names used for LMS include Course Management Systems (CMS) and Virtual Learning Environment (VLE). LMS are software systems that are specifically designed and marketed to educational institutions to support teaching and learning. As such they generally provide tools for communication, student
assessment, presentation of study material and organisation of student activities (Luck, Jones, McConachie, & Danaher, 2004). There is evidence to suggest, however, that this strategy suffers from some flaws including: not being particularly innovative; being limited in quality; and, limited in the ability to integrate with other systems (Alexander, 2001; Paulsen, 2002). Even the most advanced institutions report little more than 50% adoption by faculty (Sausner, 2005). With some exceptions universities have not employed technology to the same degree, or as effectively as, the business community (Piccoli, Ahmad, & Ives, 2000). Successful implementations of LMSs in the academic environment are rather rare (Sarker & Nicholson, 2005). Early adoption of e-learning by Australian universities during the 1990s was done without critical examination of the merits and led to cases of wasted resources, unfulfilled expectations, and project and organisational failure (Pratt, 2005). There is considerable evidence that e-learning within universities struggles to engage a significant percentage of students and staff. Furthermore, e-learning has limited success in moving development beyond projects by innovators (Salmon, 2005). Van der Klink and Jochems (2004) suggest that high-level ambitions with poor implementation is the best description for e-learning implementation in most universities.

It is not all that surprising that the observed difficulties exist in the implementation of e-learning within universities. The application of information technology within universities is highly complex, confusing and raises issues that are almost over-whelming in nature (Duderstadt et al., 2002, p. x). In addition, as suggested by the OECD (2005a), e-learning remains a novel and immature activity. The transformation promised, or threatened, by e-learning is in reality a very fundamental transformation process. It is a process that is driven by
technology but involves people, organisations, and cultures that must be addressed both systemically and ecologically (Duderstadt et al., 2002, p. 179). Scholars in Information Systems can offer vision on structures and processes to effectively implement technology-mediated learning initiatives (Alavi & Leidner, 2001). Keller (2005) agrees that perspectives from information systems research and organisation theory can help better understand the implementation of e-learning. Salmon (2005) has called for more research to develop theories, principles, and methodologies of change related to the sustainability of e-learning within universities. There appears to be a need for research that can provide theoretical guidance to universities about how to effectively implement and support e-learning information systems.

1.3. Research problem and contribution

This thesis follows Alavi and Leidner (2001) in that it seeks to offer a vision on the structures, processes and technology that can be drawn upon to implement effectively technology-mediated learning within universities. The specific aim of this thesis is to address the following research question:

How to design, implement and support an information system that effectively and efficiently supports e-learning within an institution of higher education?

The primary contribution this thesis offers is an Information Systems Design Theory (ISDT) that answers the research question. An information systems design theory is an example of theory for design and action; of how to do something (Gregor, 2006). ISDTs, first explicated by Walls, Widmeyer and El Sawy (1992), are prescriptive theories developed to provide solutions to specialised classes of
information system design problems (Markus, Majchrzak, & Gasser, 2002). For practitioners, ISDTs are beneficial because they increase development reliability and the likelihood of success by providing principles, derived from kernel theories, that limit the range of system features and development activities to a more manageable set (Markus et al., 2002). As a theory the principles generated as part of an ISDT are also open to empirical testing and thus can form a basis for further research.

The final ISDT offered by this thesis is titled “An ISDT for emergent university e-learning systems” and is summarised in Table 1.1. The ISDT is formulated and explained in more detail in Chapter 5. Table 1.1 provides references to the relevant sections in Chapter 5. More detail of the method used to develop and express the ISDT is described in the next section.
Table 1.1. *An ISDT for emergent university e-learning systems*

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core components</strong></td>
<td></td>
</tr>
<tr>
<td>Purpose and scope (Section 5.6.1)</td>
<td>1. Provide ICT functionality to support learning and teaching within a university environment (e-learning). 2. Seek to provide context specific functionality that is more likely to be adopted and integrated into everyday practice for staff and students. 3. Encourage and enable learning about how e-learning is used. Support and subsequently evolve the system based on that learning.</td>
</tr>
<tr>
<td>Constructs (Section 5.6.2)</td>
<td>A range of constructs summarised in Table 5.17.</td>
</tr>
<tr>
<td>Principle of form and function (Section 5.6.3)</td>
<td>13 principles in 3 groups including: 1. Comprehensive, integrated and independent services. 2. Adaptive and inclusive system architecture. 3. Scaffolding, context-sensitive conglomerations.</td>
</tr>
<tr>
<td>Artefact mutability (Section 5.6.6)</td>
<td>As an ISDT for emergent e-learning systems the ability to learn and evolve in response to system use is a key part of the purpose of this ISDT. It is actively supported by the principles of form and function, as well as the principles of implementation.</td>
</tr>
<tr>
<td>Testable propositions (Section 5.6.7)</td>
<td>The system: 1. provides the functionality and services necessary to support university e-learning 2. provides a set of functionality that is specific to the institutional context 3. over time shows greater levels of adoption by staff and students 4. enables and encourages the university, its e-learning information systems, and its staff and students to observe and respond to new learning about the design, support and use of university e-learning 5. provides a level of differentiation and competitive advantage to the host institution</td>
</tr>
<tr>
<td>Justificatory knowledge (Section 5.6.5)</td>
<td>A range of theories and knowledge from software engineering, information systems and the broader social sciences summarised in Table 5.18 and Table 5.19.</td>
</tr>
<tr>
<td><strong>Additional components</strong></td>
<td></td>
</tr>
<tr>
<td>Principles of implementation (Section 5.6.4)</td>
<td>11 principles split into 3 groups, including: 1. Multi-skilled, integrated development and support team. 2. An adopter-focused, emergent development process. 3. A supportive organisational context</td>
</tr>
<tr>
<td>Expository instantiation (Section 5.6.8)</td>
<td>The Webfuse system from 2000 through 2009. Aspects of the BIM module for the Moodle LMS (Jones, 2010)</td>
</tr>
</tbody>
</table>
The scope of this work is made clear within the title of the ISDT, the *Purpose and scope* component of the ISDT, and in the research question. This work seeks to limit itself to the support of e-learning within universities and similarly academic-focused higher education institutions. E-learning within commercial organisations, non-profits and informal learning are beyond the scope of this work. As argued in Chapter 2 (especially in Section 2.8.3), there remains diversity between universities. This diversity is arguably sufficient to suggest value in further limiting the scope of this work to specific types of university. The perspective adopted here is that such a limitation is potentially premature given the absence of a more general ISDT for university e-learning and the widespread similarity of existing e-learning implementations at universities. While recognising that there exists some level of similarity between different institutions, this ISDT seeks to respond directly to institutional diversity. That said, the work that informs the final ISDT was performed at a particular type of university – a university with a significant history in distance education and a subsequent complex evolution over recent years. As such, the ISDT has not been tested within other types of university and care should be taken in generalising.

In addition, the thesis also offers the *Ps Framework* for understanding e-learning practice (Jones, Vallack, & Fitzgerald-Hood, 2008) – which is used and described in Chapter 2 – and, an improved representation of an ISDT (Gregor & Jones, 2007) – described in the following section and Chapter 3.

### 1.4. Research Method

The main aim of research within the information systems discipline is to study the effective design, delivery, use and impact of IT in organisations and society
(Keen, 1987). This work is an example of design research within the information systems discipline. Design research aims to make use of existing knowledge and theory to construct artefacts that improve some situation (Simon, 1996). In design research it is still important for a theory to explain a phenomenon, but it is less important than the instrumental use of a theory to build a system that is efficient and effective in the eyes of the potential users of the information system (Lee, 2000). In the past, while information systems design research has had a long history, it was not highly visible (Burstein & Gregor, 1999). More recently, there has been an increase in interest in design research arising from the publication of two prominent articles in the journal MISQ (Hevner et al., 2004; Markus et al., 2002), the release of ISWorld’s design research Web site (Vaishnavi & Kuechleer, 2004) and the creation of a design science department within the Communications of the Association for Information Systems (Hevner & March, 2004). The formulation of ISDTs, the contribution of this work, is an example of design research within the information systems discipline.

The extant design research literature describes a number of different potential research methodologies (March & Smith, 1995; Markus et al., 2002; Nunamaker, Chen, & Purdin, 1991) deemed suitable for design research. The approach used in this work approximates best with the iterative, action-research-like process described by Markus et al. (2002) and shown in Figure 1.1. Action research is a good fit for this work because as Cole et al. (2005) observe, the goal of action research is both the resolution of a practical problem and a contribution to theory. In the process shown in Figure 1.1, existing theory is used to assist in the generation of design principles, which in turn are used to generate an information system that is then put to use. Observation of use, possibly with some review of
the informing theory, informs possible revision of the underlying principles and consequently the information system. Subsequent iteration around the cycle seeks to further improve the principles underlying the ISDT and how they are expressed within the information system.

Beyond the on-going development of Webfuse, from 2002 additional work was undertaken to reflect upon and abstract the knowledge and experience gained during these cycles into an ISDT (for this doctoral thesis). Initially, this work (Jones & Gregor, 2004, 2006; Jones, Gregor, & Lynch, 2003) used the ISDT specification provided by Walls et al. (1992). It was through this experience and reflection upon the completeness of the Walls et al. (1992) specification of an ISDT that led to work which was aimed at formulating a more complete ISDT representation (Gregor & Jones, 2004, 2007). It is this more complete representation of an ISDT that is used in this thesis and summarised in Table 1.1.

1.5. Significance

The significance of the ISDT for e-learning within Universities developed within this thesis arises from three main factors: 1) e-learning is important; 2) research into the organisational implementation of e-learning within universities is limited; and, 3) there exist some limitations with the representation of ISDTs.
As outlined in Section 1.2 the implementation of e-learning in universities is difficult, and yet there has been limited research into the problem. Alavi and Leidner (2001) report that little or no research has been focused on the structures and processes needed to encourage adoption of technology-mediated learning at the organisational level. Tham and Werner (2005) assert that what existing work there is, focuses on technology development and top-down policy aspirations. For Tham and Werner (2005), there is limited focus on the human dimensions, on scaling up and on the embedding of innovations as well as the associated management of change. Kogan (2000) finds much of the research on higher education as being more normative than empirical. Nichols (2003) argues that the e-learning literature is practice-based and presented in descriptive formats which limit the transferability to other institutions. More broadly, Hevner et al. (2004) describe how the artefacts constructed within information systems design research are rarely full-grown information systems that are used in practice.

This thesis makes two contributions towards understanding e-learning implementation within universities: the Ps Framework and the proposed ISDT. The Ps Framework arose out of the attempt in this thesis to understand existing e-learning implementation and identify possible alternatives (Jones, 2004, 2008; Jones et al., 2008). The Ps Framework is described and used in Chapter 2 to argue that common e-learning implementation practices are somewhat mismatched with the requirements of e-learning. The proposed ISDT – *An ISDT for emergent university e-learning systems* – is presented in Chapter 5 and offers guidance for e-learning implementation that brings a number of advantages. These contributions arise from an action research process that combines broad
theoretical knowledge with empirical evidence arising from the design and support of a successful e-learning system

Lastly, the thesis makes a contribution to the representation of ISDTs. Through attempting to formulate an ISDT for e-learning, a variety of issues were found with the then commonly accepted ISDT representation proposed by Walls et al. (1992). In response, a new ISDT representation was proposed (Gregor & Jones, 2004, 2007), and is used in this thesis. This new ISDT representation has generated interest within the information systems design research community.

1.6. Limitations of the study

As with all research, the study described within this thesis has a number of limitations that should be kept in mind when considering its findings. Through its use of action research, this work suffers the same limitations, to varying degrees, of all action research. Baskerville and Wood-Harper (1996) identify these limitations as: (1) lack of impartiality of the researcher; (2) lack of discipline; (3) mistaken for consulting; and (4) context-dependency leading to difficulty in generalising findings. These limitations have been addressed within this study through a variety of means including: peer-reviewed publications throughout the process; use of objective data sources; the generation of theory; and an on-going process of testing. The methods for addressing the limitations of this study are described further in Chapter 6.

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1 The paper (Gregor and Jones, 2007) presenting this new ISDT representation was recognised as the Journal of the Association for Information Systems’ paper of the year for 2007 and was one of five best papers for 2007 as recognised by the International Conference on Information Systems and its senior scholars.
More broadly, the aim of this work is not to prove the resulting ISDT. Rather the aim was to gather sufficient empirical and theoretical support to build and propose a coherent and useful ISDT. The question of proof and further testing of the ISDT in similar and different contexts provides – as in all research aiming to generate theory – an avenue for future research.

A related issue is the question of additional, alternate ISDTs for e-learning in universities. The ISDT presented here is designed to guide the development of instantiations with a range of benefits including greater levels of adoption and use of functionality that becomes more specific to the institutional context. While this design has been tested, this work has not examined and makes no claims about other system attributes or outcomes that may be thought desirable, such as low initial and on-going cost, lack of dependence on specialised technical staff, support for particular pedagogical practices, and so on. Further work could examine these factors and perhaps lead to further development of this ISDT, or the development of alternate ISDTs for e-learning implementation within universities.

1.7. Organisation of the thesis

The body of this thesis is organised into six chapters:

- Chapter 1: Overview, provides a general overview of the study, some initial context to the research, the research problem, the research method employed, the significance of the research, and its limitations.

- Chapter 2: The Ps Framework, proposes and uses the Ps Framework to provide a more detailed description of what is currently known about the
implementation, requirements, and practice of e-learning within universities. The chapter argues that there exists a significant mismatch between the nature and requirements of e-learning within universities as well as the characteristics of the dominant process and product models currently used to implement e-learning.

- Chapter 3: Research method, describes how and why this work used an iterative action research method to formulate an ISDT. This chapter includes a brief outline of the improved specification of an ISDT (Gregor & Jones, 2007) that arose from this work.

- Chapter 4: Build it and they will come, describes the first action research phase of this work that lasted from 1996 through 1999. It offers a definition of the initial problem or context, a description of the intervention that was attempted, an evaluation of its performance, and reflection on that experience. The reflection process leads to a formulation of “An ISDT for e-learning within universities” – an initial ISDT for e-learning – and a collection of lessons learned during this process.

- Chapter 5: Better, faster, integration and adoption, describes the second action research phase that lasted from 2000 through 2009. It uses the same structure as Chapter 4 to describe the initial problem and context, the resulting interventions, an evaluation of that intervention, and reflection on the experience. The main product of this chapter is the “ISDT for emergent university e-learning systems”, the primary contribution of this thesis.
Chapter 6: Reflections, implications, and conclusions, reflects upon and summarises the research undertaken and outlines its contributions, implications, limitations, conclusions and potential for future work.

1.8. Summary

The use of information and communication technologies (ICTs) to enhance and support learning and teaching (e-learning) within universities is attaining an importance that cannot be denied (deFreitas & Oliver, 2005). It has been suggested, however, that the best description for e-learning implementation within universities is: high-level ambitions with poor implementation (Van der Klink & Jochems, 2004). The application of ICTs in universities is highly complex, confusing and raises issues that are almost over-whelming in their nature (Duderstadt et al., 2002).

This study seeks to provide one answer to the difficult and important question of how to design, build and support the information systems necessary for e-learning within a university setting. It seeks – as suggested by Alavi and Leidner (2001) – to provide a vision from information systems on the structures and processes necessary to effectively implement e-learning. This vision is provided in the form of an Information Systems Design Theory (ISDT): “An ISDT for emergent university e-learning systems”. The ISDT was formulated by drawing on 14 years of action research aimed at designing, supporting and improving the Webfuse information system. Webfuse was used to support e-learning at Central Queensland University from 1997 to 2009.

This work is important because it offers a useful and different solution to a complex and important problem – the effective implementation of e-learning.
within a university. It is important because there is little existing research in this area. Moreover, there is evidence that existing practice is somewhat limited. The work is also important because there is no evidence of similar work being informed through the design and support of a long-term information system used within a real organisation. The work also contributes an improved structure and representation of information system design theories (Gregor & Jones, 2007).
Chapter 2 - The Ps Framework

2.1. Introduction

This chapter provides a review of the literature relevant to the thesis topic, which is the formulation of an Information Systems Design Theory (ISDT) for e-learning within universities. This chapter seeks to examine critically the field of e-learning, the requirements and constrains required by university e-learning, and how universities are implementing the information systems to support e-learning. The intent of this examination is to identify any limitations of previous work and any issues worthy of research.

Perry (1998) suggests that the development and use of a new classification model can show that a literature review has moved from the merely descriptive to the constructively analytical. In this chapter, the Ps Framework is used to describe and analyse what is known about e-learning in universities. The knowledge in the Ps Framework was, and continues to be, informed by on-going work and research, including the work described here. The Ps Framework has been used previously to assist in understanding and identifying the limitations and issues around the extant literature covering the practice of e-learning within higher education as well as framing future possibilities (Jones, 2008; Jones et al., 2008).

The chapter begins (Section 2.2) with a brief explanation of the Ps framework and its seven components. It then uses the Product (Section 2.3), Process (Section 2.4) and Past Experience (Section 2.5) components of the Ps Framework to describe and analyse the predominant, current approach to e-learning within higher education: that is, the implementation of Learning Management Systems (LMS).
In addition, both the Product and Process sections will mention that there are alternatives to the dominant approach. These sections will seek to identify the “best-fit” situations for the alternatives. The Past Experience section presents evidence of how effective current approaches have been and examines the earlier as well as broader history of technology-mediated learning.

Having examined current practice, the chapter then seeks to analyse what is known about the characteristics and requirements of university e-learning. The examination of current practice is achieved through sections based on the remaining four components of the Ps Framework: People (Section 2.6), Pedagogy (Section 2.7), Place (Section 2.8), and Purpose (Section 2.9). The analysis in these four sections will argue that, depending on the perceived purpose for e-learning, there can be a significant mismatch between the requirements of e-learning within universities and the characteristics of the current, dominant approach to fulfilling those requirements. That mismatch may offer an explanation for the limited quantity and quality of existing use. Furthermore, it may also offer indications of how practice could be improved.

2.2. The Ps Framework

This chapter uses the Ps Framework as a basis for the description and analysis of the extant literature. It also seeks to identify any limitations around the problem of designing and supporting information systems for university e-learning. The Ps Framework has been informed by an earlier use of Alter’s (2002) Work Systems Framework to describe conceptualisations of e-learning (Jones, 2004). The Ps Framework has also been used to frame futures of university e-learning and Personal Learning Environments (PLEs) (Jones, 2008; Jones et al., 2008). The
position taken in this thesis, and demonstrated in this chapter through the use of
the Ps Framework, is that the information technology associated with e-learning is
one of a number of components of an emergent process of change where the
outcomes are indeterminate because they are situationally and dynamically
contingent (Markus & Robey, 1988).

As a consequence of the particular stance adopted in this thesis, it is thought that
e-learning implementation can be improved through a more complete
understanding of all seven components of the Ps Framework. Only one of the
components of the Ps Framework – Product – specifically encompasses
information technology. The remaining six components seek to describe and
understand the complex and dynamic social context within which e-learning is
applied. The Ps Framework can be used at both a broad (e.g., all Australian
universities, or even all universities) or narrow (e.g., a specific university) level of
analysis depending on the purpose. It is understood that implementation of a
specific system would be best informed by a narrower analysis focusing on the
specifics of the individual organisation. For the purposes of this literature review;
however, the analysis is aimed at the broadest possible level.

The seven components of the Ps framework, and the types of questions they seek
to answer, are:

1. The **Purpose**

   What is the reason for adopting e-learning, or changing how e-learning is
currently implemented? What is the aim or intent behind e-learning
adoption? How is e-learning understood?
2. **Place**

What social, political and other external factors must be recognised and responded to by a University? What are the internal characteristics of universities?

3. **People**

What type of people and roles (e.g., management, professional and academic staff, students) exist within universities? What are the beliefs, biases and cultures of these people and their associated roles?

4. **Pedagogy**

What conceptualisations about learning and teaching do people within the university context bring to e-learning? What practices are being used to learn and teach? What practices might they like to adopt? What are good ways to teach and learn?

5. **Past experience**

What has occurred before with e-learning, both within and outside universities? What worked and what did not?

6. **Product**

Are there common types of information systems being used to support e-learning? What types of systems are being used? What are their characteristics? What are the alternatives?

7. **Process**

What types of processes currently exist within universities? Especially
those that impact e-learning implementation and support. What processes are expected to be used when implementing e-learning?

One of potentially many explanations of the relationships between the seven components starts with purpose. Some event, problem or factor arises requiring the organisation to change the way in which it supports e-learning. Responding appropriately to this event becomes the **purpose** underlying a **process** used by the organisation to determine how (part of **process**) and what (**product**) it will implement to achieve the stated purpose. This change will be influenced by a range of factors including: characteristics of the organisation and its context (**place**); the nature and conceptions of the individuals and cultures within it (**people**); the conceptualisations of learning and teaching (**pedagogy**) held by the people and the organisation; and the historical precedents both within and outside the organisation (**past experience**). This is not to suggest that there exists a simple linear, or even hierarchical, relationship between the components of the Ps Framework. The context of implementing educational technology within a university is far too complex for such a simple reductionist view (Jones et al., 2008).

Figure 2.1 provides a representation of the seven components comprising the Ps Framework for E-Learning. The situationally contingent nature of these components is represented by the **Place** which encapsulates or underpins the remaining six. The dynamically contingent nature and the complex inter-relationship between each of the components is represented by the absence of clear and neat boundaries for individual components. The representation also attempts to show that each component touches most of the other components. The
representation is intended to suggest that each component can influence the other, and vice versa.

Figure 2.1. The Ps framework
This section has provided a brief overview and description of the Ps Framework. Attention now turns to using the framework. In particular using the framework to describe and analyse existing practice around the implementation and support of information systems for e-learning within universities.

2.3. **Product**

Technology is a tool and like all tools it should fit your hand when you pick it up, you shouldn’t have to bio-re-engineer your hand to fit the tool. – Dave Snowden

The purpose of this section is to examine the nature of the information and communications technology – the product – used to implement e-learning within
universities. The examination of the product is essential to understanding e-learning due to the fact that the almost universal university approach to e-learning has involved the adoption of a particular type of system: a Learning Management System (LMS) (Coates, James, & Baldwin, 2005; Feldstein & Masson, 2006; Jones & Muldoon, 2007; Salmon, 2005; Stiles, 2007).

Learning Management Systems (LMS) are software systems that are specifically designed and marketed to educational institutions to support their teaching and learning and typically provide tools for communication, student assessment, presentation of study material and organisation of student activities (Luck et al., 2004). These systems are also referred to by a number of different terms including virtual learning environments (VLE), course management systems (CMS), learning support systems (LSS), and learning platforms (Mendoza, Perez, Diaz-Anton, & Griman, 2006). The speed with which the adoption of an LMS has spread through universities is surprising (West, Waddoups, & Graham, 2006). A 2004 survey of universities from OECD countries found that 73% had adopted an institution-wide LMS, compared to 60% in 2002, with 90% expecting to make such a claim within five years (OECD, 2005a, p. 127).

The examination of the product at the centre of the current practice of e-learning within universities is also important due to the effects of that technology. Lian (2000) argues that technology is not, of itself, liberating or empowering but serves the goals of those who guide its design and use. Westera (2004) explains how the tools themselves are never value-neutral but are replete with values and potentialities which may cause unexpected responses. Coates et al. (2005) agree suggesting that LMS are not pedagogically neutral technology. Instead, through their design they influence and guide teaching and work to shape and even define
teachers’ imaginations, expectations and behaviours. So, while technology does not unambiguously determine outcomes (Markus & Robey, 1988) systems do have profound effects on the structuring of work as well as the forms of human action they enable or constrain (Kallinikos, 2004).

The following sub-sections start by describing in more detail (Section 2.3.1) what is known about Learning Management Systems (LMS) from the e-learning literature, including their benefits and drawbacks. Next (Section 2.3.2), broader insights from the information systems literature are used to examine the nature of LMSs, identify appropriate contexts, and what alternative approaches exist. Finally, some observations drawn from the examination of the Product component are summarised in Section 2.3.3.

2.3.1. Learning Management Systems

The current dominant form of university e-learning is based on the adoption of a single, institution-wide Learning Management System (LMS). The LMS has become the educational technology most widely used within universities, second only to the Internet and common office software (West et al., 2006). This section seeks to describe what is known about the origins and nature of the LMS.

Origins and evolution of the LMS

The earliest examples of LMS appeared between 1995 and 1997 (Stiles, 2007), as tools to help those faculty who did not have the expertise, time or inclination to develop the skills to develop e-learning services by hand (Fredrickson, 1999). These were a diverse collection of solutions built and used by different schools, faculties and research initiatives (Dron, 2006). They included such systems as Bodington (Lakhan & Jhunjhunwala, 2008), Web Course in a Box, WebCT
(Goldberg, Salari, & Swoboda, 1996), Cecil (Sheridan, Gardner, & White, 2002) and TopClass (Alexander, 1999). Often these systems were developed by early adopters of Web-based learning and were related to their bottom-up efforts to improve learning (Katz, 2003). It was not unusual at this time for different parts of the same institution to be using different LMSs.

As the use and importance of e-learning to universities grew, university management identified concerns about: the costs of in-house development; limitations of the resulting tools (Bates, 2007); and concerns about duplication and diversity of platforms within a single institution. At this stage, the LMS shifted from the earlier bottom-up approach to a top-down institutional – or enterprise – strategy. It was the perceived need for a university to have a single LMS to support e-learning that led Katz (2003) to observe that the LMS became a dominant element of higher education’s information technology capability. Most of the successful enterprise LMSs trace their origins back to bottom-up projects at individual universities (Coates et al., 2005).

During the early stages of this change, the LMS industry was in a venture capital-supported phase focused on increasing market share. Around 2003, the industry switched to a model that focused more on generating profits (Sausner, 2005). One response by universities to the subsequent increasing costs of commercial LMSs has been the increasing institutional interest in open source LMSs (Browne, Jekins, & Walker, 2006). Open source LMSs are seen as a possible way to save costs (OECD, 2005a), increase interoperability and gain local control of systems (Jafari, McGee, & Carmean, 2006). A 2008 survey (The Campus Computing Project, 2008) of US-based higher education institutions found that almost 13.8% of institutions using an open source LMS as the single
campus standard (up from 10.3% in 2007). These results represent a drop of 7% in reliance on the dominant LMS provider – the commercial company Blackboard. In addition, a further 24.4% reported a high likelihood of migrating to an open source LMS by 2013.

**Benefits and features of the LMS**
The primary benefit provided by an LMS is the reduction in the effort and skill required of educators to create Web-based courses (McCormack & Jones, 1997, p. 343). A LMS can increase efficiency as all necessary tools are gathered into one easy-to-use package that helps organisational units create common templates and automate class management (Post, 2004). By bringing all aspects of a course to a single access point, including communications tools, the LMS model helps reduce the isolation observed in earlier forms of e-learning (Wesley, 2002). The integration also includes the provision of automated tracking and evaluation features enabling closer observation and supervision of student learning (Wesley, 2002).

Years of intensive LMS development and adoption within higher education has seen considerable system convergence (OECD, 2005a). As a result, there are more similarities than differences amongst LMS products, with most distinguishing themselves with micro-detailed features (Black, Beck, Dawson, Jinks, & DiPietro, 2007). The core components of a LMS include tools for synchronous and asynchronous communication, content storage and delivery, online quiz and survey tools, gradebooks, whiteboards, digital dropboxes, and email communications (Harrington, Gordon, & Schibik, 2004). The commonality of LMS features have led Malikowski, Thompson, and Theis (2007) to develop a model (discussed further in Section 2.5.2) that abstracts LMS features into five
categories: transmitting content; creating class interactions; evaluating students; evaluating course and instructions; and, computer-based instruction.

**Assumptions, pedagogy and the LMS**

In terms of support for pedagogy, there are views that a LMS, in general, does not dictate either a discipline or a pedagogy (Katz, 2003). Govindasamy (2002, p. 288) suggests that most LMS vendors deliberately distance their products from pedagogical issues, and instead adopt an indifferent attitude that is sometimes argued as being impartial. There have, however, been some LMS designed with a particular pedagogical emphasis, generally constructivist (Stiles, 2007). Coates et al. (2005) argue that LMS are largely based on training-type models that arise from an overly simplistic understanding of the relationship between teachers, knowledge and student learning. Dede (2008, p. 47) goes one step further, and argues that an LMS provides more elaborate forms of behaviourist instruction via a Web-based interface. Weigel (2005) agrees, suggesting that the tendency towards behaviourist approaches to learning – with an emphasis on parcelling up knowledge into bite-sized chunks – is one of the great weaknesses of the contemporary LMS.

Beyond pedagogy, many LMS embed traditional teaching paradigms into them through name, metaphor and user interface (Dutton, Cheong, & Park, 2004b; Stiles, 2007). Examples include the use of common terms such as blackboard and gradebook and the use of university buildings to structure the user interface (Dron, 2006; Dutton et al., 2004b; Stiles, 2007). While the use of familiar concepts make for a more intuitive interface (Stiles, 2007), they can also lead to built-in constraints on the use of LMS (Dutton et al., 2004b). These constraints contribute to the suggestion that this technology will most likely reinforce the old
systems rather than new paths (Lian, 2000). For example, the design of most LMS embodies a particularly American view where the label “course” is used for the standard organising abstraction within the system (Dron, 2006). As a result, the course becomes the standard and pre-established boundary to learning within an LMS (Weigel, 2005). Learners contribute to discussions that are closed and removed at the end of the course (Cameron & Anderson, 2006). The course focus in most LMS make it difficult to support communities of students outside of the course structure or to involve non-course participants in online courses (Beer & Jones, 2008). The course focus is one example of how the standardisation offered by the LMS – which provides significant benefits as described in the previous section – also creates problems. The question of standardisation versus customisation is expanded upon in the next section.

**Standardisation, customisation and the LMS**

Adoption of an enterprise LMS will require some standardisation of teaching and learning as all available functionality is provided by the system (Luck et al., 2004). An LMS, by its nature, is structured and has little capability for customisation (Morgan, 2003). Current LMS are not customisable for instruction aimed at a specific audience with specific content (Black et al., 2007). As learning and teaching are two of the most highly personalised sets of processes within universities, any attempt to standardise them is likely to be radical, painful and problematic (Morgan, 2003). The standardisation inherent in an LMS exacerbates the pain of adoption as a standardised product is used to support a non-standard population of university academics each with their own different discipline, teaching philosophies and instructional styles (Black et al., 2007). Importantly, however, there is also significant value in the standardisation inherent within an
LMS. Such standardisation reduces institutional pain during the selection process (Black et al., 2007) and makes the provision of support and training simpler and more cost effective.

It is this trade-off between benefits and drawbacks of standardisation that has led authors such as Morgan (2003) and Post (2004) to suggest that the LMS forms the academic system equivalent of Enterprise Resource Planning (ERP) systems in terms of pedagogical impact and institutional resource consumption. This model of an integrated, enterprise system fits the long-term culture of institutional information technology. This culture brings with it a primary aim of centralising and controlling information technology services with a view to reducing costs (Beer & Jones, 2008). Such an approach can increase tensions created by a long-term cultural divide within universities. This divide exists between the culture of administration – that values efficiency, principles of scientific management and standardised business processes – and the academic culture – more focused on tradition, erudition and innovation (Fernandez, 2008). Management perceives information technology as a cost to be minimised while academics see it as a service to be customised for their idiosyncratic requirements (Jones, 2004).

The need and importance for an institution to control costs should not be under-estimated and remains a primary aim for institutions. The LMS model can, however, also negatively impact costs and institutional flexibility. Molina and Ganjalizadeh (2006) observe that the absence of efficient migration tools significantly increases the entry costs associated with the adoption of a new LMS. The subsequent restrictions on migration of content, technical and financial factors can make it difficult for institutions to migrate between different systems.
(Coates et al., 2005). An on-going challenge to management is the observation that e-learning technologies are undergoing a continual process of change (Huynh et al., 2003) and that any frozen definition of “best” technology is likely to be temporary (Haywood, 2002). The high cost of changing systems can contribute to lock-in (Davis, Little, & Stewart, 2008).

### 2.3.2. **Monolithic, best-of-breed and procurement**

The previous section started discussion of the Product component of the Ps Framework and provided a brief description of what is known about Learning Management Systems (LMS). The aim of this section is to connect this description and the LMS with knowledge in the broader information systems literature. In particular, this section makes connections between what is known about LMS with comparisons between monolithic and best-of-breed approaches to enterprise systems, and system procurement.

**Monolithic and best-of-breed**

Weller, Pegler, and Mason (2005, pp. 253-254) identify two approaches to the design of an LMS: the monolithic or integrated approach, and the best-of-breed approach. The monolithic approach is the predominant approach and seeks to provide all common online learning tools in a single off-the-shelf package (Weller et al., 2005, pp. 253-254). The best-of-breed approach is based on a component or hybrid architecture that supports the combination of components from different vendors (Weller et al., 2005, pp. 253-254). This distinction between an integrated approach and a best-of-breed approach has been discussed more broadly within the information systems literature (e.g., Burke, Yu, Au, & Menachemi, 2009; Dewan, Seidmann, & Sundaresan, 1995; Geishecker, 1999; Hyvonen, 2003;
Light, Holland, & Wills, 2001; MacKinnon, Grant, & Cray, 2008). In fact, there has been a long-running debate between the monolithic and best-of-breed approaches, with the pendulum swinging from one view to the other and back again (Geishecker, 1999).

The adoption of an integrated system involves a centralised organisation of processes combined with a tendency to reduce autonomy and increase rigidity (Lowe & Locke, 2008). A best-of-breed (BoB) approach allows a more de-centralised selection process (Dewan et al., 1995). Light, Holland and Wills (2001) perform a comparative analysis of the single vendor or integrated, enterprise resource planning (ERP) systems and best of breed (BoB) approaches to enterprise information systems. This analysis is summarised in Table 2.1. Historically, ERPs arose to solve integration problems by providing a single, integrated information system (Hyvonen, 2003). As described in the previous section, integrating all applications into a single integrated whole was a primary rationale for the development of the LMS model.

The argument between monolithic and BoB has also been influenced by changes in technology. In the early to mid-1990s, the mainframe-dominant market automatically defaulted to an integrated ERP approach (Geishecker, 1999). More recently integration technologies like Web services and service-oriented architectures (SOA) are seen to be enabling the adoption of BoB approaches (Chen, Chen, & Shao, 2003). Such approaches are having an impact within the LMS field with attempts at implementing a BoB LMS enabled by the development of service-oriented architectures (Weller et al., 2005, pp. 253-254). Such an approach may allow a more post-industrial approach to the LMS allowing the taking of parts that are needed, when they are needed and granting
control where it is needed (Dron, 2006). Bailetti et al. (2005) report on an early system that uses Web services to implement a BoB approach for an e-learning system.

Table 2.1. Comparison of major differences between ERP and BoB.

<table>
<thead>
<tr>
<th>Best of breed</th>
<th>Single vendor ERP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation requirements and accommodations determine functionality.</td>
<td>The vendor of the ERP system determines functionality.</td>
</tr>
<tr>
<td>A context sympathetic approach to business process re-engineering is taken.</td>
<td>A clean slate approach to business process re-engineering is taken.</td>
</tr>
<tr>
<td>Good flexibility in process re-design due to a variety in component availability.</td>
<td>Limited flexibility in process re-design, as only one business process map is available as a starting point.</td>
</tr>
<tr>
<td>Reliance on numerous vendors distributes risk as provision is made to accommodate change.</td>
<td>Reliance on one vendor may increase risk.</td>
</tr>
<tr>
<td>The IT department may require multiple skills sets due to the presence of applications, and possibly platforms, from different sources.</td>
<td>A single skills set is required by the IT department as applications and platforms are common.</td>
</tr>
<tr>
<td>Detrimental impact of IT on competitiveness can be dealt with, as individualism is possible through the use of unique combinations of packages and custom components.</td>
<td>Single vendor approaches are common and result in common business process maps throughout industries. Distinctive capabilities may be impacted on.</td>
</tr>
<tr>
<td>The need for flexibility and competitiveness is acknowledged at the beginning of the implementation. Best in class applications aim to ensure quality.</td>
<td>Flexibility and competitiveness may be constrained due to the absence or tardiness of upgrades and the quality of these when they arrive.</td>
</tr>
<tr>
<td>Integration of applications is time consuming and needs to be managed when changes are made to components.</td>
<td>Integration of applications is pre-coded into the system and is maintained via upgrades.</td>
</tr>
</tbody>
</table>


It is possible to suggest that the argument between monolithic and BoB systems fails to engage with another recent change in technology. In terms of software choice both monolithic and BoB approaches assume that the choice is the responsibility of the organisation. The rise of concepts such as Web 2.0 (O'Reilly,
2005), e-learning 2.0 (Downes, 2005), and social software, however, suggest that universities are facing the need to work with a variety of separate tools already being used by students (Dalsgaard, 2006). It is the student, not the university, making the software selection choice. Stiles (2007) argues that in the future organisational needs will be best met by a BoB approach where student initiated processes will be done using their choice of tools and services. Such a process involves students arriving with a tool-box of loosely joined small pieces (Ryberg, 2008) that they will need to be able to integrate with appropriate organisational systems.

**Procurement**

There is recognition that the choice of IS procurement strategy is critical for company operations. Different kinds of systems, require different kinds of resources and consequently different procurement strategies are applicable (Hallikainen & Chen, 2005). Optimal decisions about procurement are made when there is alignment between three choices: what type of system, what procurement strategy, and what type of organisational requirements (Wild & Sobernig, 2007). Drawing on two factors – specificity of design, and requirements uncertainty – Saarinen and Vepsalainen (1994) identify three generic types of organisational requirements: routine, standard, and speculative.

Integrated systems, such as ERPs and LMS, are examples of a routine system in that they are common to many organisations, and have stable requirements with low uncertainty. Such systems are most effectively procured through package acquisition (Saarinen & Vepsalainen, 1994), which is the common practice with most universities, particularly with their choice of LMS. Alternatively, if the organisational requirements, such as those surrounding the support of e-learning
within universities, do not have high stability and certainty, then the use of package acquisition brings with it high levels of risk and cost (Saarinen & Vepsalainen, 1994).

### 2.3.3. Observations from product

From the above description of the product associated with university e-learning, it is possible to make the following observations:

1. **Observation 1)** The current dominant product (information system) used in university e-learning is the Learning Management System (LMS).

2. **Observation 2)** The LMS can be seen as an example of an integrated or monolithic information system similar to single vendor enterprise systems.

3. **Observation 3)** Integrated systems offer cost efficiencies and other benefits through standardisation, but, at the same time, can constrain flexibility and competitiveness.

4. **Observation 4)** Integrated systems are best suited to circumstances where there is commonality between organisations and stable requirements with low uncertainty.

### 2.4. Process

The previous section (Section 2.3) examined the nature of the product – the information system – commonly used to implement e-learning within universities. This section continues the description of the current practices around e-learning.
within universities by describing the common processes being used. It starts by
describing more broadly what is known about different types of processes and
their limitations (Section 2.4.1). This section establishes a spectrum that extends
from teleological through to ateleological processes. Having established this
spectrum, it is used to describe the common processes used within universities for
management and planning; institutional support of learning and teaching, and the
planning of individual courses (Section 2.4.2).

The main conclusion from this examination is that the dominant form of processes
used within universities and the practice of e-learning is teleological (i.e., plan or
purpose driven). The dominance of the teleological view of process brings with it
some significant disconnects with the characteristics and requirements of
e-learning within universities. Section 2.5 onwards examine the characteristics
and requirements of university e-learning and identify a mismatch between these
requirements and the nature of teleological processes. Instead, it appears that a
synthesis of the most productive elements of both teleological and ateleological
approaches is crucial to addressing the plethora of issues competing for the
attention of university decision-makers (Jones, Luck et al., 2005).

**2.4.1. Types of process**

Traditionally, information systems as well as many other disciplines have been
dominated by a particular kind of thinking about process (R Baskerville, Travis,
& Truex, 1992; Introna, 1996). It has become a maxim of modern society that
without objectives, without purpose there can be no success: the setting of goals
and achieving them has become the essence of “success” (Introna, 1996). Planned
or teleological change has dominated the theory and practice of change
management for the past fifty years (Bamford & Forrester, 2003). Purpose-driven or teleological models are so ingrained that people often forget that these ideas have not always existed (Kezar, 2001). This lack of awareness of alternatives is in spite of Clegg’s (2002, p. 17) observation that the debate between the “planning school” of process thought and the “learning school” of process thought has been one of the most pervasive debates in management.

Table 2.2 provides a sample of literature that has identified, compared and contrasted the two schools of thought on process. This table and subsequent discussion in this chapter uses the labels teleological and ateleological introduced by Introna (1996) to describe these two extreme ends of a spectrum. While the terms and literature described in Table 2.2 may not always be an exact match for the teleological/ateleological continuum, they do represent ideas with significant similarity.

Table 2.2. Different authors and terms for the teleological/ateleological continuum of process.

<table>
<thead>
<tr>
<th>Author</th>
<th>Teleological</th>
<th>Ateleological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mintzberg (1989)</td>
<td>Deliberate strategy</td>
<td>Emergent strategy</td>
</tr>
<tr>
<td>Weick and Quinn (1999)</td>
<td>Episodic change</td>
<td>Continuous change</td>
</tr>
<tr>
<td>Brews and Hunt (1999)</td>
<td>Planning school</td>
<td>Learning school</td>
</tr>
<tr>
<td>Clegg (2002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kurtz and Snowden (2007)</td>
<td>Idealistic</td>
<td>Naturalistic</td>
</tr>
<tr>
<td>Hutchins (1991)</td>
<td>Supervisory reflection and intervention</td>
<td>Local adjustment</td>
</tr>
<tr>
<td>Truex, Baskerville and Travis (2000)</td>
<td>Methodical</td>
<td>Amethodical</td>
</tr>
<tr>
<td>March (1991)</td>
<td>Exploitation</td>
<td>Exploration</td>
</tr>
</tbody>
</table>
Teleological and ateleological processes represent very different conceptualisations of process. Introna (1996) identified eight attributes of design processes and used them to highlight the differences between teleological and ateleological processes.

Table 2.3 is adapted from Introna (1996) and summarises the distinctions.

<table>
<thead>
<tr>
<th>Attributes of the design process</th>
<th>Teleological design</th>
<th>Ateleological design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate purpose</td>
<td>Goal/purpose</td>
<td>Wholeness/harmony</td>
</tr>
<tr>
<td>Intermediate goals</td>
<td>Effectiveness/efficiency</td>
<td>Equilibrium/homeostasis</td>
</tr>
<tr>
<td>Design focus</td>
<td>Ends/result</td>
<td>Means/process</td>
</tr>
<tr>
<td>Designers</td>
<td>Explicit designer</td>
<td>Member/part</td>
</tr>
<tr>
<td>Design scope</td>
<td>Part</td>
<td>Whole</td>
</tr>
<tr>
<td>Design process</td>
<td>Creative problem solving</td>
<td>Local adaptation, reflection and learning</td>
</tr>
<tr>
<td>Design problems</td>
<td>Complexity and conflict</td>
<td>Time</td>
</tr>
<tr>
<td>Design management</td>
<td>Centralised</td>
<td>Decentralised</td>
</tr>
<tr>
<td>Design control</td>
<td>Direct intervention in line with a master plan</td>
<td>Indirect via rules and regulators</td>
</tr>
</tbody>
</table>


**Appropriate application of process types**

It has been argued that there are risky extremes inherent in both approaches that must be avoided if organisations and systems are to be functional rather than dysfunctional (Jones, Luck et al., 2005). An extreme pre-occupation for either exploration (ateleological) or exploitation (teleological) can trap organisations in unproductive states (March, 1991). A purely deliberative strategy suggests no learning, while a purely emergent strategy suggests no control (Mintzberg, 1994, p. 25). Rather than suggesting there is a universally appropriate type of process – as suggested by the dominance of the teleological – the following discussion seeks to suggest conditions when one process type might be more appropriate than the other. The result is not a simple recipe that helps decide when to use one
process type or the other. Instead, the suggestion is more in line with that of Jones and O’Shea (2004) when – in the context of e-learning within a university – they agree with Mintzberg (1989) that a dynamic and flexible interplay between deliberate and emergent strategy assists with the management of change.

Introna (1996) identifies three necessary requirements for a teleological design process:

1. The system’s behaviour must be relatively stable and predictable.

2. The designers must be able to manipulate the system’s behaviour directly.

3. The designers must be able to determine accurately the goals or criteria for success.

Table 2.4 references a range of literature to suggest areas where the three requirements for effective teleological processes break down.
Table 2.4. How the requirements for effective teleological processes breakdown.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Mismatch</th>
</tr>
</thead>
</table>
| Stable and predictable       | A high level of turbulence in the environment makes planning insufficient (Clegg, 2002)  
How can you make sensible policy or strategy in a non-deterministic, evolutionary and highly complex world (Carlsson, 2002)?  
Organisations that focus too much on exploitation are likely to be trapped in “suboptimal stable equilibria” (March, 1991).  
Operating in a dynamic context requires organisational structures that adjust and become far more responsive to change (Mintzberg, 1989).  
Projects that involve innovation, discovery or radical change have outcomes that are unclear at the beginning or will likely involve high levels of uncertainty due to change (Kenny, 2002). |
| Direct manipulation          | Such top-down planning often falters at the operational level because implementation generates a range of messy human factors (Haywood, 2002).  
Social systems cannot be “designed” in the same way as technical systems, at best they can be indirectly influenced (Introna, 1996).  
Technology development takes place in a competitive and conflictual atmosphere where different social groups are inevitably involved and seek to shape outcomes (Allen, 2000). |
| Determination of goals       | The uncertain and confused arena of social behaviour and autonomous human action make predetermination impossible (Truex et al., 2000).  
Innovation is undetermined and there is no single “best solution” (Allen, 2000).  
As circumstances become more complex there is no immediately apparent relationship between cause and effect (Snowden & Boone, 2007). |

Introna (1996, p. 23) suggests that, information systems development using a teleological approach is “at least limiting and inadequate and at most completely inappropriate.” Ateleological processes are also not appropriate in all situations.  
Systems that engage pre-dominantly in exploration (ateleological) and too little in exploitation (teleological) exhibit too many undeveloped new ideas and too little distinctive competence (March, 1991). An extreme ateleological approach might lead to organisational anarchy, with no overarching plan for bringing together
localised energies and initiatives (Jones, Luck et al., 2005). An extreme ateleological approach has no criteria to decide what are acceptable and what are unacceptable behaviours, anything goes (Introna, 1996). Atelological processes spend time and energy discovering what to do and consequently are very inefficient (Introna, 1996). Within an ordered and predictable context the extra amount of time taken to arrive at an outcome would be wasteful instead of beneficial.

### 2.4.2. The processes used in universities

Having established a spectrum of process types from teleological to ateleological this section seeks to understand the nature and types of processes commonly used in universities. In doing so the section looks at university processes at three different levels:

1. Management and planning – processes used in the strategic planning and operation management of universities.

2. Institutional learning and teaching – processes used by universities to implement learning and teaching, including institutional e-learning.

3. Instructional design – formal decision-making procedures that guide the choice and development of effective instructional strategies.

4. Teaching – processes used by individual academics to prepare and offer courses.

The separation of instructional design from teaching seeks to separate the processes used by people with training in education or instructional design, from
the processes used by the majority of university academics who do not have formal training education.

The following will suggest that most of the processes used by universities – at least the espoused theory of such processes – are teleological. There is significant and growing support for this use of teleological processes. There are also suggestions, however, that such teleological processes are not an appropriate fit, create problems, and, in some cases, do not represent what actually happens.

**Management and planning**

While universities are increasingly more independent of the state, they are also becoming increasingly regulated (Clegg & Smith, 2008). Governments have encouraged, and in some cases required, universities to adopt strategic planning approaches in order to be more effective in managing the types of change necessary due to broader societal changes (Jones, 2004). It has been suggested that there is a need to facilitate a greater degree of sophistication in institutional thinking in strategic planning and policy implementation (Newton, 2003). In this context many, if not most, universities follow, or at least profess to follow, a purpose driven approach to setting strategic directions (McConachie et al., 2005). Codd (1988, p. 235) defines policy as any action relating to “the selection of goals, the definition of resources or the allocation of resources”. Drawing on this definition, the standard institutional task of policy formation is a teleological process.

There have been suggestions that strategic or teleological approaches to institutional planning are valid for higher education. For example, Chafee (1983, p. 60) suggests that those affected must be considered and included in the decision
making, Gibbs et al. (2000) suggest leadership must communicate widely and continually about the issues using straightforward language, and Newton (2003) identifies the need to be able to respond to the inevitable tensions and negative perceptions that arise during implementation.

Others suggest that such teleological processes are inappropriate for universities and their context. Cohen and March (1974, pp. 114-115) suggest that except for a few areas, universities fulfill none of the three presumptions underpinning long-range comprehensive plans. Meister-Scheytt and Scheytt (2005) identify significant conflict arising between the non-ambiguity required by teleological approaches and the multi-faceted and paradoxical nature of universities.

Duderstadt et al. (2002, p. 191) argue that transforming an institution as complex as the university is neither linear nor predictable. In reviewing the literature around organisational change Kezar (2001) finds limited support for the idea that teleological process models are representative of how change occurs in higher education or that such models have any efficacy for facilitating change.

**Institutional learning and teaching**

The same pressures behind the adoption by strategic planning have contributed to the recent development of university’s having institutional learning and teaching strategies (Gibbs et al., 2000). Changes in government funding have contributed to universities becoming more strategic (i.e., teleological) in their approach to learning and teaching (Gibbs, 2003). For example, Australian universities must have an institutional learning and teaching strategic plan publicly available from their Web sites before being able to participate in a government learning and teaching fund (Inglis, 2007). University teaching has become an object of policy with the definition of mission and specification goals becoming part of the
definition of learning and teaching excellence (Clegg & Smith, 2008).

Universities create learning and teaching strategies to outline goals, priorities and actions aimed at improving learning and teaching (Radloff, 2008). Learning and teaching improvement strategies become the focal point for self-regulation (Harvey & Newton, 2004). It appears that the institutional practice of learning and teaching is becoming increasingly teleological.

This increasingly teleological approach to institutional learning and teaching has also begun to impact the practice of e-learning. The OECD (2005a) found that most universities initially lacked a coordinated e-learning strategy and tend to rely on emergent faculty-led initiatives before finally adopting a more integrated institution-wide approach. By 2003 a survey of US university leaders found that most saw e-learning as a critical long-term strategy (Allen & Seaman, 2003). A range of authors (e.g., Forsyth, 2003) suggest that it is time to consider e-learning as an integral part of academic activity. One that needs to be routinely supported and as a consequence it has become almost obligatory to add e-learning to mission statements and strategic plans. Klink and Jochems (2003) make the argument that it is necessary for management to have a clear view of the purpose intended to be achieved through the introduction of e-learning in order to determine the necessary work. Similarly, and somewhat earlier, Dearing (1997) suggests that full exploitation of e-learning resources by universities could be made more effective through the development and implementation of a coherent and comprehensive e-learning strategy.

There is, however, evidence to suggest that teleological processes are not appropriate for the institutional context around learning and teaching. Table 2.5 mirrors Table 2.4 in that it uses Introna’s (1996) necessary conditions for
teleological processes to provide evidence from the literature of how the conditions for use of a teleological process may not be appropriate. Where Table 2.4 uses more general literature, Table 2.5 draws specifically on literature covering learning and e-learning within the university sector.

Table 2.5. Potential mismatch L&T strategy and requirements for a teleological process.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Mismatch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable and predictable</td>
<td>Trowler operation of L&amp;T strategies is non-linear and unpredictable (Trowler, 2002). E-learning is characterised by high levels of variability, change and uncertainty (Jones, Gregor et al., 2003). A social shaping perspective suggest that e-learning in universities can follow many paths (Dutton &amp; Loader, 2002).</td>
</tr>
<tr>
<td>Direct manipulation</td>
<td>Fanghanel (2007) points out that academic staff filter strategies and policies through their experiences, epistemologies and ideological beliefs. Gibbs et al. (2000) suggest there may only be a weak relationship between how teachers make sense of challenges and respond to cultural pressures and rationally derived analyses and plans.</td>
</tr>
<tr>
<td>Accurate determination of goals.</td>
<td>Gibbs et al. (2000) point out that strategic goals may become irrelevant as new opportunities and obstructions overtake the best laid plans. Newton (2003) suggests that there is no blueprint for learning and teaching strategy and that the search for one is flawed, even naïve. Cowburn (2005) describes how the different aims and objectives between the different strategic plans within a university increase misalignment and conflict. Clegg and Smith (2008) show how research evaluation policies pressure academic staff to focus on research at the expense of teaching. Oliver and Dempster (2003, p. 144) argue that there is no ready model or single clearly successful path for institutional e-learning strategies that will ensure e-learning is embedded.</td>
</tr>
</tbody>
</table>

In addition to the apparent misfit of teleological processes with institutional processes around learning and teaching shown in Table 2.5 there is evidence that ateleological processes are more effective. Knight and Trowler (2000) argue that the development of improved teaching and learning practices is most likely to occur via collective and collaborative approaches. These approaches are more
likely to result in change processes that are contingent and contextualised
producing outcomes that are unpredictable and fuzzy. Along similar lines, Mishra
and Koehler (2006) argue that innovative and quality teaching can only be
achieved through the use of a nuanced understanding of the complex relationships
between technology, content and pedagogy to develop appropriate context
specific strategies.

**Instructional design**

Having examined the processes used for institutional strategic and learning and
teaching planning and policy, this and the next sub-section examine the processes
used for teaching. The importance of learning and pedagogy is covered in the
Pedagogy component (Section 2.7) of the Ps Framework. Rather than examine
theories around learning these two sections focus on the types of processes used.
This section describes processes associated with the more formal processes used
by instructional design professionals. The following section examines processes
used by university academics who typically have no formal educational training.

Reigeluth (1983) defines *instructional design* as a set of decision-making
procedures guiding the choice and development of effective instructional
strategies. These strategies are based on a set of outcomes for students to achieve,
and knowledge of the context within which they will achieve them. Reiser
(2001b) describes how the field of instructional design arose out of the need for
large groups of psychologists and educators to develop training materials for the
military services. After the war this work continued and increasingly training was
viewed as a system to be designed and developed using specialised procedures
(Reiser, 2001b). Models of instructional design still have strong connection to the
models developed in the 1950s based on the ADDIE (Analyse, Design, Develop,
Implement, Evaluate) process (Irlbeck, Kays, Jones, & Sims, 2006). ADDIE is a framework designed for objectivist epistemologies where front-end analysis precedes the development of curricular content (Der-Thanq, Hung, & Wang, 2007). While seeking to understand the variety across instructional design projects, Visscher-Voerman and Gustafson (2004) identified four different paradigms for instructional design – instrumental, communicative, pragmatic and artistic. The instrumental paradigm – planning-by-objectives – was found to be the dominant paradigm in both literature and practice (Visscher-Voerman & Gustafson, 2004, p. 77).

As with other contexts, however, it is possible to identify situations where this teleological approach to process is not appropriate for instructional design. Table 2.6 draws on instructional design literature to show that Introna’s (1996) three conditions for teleological design (Table 2.4) may not always hold.

In addition to the potential mismatches outlined in Table 2.6 there are suggestions that instructional designers do not always follow this process. Kenny, Zhang et al. (2005) describe how for many instructional designers a majority of their time is not spent working within such processes, nor do they follow them in a rigid fashion. An observation that can equally be made for faculty academics and one that is examined in the next section.
Table 2.6. Suggestions that instructional design does not satisfy Introna’s (1996) three necessary conditions for teleological processes.

<table>
<thead>
<tr>
<th>Necessary Condition</th>
<th>Reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable and predictable system</td>
<td>Discipline categories bring differences (Becher &amp; Trowler, 2001) and are social constructions, subject to change from within and between disciplines. If a student finds a learning strategy troubling, the student can switch to another at will. The designer could not have predicted which strategy the student would actually use (Winn, 1990). Traditional instructional design is not responsive enough for a society characterised by rapid change (Gustafson, 1995).</td>
</tr>
<tr>
<td>Manipulate behaviour</td>
<td>Change in student strategy can circumvent the intent of the design, unless the design is extremely adaptable (Winn, 1990) Human behaviour is unpredictable, if not indeterminate, which suggests that attempts to predict and control educational outcomes cannot be successful (Cziko, 1989). Academic freedom in teaching refers to the right to teach a course in a way the academic feels reasonable (Geirsdottir, 2009).</td>
</tr>
<tr>
<td>Accurately determine goals</td>
<td>Curriculum decision making is characterised by conflict and contradictions and by attempts to guard the interest and power relations within the disciplinary community (Henkel &amp; Kogan, 1999). As the student learns, their mental models change and hence decisions about instructional strategies made now, would be different than those made initially (Winn, 1990). Influences on the choice of teaching approaches adopted are clearly more complex than any simple analytic model can convey (Entwistle, 2003). It cannot be assumed that everything is planned in advance (Levander &amp; Mikkola, 2009). In the real world, no-one is sure what the instructional goals should be (Dick, 1995). Visscher-Voerman and Gustafson (2004) speak of cases where goals cannot be formulated at the start of the process.</td>
</tr>
</tbody>
</table>

**Teaching**

Responsibility for the design of the majority of teaching within universities remains with university academics and not instructional designers. University academics – as described in the People (Section 2.6) and Pedagogy (Section 2.7)
components of the Ps Framework – do not typically have formal training in education, and consequently the process they adopt to design teaching may differ from instructional designers. Lattuca and Stark (2009) found that how academics design their teaching is not described by a rational planning model and does not separate planning from implementation. One contributing factor for this is that the dominant setting for academics is teaching an existing course, generally one the academic has taught previously. In such a setting, academics spend most of their time fine tuning a course or making minor modifications to material or content (Stark, 2000). Academics are usually not often required to engage in the development of new courses or major overhauls of existing courses (Stark & Lowther, 1988).

In addition, Levander and Mikkola (2009) observe that the actual teaching and learning that occurs is more in line with the teacher’s implicit internalised knowledge, than that described in published course descriptions. Similarly, Argyris and Schon (1974) suggest that formal descriptions of the curriculum do not necessarily provide much understanding about how teachers put their curriculum ideas into action. Entwistle (2003) argues that analytical models of teaching fail to capture the full complexity of the decision making that occurs when choosing teaching approaches. Finally, Stark (2000) suggests that instructional design is not only a science, but also a creative act, linked to teacher thinking. One that must be examined contextually and thus is not amenable to a single formula or prescription. Together this suggests that a purely teleological approach to teaching is not representative of common practice, and may also not capture the complete complexity of what is required for effective teaching.
2.4.3. Observations from Process

From the above description of processes, it is possible to make the following observations on the practice of university e-learning.

Observation 5) In literature from a broad array of disciplines there is discussion about two broad types of processes teleological and ateleological, and the teleological approach to processes dominates.

Observation 6) Teleological processes are appropriate in conditions where there is a stable and predictable system, designers are able to directly manipulate system behaviour, and designers are able to accurately determine goals or criteria for success.

Observation 7) A dynamic and flexible interplay between these two teleological and ateleological processes assists with the management of change.

Observation 8) Processes adopted by universities for a range of activities – including strategic directions, management, institutional learning and teaching plans, as well as teaching – are increasingly teleological in nature.

Observation 9) There is evidence that many of these university activities do not fulfil the necessary conditions for effective use of teleological processes.

Observation 10) There is significant evidence that ateleological processes better represent what actually happens, are more appropriate, and may even be essential to the practice of e-learning.
2.5. Past experience

Progress, far from consisting in change, depends on retentiveness.

When change is absolute there remains no being to improve and no direction is set for possible improvement: and when experience is not retained, as among savages, infancy is perpetual. Those who cannot remember the past are condemned to repeat it. (Santayana, 2009, p. 284)

A major aim of the previous two sections on Product (Section 2.3) and Process (Section 2.4) was to provide a description of the current dominant approach to e-learning within universities. This section seeks to examine what is known about the past experience of this form of e-learning and to relate that to the broader history of technology-mediated learning. In doing so, the section seeks to show that current dominant practices have been somewhat less than successful and appear to be following the same patterns as prior cycles in technology-mediated learning. Findings are supportive of the suggestion that current practice could be improved to better match the requirements of e-learning.

This section starts by suggesting that there are six identifiable paradigms or stages to the use of e-learning within universities (Section 2.5.1). Each stage is enabled by changes in technology, the affordances of that technology and what was done with it. Next, is an examination of what is known about the quantity and quality of the usage of industrial e-learning – identified as the current dominant paradigm in university e-learning – (Section 2.5.2). The somewhat less than revolutionary impact of e-learning on the practice of learning and teaching within universities (described in Section 2.5.2) is then linked with observations that can be drawn
from the broader history of technology-mediated learning (Section 2.5.3). The section closes with a summary of the observations that can be drawn from the Past Experience of industrial e-learning (Section 2.5.4).

2.5.1. **Paradigms of e-learning**

Hirschheim and Klein (1989) suggest that the a paradigm can be seen as the set of assumptions which enable the members of a professional community to share perceptions and engage in commonly shared practice. Drawing on this definition, this section seeks to describe five identifiable paradigms of e-learning within universities. These paradigms are identified by a shared set of assumptions around the available software tools for e-learning, who controls those tools, and the affordances and capabilities of those tools. Table 2.7 names these five paradigms of e-learning within universities, outlines the period when most prevalent, and offers a short description.

As will be shown in the following section (Section 2.5.2) the industrial paradigm is the current dominant university e-learning paradigm. As shown in Table 2.7, however, the significant differences between paradigms and evidence of the development of new paradigms suggest that the question of e-learning within universities is far from settled or static.
Table 2.7. Five paradigms of university e-learning.

<table>
<thead>
<tr>
<th>Period</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late 1980s to early 1990s</td>
<td>Text-based CMC</td>
<td>Text-based tools for e-mail, Usenet news, perhaps FTP. Not always Internet based. Very limited use. Limited access. Difficult to use. (e.g., Oliver, 1985)</td>
</tr>
<tr>
<td>~1995 – late 90s</td>
<td>Web-based Lone Ranger</td>
<td>Lone-Ranger academics using Web and Internet tools to enhance teaching. Increasing access, creation difficult. Little institutional support (e.g., Jones, 1996b)</td>
</tr>
<tr>
<td>1995 to 1999</td>
<td>Cottage Industry</td>
<td>Ad hoc development of systems to increase ease-of-use. Often multiple in an institution. Often arise from work of Lone-Rangers. Origins of the LMS (e.g., Goldberg et al., 1996)</td>
</tr>
<tr>
<td>1998 – ??</td>
<td>Industrial</td>
<td>E-learning becomes an institutional concern. Must be a single institutional, “enterprise ready” system represented by a LMS. (e.g., Tickle, Muldoon, &amp; Tennent, 2009)</td>
</tr>
<tr>
<td>~2005 – ??</td>
<td>Post-industrial</td>
<td>Rise and increasing availability of Internet access, social media, mobile devices etc. turns focus from institutional provision to the use of personal tools. From integrated systems to learning networks (Downes, 2007)</td>
</tr>
</tbody>
</table>

2.5.2. Usage of industrial e-learning: quantity and quality

The current dominant university e-learning paradigm – as defined in Table 2.7 – is industrial e-learning. This paradigm is characterised by universities adopting one enterprise LMS. The implementation of an LMS has become the almost universal approach to the adoption of e-learning at universities (Jones & Muldoon, 2007). Despite the associated complexities and risks almost every university seems compelled to have one (Coates et al., 2005). LMS have become perhaps the most widely used educational technologies within universities, behind only the Internet and common office software (West et al., 2006). Harrington,
Gordon, et al. (2004) suggest that higher education has seen no other innovation result in such rapid and widespread use as the LMS.

While institutional adoption of the LMS is significantly widespread, there remain questions about the usage of the LMS at other levels. This section provides a brief summary of what is known about the adoption and use of LMS at the levels of:

- **Staff adoption**
  What percentage of academic staff are using the LMS in their teaching?

- **Feature adoption**
  What features are staff using within the LMS, and to what levels?

- **Quality**
  How good is the e-learning being produced through use of an LMS?

**Staff adoption**

Even with the universal implementation of LMSs, the level of adoption of the systems within many institutions has been limited (Jones & Muldoon, 2007). Vodanovich and Piotrowski (2005) report that of the 74% of faculty surveyed as being positive towards using the Internet for education, 70% view it as effective but only 47% actually used it for education. Other best practice implementations – recommended by LMS vendors – report no more than 55% staff adoption rates (Sausner, 2005). Most universities are struggling to engage a significant percentage of students and staff in e-learning (Salmon, 2005).

**Feature adoption**

Coates et al. (2005) suggest that it is the uptake and use of features, rather than their provision, that really determines their educational value. As outlined above
there remains concern about the limited amount of adoption. More importantly there is concern that existing adoption has not been of a significantly high educational quality. Badge et al. (2005) report about sixty per cent adoption amongst staff but its use is almost entirely for content distribution with only a limited amount of online assessment. The usage pattern observed by West et al. (2006) is that instructors rarely adopt all of the LMS’s features.

In order to synthesise research on LMS feature adoption across different LMS, Malikowski et al. (2007) proposed a model that consists of five LMS feature categories; a suggested order in which features are adopted; and, an indication of how much each feature category is being used in courses. Figure 2.2 is a graphical representation of the Malikowski et al. (2007) model developed by Beer, Clark and Jones (2009). It shows five feature categories – transmitting content, creating class interactions, evaluating students, evaluating course and instructors, and computer-based instruction – and examples of tools within those categories.
After surveying a range of literature reporting on LMS feature adoption, Malikowski et al. (2007) identified general LMS feature adoption rates for each feature category. These adoption rates are shown in Figure 2.2. The figure shows that content transmission is the most used feature category with it being typical for greater than 50% of courses to use these features. Class interaction and student evaluation features are typically found in more than 20% of courses, but less than 50%. Course evaluation and computer-based instruction features are found in less – generally much less – than 20% of courses. These findings around the limited quantity of industrial e-learning adoption complement concerns about the quality, a topic covered in more detail below.

**Quality**

The learning and teaching literature is in broad agreement that conceptions of teaching which are student-centred/learning-oriented are of significantly greater quality than conceptions which are teacher-centred/content-oriented (Herrington,
Reeves, & Oliver, 2005; Kember, 1997). The literature on industrial e-learning indicates the majority of it is teacher-centred/content-oriented. Academics use Learning Management Systems (LMSs) to transmit course documents to students (Dutton et al., 2004b; Malikowski, Thompson, & Theis, 2006; Morgan, 2003) In the rush for universities to place courses on the Internet it is evident that the acquisition of knowledge remains the paramount goal for many educators (Herrington et al., 2005). With few exceptions, almost all universities that have adopted a LMS have taken an approach where the LMS substitutes for existing media and have retained existing pedagogy (Salmon, 2005) based on information distribution.

The evidence suggests that adoption of an LMS does not lead to any increase in student learning or the quality of teaching. Instead, the primary advantage is convenience to students (Harrington et al., 2004). Additionally, while it is clear that there is an increasing use of industrial e-learning, there is no accompanying widespread change in pedagogy (Browne et al., 2006). The adoption of industrial e-learning has not measured up to the hype (Reeves, Herrington, & Oliver, 2004; Twigg, 2001; Wise & Quealy, 2006; Zemsky & Massey, 2004). Beyond individual cases in journals, it is difficult to find any grounds on which to assert that industrial e-learning brings sustained improvement in learning (Clegg, Hudson, & Steel, 2003).

2.5.3. **History of technology-mediated learning**

This section seeks to set e-learning in the broader historical context of technology-mediated learning since 1900. The intent is to identify what similarities, differences or lessons can be drawn from this broader historical
context. Most histories of Technology-Mediated Learning (TML) commence with the start of the 20th century – before this time the available technologies were generally limited to the teacher, chalkboard, and textbook – and the application of different types of technology to learning (Reiser, 2001a).

Analysis of the history of TML reveals a common, repeated cycle that seems to apply to the arrival of each new technology. This cycle – described below – has significant similarities with those identified by authors examining technology in education (Reiser, 2001a; van Dam, 1999), information technology in general (Fenn & Raskino, 2008), and management fads in higher education (Birnbaum, 2000). The simplified cycle used here consists of three steps: growing revolution, minimal impact, and the resolution of dissonance. The following offers a brief description of each cycle with examples taken from literature examining the history of TML.

This technology-mediated cycle corresponds to the observation of Sims (2004) that the understanding and knowledge accrued by previous decision-makers appears to become lost as each new wave of technology emerges. For example, Heines (2004) illustrates how the quiz functionality in modern LMSs does not include support for basic and long established rules of quiz construction. Nor does it include support for other fundamental knowledge arising out of earlier work such as that of Skinner (1958) that stretches back through the 1950s to the early decades of the 20th century. Oliver (2003), suggests learning technology often seems an amnesiac field, where the lessons learnt seem lost to current researchers and practitioners with their reluctance to set current developments in a historical context. In addition, when this cycle is combined with the observations of the
quantity and quality of use of industrial e-learning use (Section 2.5.2), it appears likely that industrial e-learning is entering a “minimal impact” stage.

**Growing revolution**

A new technology is identified and seems to offer a potential solution to a number of perceived problems with learning. The technology is often seen as a silver bullet promising revolutionary change. For example, Cuban (1986, p. 19) quotes Darrow on the possibilities that radio offers learning “Radio may come as a vibrant and challenging textbook of the air.” Another example is Papert’s (1984, p. 422) thoughts on the personal computer “the computer is going to be a catalyst of very deep and radical change in the educational system.” On the topic of e-learning, Peters (2002) is one of many to suggest that e-learning will force a radical restructuring of our educational institution.

**Minimal impact**

At some significant time after the growing revolution it is recognised that the expected revolution has not eventuated. In terms of radio, Cuban (1986) suggests that by the 1950s – twenty years after the peak of expectations around the impact of radio – it had had little impact on instructional practices. With personal computing, Reiser (2001a) reports that by 1995 substantial numbers of teachers report little or no use of computers for instructional purposes. Furthermore, where computers are used, it is primarily for drill and practice or learning computer skills (e.g., word processing). Similarly with e-learning, Bates (2004) suggests that rather than being a paradigm shift, e-learning more closely resembles old wine in new bottles.
Resolution of dissonance
As evidence of minimal impact grows it becomes necessary to resolve the dissonance between the promise and the observed reality. Birnbaum (2000) describes how this is typically achieved by assigning the failure to weakness of specific individuals; unforeseeable external forces; or correctable flaws in implementation. Often, the intent is to enable the reinvention and recycling of the technology with minor modifications. Petrina (2004, p. 305) describes how Sidney Pressey – the designer of early, mechanical testing machines – attributed their failure to “the intellectual inertia and conservatism of educators who regard such ideas as freakish or absurd, or rant about the mechanisation of education.” While Bates (2004, p. 273) describes how the less than revolutionary impact of e-learning has been attributed in part to institutions and governments “not doing enough to prepare managers, teachers, and students for the organisational, institutional and cultural changes necessary for e-learning to be successful.”

2.5.4. Observations from Past Experience
From the above description of past experience with e-learning, it is possible to make the following observations:

Observation 11) The current dominant e-learning paradigm – industrial e-learning – is not the first form of university e-learning and will not be the last.

Observation 12) Measured at the institutional level the adoption of industrial e-learning is almost universal. At the level of academic staff or feature adoption, however, usage is more limited.
Observation 13) There is evidence that a significant proportion of industrial e-learning is of questionable educational quality.

Observation 14) It appears that industrial e-learning may be going through a fad cycle that is identifiable in the history of technology-mediated learning since the 1990s and other fields.

2.6. People

The previous sections have sought to describe the current dominant practice of e-learning within universities – industrial e-learning. The Product (Section 2.3) and Process (Section 2.4) sections described the nature of industrial e-learning while the section on Past Experience (Section 2.5) provides a perspective on what is known about the results of industrial e-learning. This section on the People component of the Ps Framework and subsequent sections on Pedagogy (Section 2.7), Place (Section 2.8), and Purpose (Section 2.9) provide a description of the characteristics, context and constraints on e-learning within universities.

This section begins with establishing the importance of considering the people involved with e-learning and, more broadly, change involving information technology (Section 2.6.1). It then provides a description of some of the key characteristics of the people involved with e-learning within universities including: the diversity of the people and their beliefs (Section 2.6.2), that people are not rational (Section 0) and people mean agency (Section 2.6.4). Given these observations, it is suggested that techno-rational/teleological approaches that fail to engage with people and their experiences are unlikely to create significant, sustainable improvements. As such, it is possible, that the limitations in the adoption and quality of industrial e-learning arise due to a mismatch. The
mismatch exists between the nature of the process and product of industrial
e-learning and the need to effectively engage with the needs and characteristics of
the people involved in e-learning.

2.6.1. The importance of people

There has been significant research within the information systems discipline
around the importance and impact of people on information systems and their
success. Examples of the literature include research examining: user participation
and involvement (Ives & Olson, 1984); technology acceptance and use (Davis,
1989; Venkatesh, Morris, Davis, & Davis, 2003); decision-making around system
selection and implementation (Bannister & Remenyi, 1999; Jamieson, Hyland, &
Soosay, 2007); system success (DeLone & McLean, 1992; Myers, 1994);
development methods (Mumford, 1981); and, the social shaping of technology
(Kling, 2000). In terms of user participation and involvement, Lynch and Gregor
(2004) found that previous studies were inconclusive in terms of links with
system success. They suggest, however, that the level of influence users have on
the development process is a better indicator of system outcomes. The perceptions
of the people who may potentially use an information and communication
technology play a significant role in their adoption and use of that technology
(Jones, Cranston et al., 2005). Information systems are designed and used by
people operating in complex social contexts, consequently such a system is
understood differently by different people and given meaning by the shared
understanding that arises out of social interaction (Doolin, 1998).

Similar findings and suggestions are evident in the educational and e-learning
literature. John and La Velle (2004) argue that new technologies at most enable
rather than dictate change. Dodds (2007) suggests that any excellence demonstrated by a university is not a product of technology, it is a product of the faculty, students and staff who play differing roles in the pursuit of scholarship and learning. For Morgan (2003), teaching and learning are two of the most highly personalised processes. Numerous authors (e.g., Alexander, 2001; Oblinger, 2003) identify that understanding learners, and particularly their learning styles, attitudes, and approaches as essential to the effective facilitation of learning. For Watson (2006), it is clear that consideration of the human dimension is critical to education. Since, as Stewart (2008) observes, the beliefs held by those involved in the educational process, regardless of how ill-informed, can have a tremendous impact on the performance of both students and teachers and how effectively technology may be utilised. Personal characteristics have been found to influence e-learning implementation (Siritongthaworn, Kairit, Dimmitt, & Paul, 2006) and most universities are still struggling to engage a significant percentage of students and staff in e-learning (Salmon, 2005).

2.6.2. **The diversity of people**

Having established that consideration of and response to the nature of people is important, this and following sections seek to describe some of the characteristics of people relevant to the implementation of university e-learning. This section seeks to illustrate that the diversity of the people involved with e-learning is high. Such diversity is a potential mismatch for the primarily teleological processes that form the basis for the dominant form of e-learning.

**Increasing diversity in roles and structure**

The development of online teaching and learning requires a complex combination of skills and experience from a variety of professional fields (Jones et al., 1999).
So while academics were able to independently develop teaching resources and activities, e-learning typically requires these same academics to work with teams of multimedia and software developers. (Coates et al., 2005). Shephard (2004) identifies numerous very different groups of staff within universities that may be called upon to offer support to academic staff in the use of e-learning. The list can include: instructional designers, academic staff developers, information technology professionals and a number of others. Shephard (2004) goes on to describe the significant diversity of these groups. Each of these groups bring different and often conflicting views (Luck et al., 2004) or technological frames (Orlikowski & Gash, 1994) to e-learning. Differences in technological frames between those involved with information systems projects can lead to actions that hamper technology implementation (Orlikowski & Gash, 1994).

Diversity is also present, in very different ways, in questions concerning the management and leadership of e-learning within universities. As pointed out by Bolden (2004) there is diversity in the very definition of leadership; no consensus on how best to develop leaders and leadership; and, little evidence of the impact of leadership on performance and productivity. University leaders are facing the problems that arise from two competing and even contradictory needs: public accountability, and institutional autonomy and diversity (Smith & Adams, 2008). Policy choices by school or departmental leaders can result in significant diversity across the many schools or departments (Dutton et al., 2004b). Increasingly there is significant diversity in the backgrounds, perspectives, and organisational structures supporting e-learning within universities.
**Student diversity**

The ability to respond to the diversity within the body of students is seen as increasingly important. The diversification and massification of the student body has led universities to shift their education rhetoric from a notion of “one size fits all” to a concept of tailored, flexible learning (Lewis, Marginson, & Snyder, 2005, p. 66). Rather than see learning as one size fits all, the ability to deviate from this standard model and customise learning to meet local requirements is seen as a strength (Cavallo, 2004, p. 105). A familiarity with the evolving characteristics of adult learners and a sensitivity to their diverse needs improves the facilitation of their academic journey (Semmar, 2006). There is a growing percentage of adult learners within the university student population and their preferences in learning include a desire for variety and flexibility (Herrington et al., 2005; Knowles, Holton, & Swanson, 2005, p. 40). The ability to respond to student diversity is important for the success of e-learning within universities.

**Diversity of academics**

Defining the characteristics of an academic is increasingly problematic (Williams, 2008). There is some shared understanding that the academic role involves research and teaching (Williams, 2008). Mishra (2005), however, points out that it would be difficult to find two academics who take identical approaches to teaching the same content. A significant component of this diversity may arise from Silver’s (2003) suggestion that an academic’s assumptions about learning and teaching are largely determined by the discipline in which they teach. These disciplinary differences impact on the kind of support required for the enhancement of learning and teaching practice (Harpe & Radloff, 2006). The diversity between disciplines is also evident in the significant differences between
disciplines in terms of LMS tool usage (Smith, Heindel, & Torres-Ayala, 2008). The variation in academics, students and disciplines combined with the absence of any unifying educational theory or practice suggests that there is no one correct method for implementing an online course (McCormack & Jones, 1997).

Ignorance of the diversity of academic staff and the subsequent homogeneity of the standard approach to technology implementation and support is seen as one of the key reasons why instructional technology has failed to be mainstreamed (Geoghegan, 1994). Drawing on the work of Moore (2002), Geoghegan (1994) identifies a chasm – a significant difference – between two broad groups of academic staff. There is a significant difference (summarised in Table 2.8) between early adopters of technology and the early majority. Geoghegan (1994) proposes that approaches to encouraging use of instructional technology that works well for early adopters, is not likely to work well for the early majority. It is further argued, that an inability to respond to this difference is a significant contributing factor to the isolated pockets of success for instructional technology. Such isolated success is achieved despite growing comfort with technology and significant expenditures on instructional technology. There is a need for e-learning implementation to respond to the diversity inherent in academic staff.
Table 2.8. Comparison of early adopters and early majority

<table>
<thead>
<tr>
<th>Early Adopters</th>
<th>Early majority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Like radical change</td>
<td>Like gradual change</td>
</tr>
<tr>
<td>Visionary</td>
<td>Pragmatic</td>
</tr>
<tr>
<td>Project oriented</td>
<td>Process oriented</td>
</tr>
<tr>
<td>Risk takers</td>
<td>Risk averse</td>
</tr>
<tr>
<td>Willing to experiment</td>
<td>Need proven uses</td>
</tr>
<tr>
<td>Self sufficient</td>
<td>Need support</td>
</tr>
<tr>
<td>Relate horizontally (interdisciplinary)</td>
<td>Relate vertically (within discipline)</td>
</tr>
</tbody>
</table>

*Note: Adapted from “Whatever happened to instructional technology?”, by W. Geoghegan, 1994, Paper presented at the 22nd Annual Conference of the International Business Schools Computing Association.

### 2.6.3. People are not rational

The practice of e-learning within universities has arisen at a time when changes in broader society increasingly have an emphasis on accountability, efficiency and managerialisation. As described by Morgan (1992, p. 147), this techno-rational approach sees management as a scientifically rational and efficient application of neutral knowledge on a par with the natural sciences. A key component of techno-rational discourse is the use of quantitative data and measurement to ensure accountability (Kappler, 2004). Dillard and Yuthas (2006, p. 204) suggest that enterprise systems – which as argued above include the enterprise LMS – are an extreme application of a techno-rational perspective. With its emphasis on teleological processes, enterprise LMS, accountability and efficiency, it appears that the current dominant form of university e-learning has a strong techno-rational flavour. This flavour seems somewhat at odds with the nature of the people involved.

At the level of the individual, there is significant research to indicate that people have faced significant difficulties when seeking to make rational decisions. It has
been shown that when making decisions people rely on strategies such as rules of thumb and heuristics to simplify decisions, several of which suffer from systematic biases influencing judgement (Tversky & Kahneman, 1974). Cognitive biases are mental behaviours that negatively impact decision quality in a significant number of decisions for a significant number of people. They are inherent in human reasoning (Arnott, 2006). Arnott (2006) develops a taxonomy of 37 cognitive biases identified by psychological research. Given a complex environment, there are limits to the ability of human beings to adapt optimally, or even satisfactorily (Simon, 1991). For example, findings from neuro-science and psychology identify a strong tendency in people to gravitate toward the familiar and away from the unfamiliar (Bailey, 2007). Similarly, technological frames help people fill gaps in the available information with information consistent with their existing knowledge structures (Davidson, 2002, p. 330). Research into decision making around information systems projects has revealed that such decisions are rarely logical or rational (Bannister & Remenyi, 1999). Decision making about the implementation of information systems is not a techno-rational process, instead many decision makers rely on intuitions, instincts and simple heuristics (Jamieson & Hyland, 2006). Jones and O’Shea (2004) argue that the practice of innovation and change development within universities can never be a rational process.

### 2.6.4. People mean agency

Techno-rational approaches to management treat people as objects to be manipulated in accordance with scientific laws (Morgan, 1992, p. 147). Such approaches embody a deterministic approach that views potential adopters as predisposed to adopt innovations that are quantifiably superior from some
technical perspective (Surry & Farquhar, 1997). The expanded technological determinist view suggests that it is technology that shapes the forms of society and organisations (Jones, 1999). Increasingly, however, interest in explaining the organisational consequences of information systems had led to positions that privilege human agency over social structure and technological features (Boudreau & Robey, 2005). Information systems development is then not a case of people with clearly-defined goals applying technologies with clearly-defined properties to achieve clearly defined organisational effects (Jones, 1999).

Boudreau and Robey (2005) show that the organisational consequences of an ERP system – known to be notoriously inflexible once configured and implemented and where adoption is typically motivated by a desire for greater control – could be shaped and enacted through use rather than simply embedded in technical features. The trajectory of emergence of use is not wholly determined either by human agency or the material property of the technology, but rather by the unpredictable interplay of the two.

In considering adoption, it is important to recognise agency: the ability of the individuals or groups within universities to respond consciously or unconsciously to and change practices (Trowler & Knight, 1999). Consideration of agency is especially important since taking full advantage of e-learning will require university administrators, lecturers and students to think differently about teaching and learning (Volery, 2001). The conditions under which e-learning is introduced or operates is shaped by agendas of those in management positions (Clegg et al., 2003). Rather than being of itself liberating or empowering technology serves whichever goals motivate the people guiding its design and use (Lian, 2000).
It is dangerous to make assumptions about students’ adoption or rejection of educational technology as their choice and practices are shaped in quite subtle ways (Goodyear & Ellis, 2008). Selwyn (2007) sees students as making active choices informed by the signals they pick up from teachers, the curriculum, assessment and workplace demands. When a technical innovation threatens to disrupt established methods, the people affected by this disruption – teachers, administrators, students and technology staff – will resist, assimilate, subvert or otherwise appropriate what is being proposed or imposed (Dutton, Cheong, & Park, 2004a). E-learning can directly challenge traditional pedagogies and consequently is likely to generate resistance (Folkers, 2005). Several writers have described how the lack of compatibility with existing pedagogies may cause academics to resist using technology in their learning and teaching (Holden & Wedman, 1993).

Resistance is even more likely when academics have significant autonomy, limited formal teaching knowledge, and are not rewarded for improving teaching. Academics are very autonomous individuals and there has generally been no tradition for tightly controlling the actions of faculty members within universities (Waeraas & Solbak, 2009). Many academics come to their own teaching with immense amounts of content knowledge but little or no knowledge of teaching and learning (Weimer, 2007). The experience and training of academic staff not only focuses on discipline and research expertise, it can, and often does, socialise aspiring academics towards a vision of academic work that emphasises these tasks (Austin, 2002). Academics are expected to engage equally in research and teaching and yet work towards promotion criteria that primarily value achievements in research (Zellweger, 2005). Fairweather (2005, p. 417) found that
spending more time teaching in the classroom remains a negative influence on academic pay and that the trend is worsening most rapidly in institutions whose central mission’s focus on teaching.

2.6.5. Observations from People

From the above it is possible to make the following observations about the nature of university e-learning:

Observation 15) The people participating in projects associated with change and information systems are important to and impact directly the outcomes of such projects.

Observation 16) There is significant diversity in the people, backgrounds, structures and perspectives involved with university e-learning.

Observation 17) The people involved in university e-learning – like most people – are unlikely to act in an entirely rational or objective way.

Observation 18) The people involved in university e-learning can and will take actions that can modify the practice and outcomes of e-learning.

2.7. Pedagogy

Alavi and Leidner (2001, p. 4) propose that the objective of using technology in learning is for the student to learn something that would otherwise have not been learnt without technology, or to learn it in a more efficient manner. The aim of this section is to present a perspective of what is known about student learning and the factors that influence it. Not surprisingly, it starts with a description of what is known about learning (Section 2.7.1) before examining what is known
about university learning and teaching (Section 2.7.2). The section closes by
drawing some observations about pedagogy for university e-learning (Section
2.7.3). As with other prior sections, this section suggests that there is significant
diversity and change inherent in pedagogy.

2.7.1. Learning
Explanatory accounts of learning range across culture, biology, and cognition;
provide a multitude of theoretical perspectives drawing on different
methodological traditions; and, bring different educational phenomena into focus
(Bell, 2004). The scientific literature on cognition, learning, development, culture
and the brain is voluminous (Bransford, Brown, & Cocking, 2000). Education,
like other branches of the social sciences, has no single, unifying mature theory.
Instead theories, ideas and approaches coexist in various states of cohesion and
tension (Dillon & Ahlberg, 2006). There are many schools of thought on learning,
and no one school is used exclusively to design e-learning (Ally, 2004, p. 6).

The diverse and unsettled nature of learning means that the aim of this section is
not to offer an in-depth description of what is currently known about learning.
Instead, the aim of this section is to illustrate that what is known about learning is
voluminous, diverse, often contradictory, multi-disciplinary and personal. To do
this, the section draws first on Ertmer and Newby’s (1993) four perspectives on
learning: epistemology; theories from science; learning theories; and instructional
design theories. The literature from each of these four perspectives of learning are
drawn upon with the aim of showing how each perspective contains significant
diversity of views. Finally, additional diversity is illustrated by drawing on
insights from a range of literature focused on teaching.
**Epistemology**

Epistemology is concerned with the nature of knowledge and how we come to know things (Driscoll, 1994) that is, what does it mean to know (Siemens, 2006a). There is not a single view of epistemology. Ertmer and Newby (1993) in examining the connection between epistemology and learning theory identify two fundamental perspectives of epistemology: empiricism and rationalism. Driscoll (1994) adds nativism as a third epistemological perspectives—the belief that knowledge is innate or present at birth. More recently the epistemology of connective knowledge has been proposed as particularly appropriate for e-learning (Downes, 2006). Pallas (2001, p. 6) identifies the proliferation of epistemologies as one of the most confusing developments in educational research over the past quarter-century and goes on to list a “welter of names”—positivism, naturalism, postpositivism, empiricism, relativism, feminist standpoint epistemology, foundationalism, and postmodernism.

**Theories from science**

Scientific disciplines including, but not limited to, psychology, neuroscience, and biology have taken an interest in learning and have developed a range of related theories. Each of these disciplines seek to understand and describe how human learning functions using each of the relevant disciplinary perspectives. Beyond the diversity between these disciplines, there exists diversity within the disciplines. For example, Seidel, Perencevich, and Kett (2005) argue that psychology can provide descriptive laws that describe how cognitive development, learning, meta-cognition and other elements of learning actually occur. Driscoll (1994, p. 7), however, illustrates the existence of diverse perspectives within this one
discipline by illustrating how behavioural, cognitive and social psychologists develop different views of learning.

**Learning theories**

Learning theories seek to provide insight into the act of how individuals learn learning (Siemens, 2006a). A learning theory comprises a set of constructs linking observed changes in performance with what is thought to bring about those changes (Driscoll, 1994, p. 9). Discussions of different learning theories (e.g., Driscoll, 1994; Ertmer & Newby, 1993) tend to focus on three distinct viewpoints: behaviourism, cognitivism and constructivism. These learning theories link closely to and build upon three different perspectives of the behavioural, cognitive and social psychologists mentioned above.

The full diversity of learning theories, however, includes the on-going development of new and different theories as well as increasing diversity within existing theories. In terms of new theories, Mayer (1996, p. 160) suggests a fourth perspective is about to emerge and Siemens (2005, 2006b) and Downes (2006) have proposed Connectivism as one candidate for this fourth perspective. Evidence of diversity within theories can be illustrated by: Steffe and Gale (1995) describing six versions of constructivism; significant overlap in the ideas and principles of different theories; (Ally, 2004); often contradictory classifications of learning theories and theorists (Siemens, 2006a); and, the observation that theorists themselves are evolving and changing their ideas over time (Sackney & Mergel, 2007).
**Instructional design theories**

Instructional design theories draw on learning theories and other insights to offer prescriptive theories that offer explicit guidance on how to better help others learn (Reigeluth, 1999, p. 5). These theories offer guidance and propositions around how to design instruction. The origins of formal instructional design procedures have been traced back to the development of military training materials during the Second World War (Reiser, 2001b). During the 1970s and 1980s, however, there was a large increase in the number of instructional models (Reiser, 2001b). This proliferation means that the initial impression of instructional design theories is one of diversity, followed by being perplexed by so many theories being at odds with one another (Duchastel, 1998).

**PCK, TPACK and the diversity of teaching**

Another source of insight into how to design instruction is Shulman’s (1986) idea of pedagogical content knowledge (PCK) and the development of technological pedagogical content knowledge (TPACK) by Mishra and Koehler (2006). Both PCK and TPACK argue against the traditional idea that there are collections of separate knowledge required to teach. Rather than needing a knowledge of pedagogy and a knowledge of the content being taught, Shulman (1986) suggests that teaching is most effective when knowledge about content and pedagogy is blended into a single collection of knowledge, that is, a knowledge of which pedagogies are most appropriate for a given set of content. Pedagogies deemed highly appropriate for teaching mathematics are not likely to be a good fit for the teaching of drama. Dede (2008) supports this perspective by arguing that numerous research studies have shown that there is no optimal pedagogy effective for all subject matter.
In extending PCK into TPACK, Mischra and Koehler (2006, p. 1029) argue that there is no single technological solution that applies for every teacher, every course, or every view of teaching. Quality teaching requires developing a nuanced understanding of the complex relationships between technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations. Productive technology integration in teaching needs to consider all three issues not in isolation, but rather within the complex relationships in the system defined by the three key elements.

Dede (2008) makes a similar point that no application of technology to learning and teaching is universally good. There is no one best way of developing instruction (Davies, 1991) and instructional design can only progress with the recognition that “learning is a human activity quite diverse in its manifestations from person to person and even from day to day” (Dede, 2008, p. 58).

### 2.7.2. University learning and teaching

Theoretical insights into how people learn or how to design instruction do not capture the full story of university learning and teaching. This section examines the literature into how the theoretical insights around learning and teaching are translated into practice within universities. This literature reinforces the important part played by the people – as argued in Section 2.6 – and in particular the academic or pedagogue.

Figure 2.3 is a representation of Trigwell’s (2001) model of university teaching. In developing this model to evaluate good teaching, Trigwell (2001) argues that rather than separating learning, teaching, context and other aspects associated with
university learning, all these aspects must be considered together. Furthermore, in order for learning to be judged effective, they must be aligned. The model is intended as a series of concentric circles with student learning at the centre. The nature and quality of that learning, however, is impacted upon by the strategies adopted by the teacher, which are in turn influenced by the planning carried out by the teacher, the teacher’s thinking around or conception of learning and teaching, and the context.

![Diagram of the model of university teaching](image)

*Figure 2.3. Model of university teaching. Adapted from “Judging university teaching”, by K. Trigwell, 2001, The International Journal for Academic Development, 6(1), p. 67.*

**Conceptions of teaching and learning**

There is a significant body of literature that establishes the conceptions of learning and teaching held by academics and links those conceptions to the quality of student learning outcomes (Biggs, 2001; Eley, 2006; Gonzalez, 2009; Kember & Kwan, 2000; Norton, Richardson, Hartley, Newstead, & Mayes, 2005; Trigwell, 2001). That literature generally places pedagogue conceptions into one of two main orientations: teacher-centred/content-oriented and student-centred/learning-oriented. Figure 2.4 shows a graphical representation of these orientations and five underlying conceptions identified by Kember (1997). The learning theories of greatest current influence suggest that learning occurs through the student’s active construction of knowledge supported by various
perspectives within meaningful contexts with social interactions playing a critical role (Oliver, 2000). It is a view that suggests the highest levels of student learning occur when the focus is on what the student does (Biggs, 2001).

![Diagram of teaching conceptions](image)

*Figure 2.4. A multiple-level categorisation model of conceptions of teaching.*

Adapted from “A reconceptualisation of the research into university academics’ conceptions of teaching”, by D. Kember, 1997, *Learning and Instruction, 7*(3), p. 264.

As shown in the Past Experience component of the Ps Framework, and especially in Section 2.5.2, the majority of LMS feature adoption by academic staff is focused on content transmission. The emphasis on content transmission suggests that the majority of university academic staff have teacher-centred/content-oriented conceptions of teaching. The situation is, however, more complicated than this. While academics are more likely to adopt teaching strategies that are consistent with their conceptions of learning and teaching there can be significant differences between espoused theories and theories in use (Leveson, 2004). Richardson (2005) synthesised a collection of literature around the influences on approaches to teaching and developed an integrated model (Figure 2.5). The model describes what influences teacher choice of teaching approaches. This model shows how teachers’ conceptions of teaching are heavily influenced by their discipline. In the absence of formal qualifications or knowledge in learning and teaching, most academics teach in ways they have
been taught (Phillips, 2005) and/or which fit with disciplinary norms and their recent teaching experience (Entwistle, 2003). It also shows how perceptions of the teaching environment impacts teaching approaches.

Figure 2.5. Integrated model of teachers’ approaches to teaching, conceptions of teaching, and perceptions of the teaching environment. Adapted from “Students’ approaches to learning and teachers’ approaches to teaching in higher education”, by J. Richardson, 2005, *Educational Psychology, 25*(6), p. 676.

While pedagogues may hold higher-level views of teaching, other contextual factors may prevent the use of those conceptions (Leveson, 2004). Environmental, institutional, or other issues may impel pedagogues to teach in a way that is against their preferred approach (Samuelowicz & Bain, 2001). Prosser and Trigwell (1997) found that pedagogues with a student-focused approach were more likely to report that their departments valued teaching, that their class sizes were not too large, and that they had control over what was taught and how it was taught. In examining conceptions of e-learning held by academic staff, Gonzalez (2009) found that institutional factors and the nature of the students were the most relevant contextual factors influencing teaching.

These findings suggest that simply providing knowledge about learning theories, or new approaches to learning (e.g., e-learning), is not sufficient to change the approaches to teaching adopted by academics. Ho, Watkins, et al. (2001) identify a lack of empirical evidence that helping academics develop alternate conceptions of teaching will result in prompt improvement in teaching practice. Similarly,
Richardson (2005) suggests that there is little evidence to suggest that conceptions of teaching develop and change through increasing teaching experience, or through formal training. Leveson (2004) argues that efforts to improve teaching have often failed because the complexity of teaching has been underestimated. Such attempts should consider the integrated system of relationships that constitute the teaching experience as a whole.

### 2.7.3. Observations from Pedagogy

From the above examination of what is known about pedagogy it is possible to make the following observations about university e-learning:

- **Observation 19)** Knowledge about how people learn arises from a number of very different disciplines, each containing significantly different explanations that continue to change and evolve.

- **Observation 20)** There is no universal or optimal pedagogy or technological solution that applies to all subject matter in all contexts.

- **Observation 21)** Student learning within universities is influenced by the conceptions of learning and teaching held and teaching strategies adopted by university academics. These are in turn influenced by academics’ perceptions of the teaching context.

- **Observation 22)** A nuanced understanding of the complex relationships between technology, content, pedagogy within a particular context, enables the development of appropriate strategies.
2.8. **Place**

This section seeks to describe the context, or place, within which university-based e-learning occurs. Understanding place is important, as is shown in Section 2.7.2 the context can have a significant impact on learning and teaching. Knight and Trowler (2000) report on the Rand Change Agent Study (1974-78) that identified mutual adaptation of the innovation and the context as an essential component of successful innovations. Contextual factors shape the decision making process and may amplify, moderate or suppress certain factors (Jamieson et al., 2007).

The section uses a definition of place that includes a number of levels. It starts with a description of the society in which universities, and their practice of e-learning, operates (Section 2.8.1). This description is limited to an examination of broad global trends. The next section (2.8.2) examines the university sector and how those broader societal changes are influencing universities. From there Section 2.8.3 examines how the nature of an individual university is understood and subsequently influences how e-learning is practiced. Finally, Section 2.8.4 identifies a number of observations from this description of place.

### 2.8.1. **Society**

With origins stretching back to the twelfth century and the emergence of the Universities of Paris, Bologna and Oxford (Katz, 2003), the concept of a university has seen and shaped a number of significant changes in society. Today, while there is broad recognition that important societal change is taking place, it is more difficult to identify agreement on the causes, impacts and even definitions of these changes. There remains a lack of agreement amongst social theorists on definitions and implications (Deem, 2001). For example, Brenan (2008) and
Kwiek (2005) identify globalisation and the knowledge society as two related but separate concepts while Vaira (2004) suggests globalisation includes the idea of the knowledge society. Rather than engage in this on-going debate, this section seeks to illustrate how one understanding of globalisation is creating significant, on-going, uncertain, and often contradictory pressures for changes in universities and their practice of learning and teaching.

Globalisation is a term used to describe a recent change in the nature of industrial societies, a change that has fundamental implications for the shape and role of higher education (Brennan, 2008). The discourse around globalisation has affected higher education through the new social, political and economic demands made of such institutions, and in terms of the impact the policy-making, governance, organisation and academic work and identity aspects of institutions (Vaira, 2004). While shared views have emerged, there remain contested perspectives of globalisation and it appears to have ambiguous implications for the future of higher education (Brennan, 2008). Vaira (2004) describes globalisation through three core features: a minimalist state; entrepreneurialisation and managerialisation; and the knowledge society. The rest of this section draws on literature to describe the influences of these three features of globalisation.

Governments across the world are keen to reduce their contribution to the funding of universities (minimalist state), while at the same time seeing the importance of raising the skills and qualification attainment of their populations (knowledge society) (Jones & O'Shea, 2004). While reducing funding, there is a shift (entrepreneurialisation and managerialisation) from regulation toward evaluation of performance and outcomes in combination with a wider confidence in market-like capabilities (Vaira, 2004). Governments are insisting on stronger
managerial systems and evaluation (Maurice Kogan, 2000). This insistence results in the introduction of managerialism, of targets and the monitoring of efficiency and effectiveness in the form of staff appraisal, overt measurement of employee performance and more subtly through self and peer-regulation (Deem, 2001). Managerialism encompasses ideology, discourses and techniques originating in the private sector and speaks of professional administrators, line managers and competitive bidding for resources (Kolsaker, 2008).

As the welfare state gradually erodes (minimalist state), universities are encouraged to source funding from actors (entrepreneurialisation and managerialisation) other than governments (Brennan, 2008). Such a trend increases the diversity of stakeholders, universities, and their missions (Jongbloed, Enders, & Salerno, 2008). It increases complexity in the composition of external actors and arenas of action and requires exploration of how to respond to the increasing volatility and unpredictability of a more complex, fluid and varied environment (Brennan, 2008). The diversity of the society within which universities operate is increasing through a range of other factors. Kwiek (2005) identifies a subset of them including: changing demographics, ageing of societies, post-patriarchal family patterns.

Other changes such as thirty years of technological development, the new rhetoric of competitive advantage, greater emphasis on knowledge production and information processing, wider and faster flow of communications, a shift in work from manual to flexible and educated knowledge gives rise to the idea of the knowledge society (Vaira, 2004). It has been suggested that ICTs will enable a change in hierarchical organisations (OECD, 2000); result in a state of perpetual innovation that leads to a level of complexity within organisations not previously
seen (Tapscott, 1996); and, an ever-accelerating tempo of change that brings rapid obsolescence disrupting conventional infrastructure and planning processes (Duderstadt et al., 2002, p. 175). At the same time, the knowledge society is increasing the importance of educational institutions providing necessary human capital for these developments (Vaira, 2004). It has also created a consensus that lifelong learning is a culture and attitude (Grace, 2006). Further, there are decreasing distinctions between formal and non-formal education (Valimaa & Hoffman, 2008) amongst other factors that challenge existing models of universities.

### 2.8.2. Sector

The societal changes described in the previous section are introducing significant, on-going, uncertain and often contradictory pressures for change in universities. This pressure for change has led a variety of authors to described the intense change (McNaught, 2003), massive change (Newton, 2003), and grotesque turbulence (Webb, 1994, p. 43) that universities and their environment are undergoing. This on-going pressure for change is increasing the importance for universities to be responsive. Huynh, Umesh, et al. (2003) argue that those universities who are able to adapt to changes in the environment while keeping costs under control will be the successful institutions. Scott (2006) agrees and believes that universities must remain flexible enough to be responsive to emerging social demands, technological change and economic realignments. Finally, Klor de Alva (2000) suggests that those institutions who cannot continually change will become irrelevant.
Martin and Etzkowitz (2000) outline two views for the future of the university: the declinist thesis, where the future of the university is under threat; and, the optimistic thesis, where the university will become more powerful. These views may be linked to the opposing perspectives of universities as being resistant to change (Green & Hayward, 1997), or very adaptable organisms that have a proven ability to evolve in a changing environment (Martin & Etzkowitz, 2000). Indeed, it has been argued that universities are a social artefact that can fill any purpose society sets for them without disastrous consequences (Kogan, 2000).

The university sector does have a history, both recent and distant, of responding to changes in society. Table 2.9 provides a summary of some of the recent changes within the university sector. These are just some of the changes that have arisen in response to the three broad societal changes attributed to globalisation in the previous section. Beyond providing evidence of just how much the university sector is changing in response to these societal forces, Table 2.9 also offers some evidence of the contradictory nature of some of these changes. For example, universities are being expected to be diverse (Huisman, Meek, & Wood, 2007), but also to standardise (Marginson, 2007). They are expected to be accountable and reduce risk, but at the same time be innovative (Findlow, 2008). From this, it appears that the university sector is undergoing significant, contradictory change and that this trend is likely to continue.

2.8.3. **Institution**

The previous section examined how the university sector is responding to the broader societal changes. This section seeks to establish that while there are similarities between universities, there are also significant differences.
Understanding that these differences exist is important. As Nichols (2007) argues, the institutional context is all important in terms of the adoption of e-learning. For Parchoma (2006), an understanding of the driving and restraining forces within an individual academic context is important in determining whether a broad-scale e-learning strategy is feasible. This section starts by arguing that, contrary to some assumptions, all types of organisations are not the same, there are generally not universally applicable solutions to common organisational problems. The existence of differences between organisations is further illustrated by describing the significant differences between different universities. The point to be made is that each individual university is likely to have some significant difference with other universities, differences that should be considered and engaged with in the implementation of e-learning.
Table 2.9. Connections between societal change and change within the higher education sector.

<table>
<thead>
<tr>
<th>Societal change</th>
<th>Sector changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimalist state</td>
<td>Increased competition and competitiveness (Cunningham et al., 2000)</td>
</tr>
<tr>
<td></td>
<td>Increased relationships (Gallagher, 2000; Jongbloed et al., 2008)</td>
</tr>
<tr>
<td></td>
<td>Diversity (Huisman et al., 2007)</td>
</tr>
<tr>
<td></td>
<td>Standardisation (Findlow, 2008; Marginson, 2007; Vaira, 2004)</td>
</tr>
<tr>
<td></td>
<td>Massification (Birnbaum, 1983; Rye, 2009)</td>
</tr>
<tr>
<td></td>
<td>Accountability and reduced risk (Ewell, 2009; Findlow, 2008; Jongbloed et al., 2008; Kolsaker, 2008; Marginson, 2007)</td>
</tr>
<tr>
<td>Entrepreneurialisation and</td>
<td>Responsive (Brennan, 2008; Huynh et al., 2003)</td>
</tr>
<tr>
<td>managerisation</td>
<td>(Huynh et al., 2003; Scott, 2006)</td>
</tr>
<tr>
<td></td>
<td>Increased relationships (Gallagher, 2000; Jongbloed et al., 2008)</td>
</tr>
<tr>
<td></td>
<td>Diversity (Huisman et al., 2007)</td>
</tr>
<tr>
<td></td>
<td>Massification and commodification (Cunningham et al., 2000; Gallagher, 2000; Schofer &amp; Meyer, 2005)</td>
</tr>
<tr>
<td></td>
<td>Internationalisation (Vaira, 2004)</td>
</tr>
<tr>
<td></td>
<td>Innovation (Brennan, 2008; Findlow, 2008; Jongbloed et al., 2008; Valimaa &amp; Hoffman, 2008)</td>
</tr>
<tr>
<td></td>
<td>Accountability and reduced risk (Ewell, 2009; Findlow, 2008; Jongbloed et al., 2008; Kolsaker, 2008; Newton, 2003)</td>
</tr>
<tr>
<td></td>
<td>Increased competition and competitiveness (Cunningham et al., 2000)</td>
</tr>
<tr>
<td></td>
<td>Limits on improving learning and teaching (Knight &amp; Trowler, 2000; White, 2006)</td>
</tr>
<tr>
<td></td>
<td>Students are customers (Ewell, 2009; White, 2006)</td>
</tr>
<tr>
<td>Knowledge society</td>
<td>Changes in learning and teaching (Cunningham et al., 2000; Elton, 1999; Lewis et al., 2005; Newton, 2003; Williams, 2008)</td>
</tr>
<tr>
<td></td>
<td>Massification and commodification (Cunningham et al., 2000; Gallagher, 2000; Schofer &amp; Meyer, 2005)</td>
</tr>
<tr>
<td></td>
<td>Internationalisation (Schapper &amp; Mayson, 2004; Turner &amp; Robson, 2007)</td>
</tr>
<tr>
<td></td>
<td>Expansion of disciplines (Valimaa &amp; Hoffman, 2008)</td>
</tr>
<tr>
<td></td>
<td>Standardisation (Findlow, 2008; Marginson, 2007; Vaira, 2004)</td>
</tr>
<tr>
<td></td>
<td>Innovation (Brennan, 2008; Findlow, 2008; Jongbloed et al., 2008; Valimaa &amp; Hoffman, 2008)</td>
</tr>
</tbody>
</table>
All organisations are not equal

New ideas in business, many of which become fads, are often presented as universally applicable quick-fix solutions (Birnbaum, 2000). Underpinning this practice is the assumption that all organisations are equal, that ideas which work in one type or organisation, will work in another. It is this assumption of equality that leads to advice such as Cooke’s (1910, p. v) suggestion that university operations could be improved by harnessing the insights of “those who conduct industrial enterprises.” The following argues that there are recognisable differences between organisations – even those involved with industrial enterprise – that limit this sort of universally applicable fix.

Maister (1993) suggests that professional firms – such as legal and accounting practices – differ from other business enterprises in that they provide highly customised services in highly personalised ways. As a result, common management principles such as standarisation, routinisation, and supervision are difficult to apply in these firms (Maister, 1993). There is significant literature also describing differences between organisations. Handy (1993) identifies four different types of organisational culture – role, achievement, power and support. Mintzberg (1993) grouped organisational structures into five clusters – simple structure, machine bureaucracy, professional bureaucracy and adhocracy – based on the prime coordinating mechanism, the key level within the organisation and the type of decentralisation. There are a variety of measures from which organisational diversity may arise.

In terms of how universities may differ from other organisations, Dodds characterises universities as having distributed decision making, a high degree of local autonomy and distributed resource allocation (Dodds, 2007). Unlike private
enterprises which relate primarily to one societal subsystem – the economy (Meister-Scheytt & Scheytt, 2005) – a university is a meta-institution which interacts and is intertwined with the professions, governments, social movements, business, ethics and morality, education, culture, science, art (Agre, 1999; Meister-Scheytt & Scheytt, 2005). Kezar (2001) describe a non-exhaustive list of thirteen features that are distinctive to universities and suggests that mistakes in analysis and strategy may result if these factors are overlooked and that concepts foreign to the academic will fail to engage those who must bring about change. Finally, Meister-Scheytt and Scheytt (2005) suggest that while approaches from business should not be regarded as false in principle, they appear to be insufficient when examined against the model of universities as knowledge-intensive organisations.

**Types of universities, structures and cultures**

Not only are there differences between types of organisation, there is also significant differences between organisations of the same type, like universities. Barnett (2004) observes that there does not appear to be much in common between a research-led, internationally respected university and a community college that conducts no research. In terms of identifying different types of universities, Martin and Etzkowitz (2000) identify four: the classical university, the technical university, the regional university, the teaching university and a number of hybrids. McNay (1995) identifies another four distinct types of university – collegiate, bureaucracy, corporate and enterprise – based on the extent to which policy is defined and operations controlled. In terms of ability to resist change, Valimaa and Hoffman (2008) distinguish between the older, established universities and other types of institutions. In the relatively small
Australian university sector, Marginson (1997) has identified five types of university including the Sandstones, Redbricks, Gumtrees, Unitechs, and the New Universities. Hearn (1996) extends this to suggest that response to change by universities will vary in important ways from sector to sector, system to system, institution to institution, department to department, and person to person.

One attribute of universities that illustrates and creates differences is organisational structure. Traditionally, universities are loosely coupled (Weick, 1976) in that they illustrate a lack of central coordination, have greater differentiation amongst components, higher degrees of specialisation amongst workers and lower predictability of future action (Kezar, 2001). Fragmentation is a common characteristic of university structures with institutions typically composed of nearly autonomous schools and faculties and individual academics within these that decide what to teach and how (Green, 1997). Due to this fragmentation, central support units within universities are faced with a wide heterogeneity of needs and potentialities (Zellweger, 2005).

Apart from differences arising from structure, there are differences that arise because of culture. Zellweger (2005) argues that adequate support of e-learning requires different support units – information technology, libraries, and faculty development – between which it is possible to observe latent cultural conflicts. Ayers (2004) observes that academic and information technology cultures, two of the main sub-cultures involved with e-learning within universities, do not mix together well. The differing viewpoints, and subsequently the varying and competing priorities of the different sub-cultures within an organisation, can lead to considerable internal tension (Luck et al., 2004). Allen (2000) found that perceptions of the other units, rather than perceptions of the innovation, played a
larger role in adoption decisions. These perspectives all lend weight to Lea’s (2003) suggestion that a critical strategy for effective e-learning is to recognise the different cultures of learning among and within organisations.

This cultural diversity, however, is not limited to those existing between academic and support groups. Churchman (2006) suggests that notions of a universal academic culture may be obsolete within an environment in which the academic role is becoming more obsolete. If any notion of a universal academic culture exists, Green (1997) argues that it rises from values such as unfettered inquiry, the pursuit of knowledge for its own sake, and the quest for freedom from external interference. Nixon, Beatie et al. (1998, p. 278) describe how the concept of academic freedom is seen to allow academics to speak their minds, teach in accordance with their own interests, and enjoy security of tenure. The combination of this concept of academic freedom with Gibbs et al.’s (2000) observation that academics are trained not to accept propositions uncritically greatly increases the diversity of views held by academics. This diversity between academics is further enhanced through disciplinary differences and other factors. Harpe and Radloff (2006) assert that considerable evidence exists to suggest that different academic disciplines have their own culture, language and practices which influence their learning and teaching. Hence, the kind of support required for the enhancement of learning and teaching is also different. Knight and Trowler (2000) point out that individual disciplines may themselves have a fragmented nature.
2.8.4. **Observations from Place**

Based on the above discussion, it is possible to make the following observations about university e-learning:

Observation 23) Broader societal changes (e.g., globalisation) are creating significant, on-going, uncertain, and often contradictory pressures for changes in universities and their practice of learning and teaching.

Observation 24) It is becoming increasingly important, even compulsory, for universities to be responsive to these pressures for change.

Observation 25) There are differences between and within individual universities that should be actively considered and responded to in the implementation of e-learning.

2.9. **Purpose**

In any change project – such as the implementation of e-learning within a university – establishing and gaining widespread agreement about the purpose underpinning the need for change is widely seen as an essential first step. Such a view is especially true if, as observed in Section 2.4, the dominant espoused theory of processes within a university is teleological. Hitt and Hartman (2002) represent this tendency to the teleological with their recommendation that transformational change through e-learning requires institutional leaders, amongst other things, to articulate a clear, bold vision and demonstrate a broad understanding and acceptance of that view. Wise and Quealy (2006) capture the teleological tendency on a slightly smaller scale with their finding that realistic
operationalised objectives and a defined project scope are the common features of successful implementations of Learning Management Systems (LMS) (i.e., industrial e-learning). It should be noted that, as shown in Table 2.3, even ateleological processes have an ultimate purpose to maintain a sense of wholeness and harmony with the system. Given the need for purpose by either type of process, this section seeks to examine what is known about the purpose of universities (Section 2.9.1), learning (Section 2.9.2), and e-learning (Section 2.9.3). It seeks to show that any concept of common purpose is likely to be difficult due to a diversity of views and on-going change.

2.9.1. **Purpose of universities**

Martin and Etzkowitz (2000) identify two main conceptions of the overall purpose of a university: the pure or “immaculate” conception; and, the instrumental or utilitarian ethos. The pure conception views the purpose of the university as education and knowledge for its own sake. The instrumental perspective sees the purpose of the university being to create and disseminate knowledge as well as to train students with skills deemed useful to society. As explained in Section 2.8 there are increasing societal pressures encouraging a further increase in acceptance of the instrumental perspective. Table 2.10 summarises a number of factors that can drive the diversity in the purpose between and within individual universities.
### Table 2.10. Some of the factors increasing diversity in the purpose of universities.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual or societal outcomes</td>
<td>There are disagreements about whether universities should aim to promote individual or social outcomes (Bell, 2004). A variety of institutions within a national higher education system is seen as an important requirement within government policies (Huisman et al., 2007).</td>
</tr>
<tr>
<td>Competition leading to differentiation</td>
<td>Increased national and international competition cause universities to search for a unique purpose in order to increase differentiation and attract students and academic staff (Waeraas &amp; Solbakk, 2009).</td>
</tr>
<tr>
<td>Freedom</td>
<td>Freedom (to varying levels) granted to academic staff enable the pursuit of a broad range of objectives and agendas, with varying values and ethical regimes in order to fulfil the knowledge-forming role of universities (Marginson, 2007).</td>
</tr>
<tr>
<td>Responsive</td>
<td>In order to reflect the ever-changing philosophical ideals, educational policies and cultures of particular societies or institutions, university missions are dynamic and fluid (Scott, 2006).</td>
</tr>
<tr>
<td>Changing tasks</td>
<td>Tasks expected of universities are multifarious, subject to change, mutually contradictory and immediately pressing (de Ridder-Symoens &amp; Ruegg, 2003).</td>
</tr>
</tbody>
</table>

It is these and other factors that contribute to Kogan’s (2000) observation that increasingly the purpose and mandates of higher education are multiple and under constant pressure to change. Kerr (2001) suggests that the existence of several competing visions of true purpose is the cause of much of the malaise within modern university communities. Jongbloed, Enders et al. (2008) diagnose contemporary universities as suffering from an acute case of mission confusion.

Alternatively, it has been argued that goal ambiguity is a defining characteristic of universities (Hearn, 1996) and that broader agreement about purpose within a university may not only be impossible but undesirable (Marginson, 2007). Knight and Trowler (2000) fear that too singular a purpose will suppress the healthy diversity within a university and contribute to an active backstage culture of cynicism and resistance. Similarly, Marginson (2007) argues that any attempt to enforce commitment to an all-embracing set of values would inhibit innovative
thought or create tensions that fracture the institution (Marginson, 2007). Kezar (2001) proposes that the absence of a specific or single purpose is actually beneficial as it can make individuals within an organisation more open to change.

### 2.9.2. Purpose of learning within universities

It can be argued that the purpose of learning, particularly within universities, can be seen through two conceptions very similar to those identified by Martin and Etzkowitz (2000) for the broader purpose of universities: the immaculate and the instrumental. Shaul, writing in the forward to Freire (2000, p. 34) describes the difference as follows.

> Education either functions as an instrument which is used to facilitate the integration of generations into the logic of the present system and bring about conformity to it, or it becomes the ‘practice of freedom’, the means by which men and women deal critically with reality and discover how to participate in the transformation of their world.

The immaculate conception includes a broad array of work from diverse authors, including but not limited to Illich (1972) and Friere (2000). The utilitarian approach is discussed in the literature around the knowledge society (c.f. OECD, 2000; OECD, 2005a) and through the effects of globalisation (Section 2.8.1) is being adopted more broadly. While there exists the possibility of dialectic between these two extreme positions, it is recognised that university learning is becoming increasingly utilitarian through the impacts of massification of higher education and the commodification of knowledge (Table 2.9). Mass access to tertiary education is seen as a major contributor to the fostering of knowledge societies (OECD, 2005a). The knowledge society becomes increasingly dependent
upon the social institutions that create knowledge and educate people (Duderstadt et al., 2002, p. 7). Education and learning is being seen as a commodity and universities as enterprise institutions selling educational products (White, 2006).

2.9.3. Purpose of e-learning within universities
Coates et al. (2005) identify six drivers behind the adoption of e-learning by universities: efficiency; enriched student learning; new student expectations; competitive pressure; responding to massification; and, control. While numerous other authors have offered similar lists, it is generally possible to cover those reasons through the use of the Coates et al. (2005) drivers. For example, Curran’s (2004) three generic objectives for e-learning are: widening access to educational opportunity (responding to massification and competitive pressure), enhancing the quality of teaching and learning (enriched student learning), and containing and possibly reducing the cost of higher education (efficiency). Table 2.11 uses the Coates et al. (2005) drivers to summarise some representative quotes from the literature on e-learning.
Table 2.11. *Drivers behind the adoption of e-learning.*

<table>
<thead>
<tr>
<th>Driver</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>E-learning can reduce the administrative burden on teachers (Britain &amp; Liber, 2000). Practice of e-learning continues to respond to institutional and instructor demands for more efficiency and convenience (Bush &amp; Mott, 2009). Using e-learning to facilitate routine transactions and services can be critically important to the efficiency of services (Dutton &amp; Loader, 2002).</td>
</tr>
<tr>
<td>Enriched student learning</td>
<td>E-learning technologies are adopted to enhance the flexibility of traditional teaching (Nanayakkara &amp; Whiddett, 2005).</td>
</tr>
<tr>
<td>New student expectations</td>
<td>Technology is necessary to meet the changing demands and entry-level skills of recent high school graduates (Duderstadt, Wulf, &amp; Zemsky, 2005). Online education is increasingly common in tertiary education in response to the growing needs of the student population (Nanayakkara &amp; Whiddett, 2005).</td>
</tr>
<tr>
<td>Competitive pressure</td>
<td>E-learning is a way to respond to a changing and more competitive marketplace (Xu &amp; Meyer, 2007). The “you can’t not do it” shared sense of inevitability, if the university does not keep up it will face more substantial difficulties (Collis &amp; Moonen, 2001, p. 39).</td>
</tr>
<tr>
<td>Responding to massification</td>
<td>E-learning overcomes access limitations caused by the lack of physical infrastructure (Coates et al., 2005). Massification of student numbers is being sustained by information and communication technologies (Selwyn, 2007)</td>
</tr>
<tr>
<td>Control</td>
<td>LMSs appear to offer a means of regulating and packaging pedagogical activities, to create order (Coates et al., 2005). Increased visibility of online course material allows administrators to gain instant access to faculty member’s curriculum (Folkers, 2005).</td>
</tr>
</tbody>
</table>

The rationale for the adoption of e-learning within universities is not without its problems. Wise and Quealy (2006) argue that many of the perceived drivers for e-learning are not only contestable, but some are even contradictory. Pratt (2005) argues that the adoption of e-learning by most Australian universities in the 1990s
was not informed by critical examination or forethought, but instead could be seen as a result of a management fashion or fad. In addition, observations made above – such as people having agency (Section 2.6.4) and fragmentation arising from different cultures and perspectives (Section 2.8.3) – suggest that an institution’s expressed purpose for e-learning may undergo some translation and transformation by different organisational units and members during implementation.

### 2.9.4. Observations from purpose

From the above examination of the Purpose component of university e-learning, it is possible to make the following observations:

Observation 26) Universities are increasingly expected to have specified purposes – purposes that are increasingly instrumental – for the institution and its support for learning and e-learning.

Observation 27) A University having a singular purpose may be: impossible; damaging; and, limit capacity to change.

Observation 28) There are a number of commonly expressed drivers – which may be contestable or contradictory – behind the adoption of e-learning by universities.

### 2.10. Conclusions

This chapter has proposed and used the Ps Framework (Jones et al., 2008) to describe and analyse both the current dominant practice of e-learning in universities and its nature or requirements. The current dominant practice is described here as industrial e-learning and is characterised by the use of an
integrated, monolithic enterprise product model (Section 2.3) – labelled a Learning Management System (LMS) – combined with a significant emphasis on teleological processes (Section 2.4). It has been shown that Past Experience (Section 2.5) with industrial e-learning has resulted in a somewhat limited adoption in terms of quantity and little or no change in terms of the quality of learning and teaching.

The nature and characteristics of e-learning within universities has been described through the use of the remaining four components of the Ps Framework: People (Section 2.6), Pedagogy (Section 2.7), Place (Section 2.8) and Purpose (Section 2.9). From the description of university e-learning in these sections, 28 observations have been made about its requirements and characteristics. These observations suggest that there have been significant pressures upon universities to adopt more teleological processes, and there has been a significant move towards using such approaches. These observations, however, also characterise university e-learning as involving and requiring significant levels of diversity, uncertainty and rapid change. This need to support diversity, uncertainty, and change raises questions about the suitability of the industrial e-learning approach given that it is most suited to situations characterised as consistent, certain, and stable.

There is significant literature (e.g., Dishaw & Strong, 1999; Goohue & Thompson, 1995; McGill & Hobbs, 2008) suggesting that there should be a fit between organisational requirements and its information technology. Weak fit promotes the existence of risk-related behaviours in organisations (Hogarth & Dawson, 2008). The apparent weak fit between the current practice and requirements of e-learning within universities may be one explanation for the
rather limited quality and quantity of current e-learning usage. It would also seem
to suggest, that it is important for the implementation of e-learning within
universities to adopt process and product models that create a better fit between
organisational requirements and its information technology. Achieving a more
appropriate fit is the aim of the information systems design theory being
developed by the work described in this thesis.
Chapter 3 - Research Method

Many shall run to and fro, and knowledge shall be increased. (Daniel 7:9)

Validity is subjective rather than objective: the plausibility of the conclusion is what counts. And plausibility, to twist a cliché, lies in the ear of the beholder. (Cronbach, 1982, p. 108)

3.1. Introduction

This thesis aims to answer the “how” question associated with the design, and support of information systems to support e-learning in universities. It seeks to achieve this by using an iterative action research method (Cole et al., 2005) to formulate an information systems design theory (ISDT) (Gregor & Jones, 2007; Walls, Widmeyer, & El Sawy, 2004; Walls et al., 1992). This chapter aims to situate, explain, and justify the nature of the research method adopted in this work. It starts by examining the question of research paradigm and its connection with theory (Section 3.2). In particular, it seeks to explain why, in terms of selecting a research method, that the choice of paradigm is seen as secondary to deciding the type of theory to be produced. The chapter then uses four questions about a body of knowledge identified by Gregor (2006) to describe the particular perspectives that inform the research method adopted in this thesis (Section 3.3).

The formulation of an ISDT is one example of design research. At the start of this work, design research was not a dominant research methodology within the field of information systems (Lee, 2000). Moreover, there was a reluctance to accept the importance of this type of knowledge within information systems (Gregor,
To this day there remain diverse opinions about the nature, place, and processes associated with design research and design theory (Baskerville, 2008; Kuechler & Vaishnavi, 2008). Consequently, the thinking underlying this thesis, and the content and structure of this chapter, has undergone a number of iterations as understanding has improved. For example, initial descriptions of this work (Jones & Gregor, 2004, 2006; Jones, Gregor et al., 2003) used the structure of an ISDT presented by Walls, Widmeyer, and El Sawy (1992). This thesis now uses the improved specification of an ISDT as developed by Gregor and Jones (2007). This improved specification arose, in part, from work associated with this thesis. For these reasons, this chapter may delve into greater detail about the issues of research methods than is traditionally the case.

### 3.2. Paradigms and theory

It is traditional at this point to discuss the research paradigm underpinning the thesis. This practice appears to arise from the assumption that a paradigm embodies the particular world-view that provides the fundamental assumptions underpinning the research project and the subsequent selection of the research method. This thesis takes a slightly different approach. Instead of starting with the paradigm, this section will examine questions of alignment between the research question, the type of theory being produced, and the research methodology being used to develop or test that theory. First and foremost, the aim of research is the generation and evaluation of knowledge which is explained in Section 3.2.1. Section 3.2.2 argues that this knowledge is typically expressed as different types of theory and that the type of theory helps identify an appropriate research method. Lastly, Section 3.2.3 seeks to connect this view with some perspectives on the nature of research paradigms expressed by other authors (Section 3.2.3).
3.2.1. What is research?

The sixth edition of the OECD’s (2002, p. 30) Frascati Manual defines research and experimental development as a:

creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

Vaishnavi and Kuechleer (2004, n.p.) define research as “an activity that contributes to the understanding of a phenomenon.” Research, in its most conceptual sense, is nothing more than the search for understanding (Hirschheim, 1992). Stenhouse (1981) describes research as systematic, self-critical inquiry that is founded in curiosity and driven by a desire to understand. Research arises from a stable, systematic and sustained curiosity that is subjected to public criticism and, where appropriate, empirical tests.

Based on these perspectives it appears that a major aim of research is to generate and evaluate knowledge. Various perspectives on the nature of that knowledge, its purpose, validity, novelty, and utility exist. Returning to the OECD (2002, p. 77–79), research and development covers three main activities:

1. basic research

Experimental or theoretical work, without practical application in view, that aims to acquire new knowledge of the foundations of phenomena and observable facts.
2. **applied research**

   Original investigation aimed at acquiring new knowledge primarily for a specific practical aim or objective.

3. **experimental development**

   Systematic work based on existing knowledge that is directed towards producing new, or improving existing, processes, systems or services.

In spite of these differences, a major aim of research is seen as being able to make a contribution to knowledge. If this is the case, then how is that knowledge represented?

### 3.2.2. The role of theory and method

Venable (2006) states that theory should be a primary output of research. Eisenhardt (1989) identifies theory development is a central activity in organisational research. Gregor (2006) argues that developing theory is what separates academic researchers from practitioners and consultants. In creating and validating knowledge, scientists rely on a clear and succinct statement of theory, theory that embodies statements of the knowledge that has been developed (Venable, 2006). For Van de Ven (1989), good theory is useful because it advances knowledge in a scientific discipline and guides research towards crucial questions. Gregor (2006) agrees and suggests that theories enable knowledge to be accumulated in a systematic manner and the use of this knowledge can inform practice (Gregor, 2006).

As observed by Baskerville (2008), however, there has been a long-running search for the meaning of “theory.” DiMaggio (1995) identifies at least three views of what theory should be and suggests that each has some validity and
limitations. Sutton and Staw (1995) describe disagreements about: whether a model and a theory are different; whether or not a typology is a theory; and, other questions about theory. This uncertainty may be one factor behind Gregor’s (2006) observation that many information systems researchers use the word theory, but fail to give any explicit definition. More broadly, Sutton and Staw (1995) suggest that this uncertainty about what theory is, may explain why it is difficult to develop strong theory. This section seeks to describe the view of theory adopted within this work. Furthermore, it seeks to describe the relationship between theory and research methods.

**Types of theory**

Part of the confusion around theory centres on its purpose and around whether or not there are different types of theory. Within the Information Systems field there have been several different approaches to identifying theory types. Walls et al. (1992) see science as the process of designing theories. Consequently they view the differences between design and descriptive research as differences between types of theory. Iivari (1983) described three levels of theorising: conceptual, descriptive and prescriptive. A number of authors (Kuechler & Vaishnavi, 2008; Nunamaker et al., 1991; Walls et al., 1992) have used the distinction of kernel and design theories. Taking a broad view of theory, Gregor (2006) identified five inter-related categories of theory based on the primary type of question at the foundation of a research project. These five categories and their question of interest are summarised in Table 3.1.
Table 3.1. Gregor’s (2006) taxonomy of theory types in Information Systems research.

<table>
<thead>
<tr>
<th>Theory type</th>
<th>Distinguishing attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Analysis</td>
<td>Says “what is.” The theory does not extend beyond analysis and description. No causal relationships among phenomena are specified and no predictions are made.</td>
</tr>
<tr>
<td>II. Explanation</td>
<td>Says “what is,” “how,” “why,” “when,” “where.” The theory provides explanations but does not aim to predict with any precision. There are no testable propositions.</td>
</tr>
<tr>
<td>III. Prediction</td>
<td>Says “what is” and “what will be.” The theory provides predictions and has testable propositions but does not have well-developed justificatory causal explanations.</td>
</tr>
<tr>
<td>IV. Explanation and prediction (EP)</td>
<td>Says “what is,” “how,” “why,” “when,” “where,” and “what will be.” Provides predictions and has both testable propositions and causal explanations.</td>
</tr>
<tr>
<td>V. Design and action</td>
<td>Says “how to do something.” The theory gives explicit prescriptions (e.g., methods, techniques, principles of form and function) for constructing an artefact.</td>
</tr>
</tbody>
</table>


The taxonomy presented in Table 3.1 is relatively novel and there exists opportunities for further work and improvement (Gregor, 2006). There also remains some disagreement about the designation of design theory to Theory type V (Venable, 2006). It does seem, however, to provide a foundation on which to build sound, cumulative, integrated and practical bodies of theory within the information systems discipline (Gregor, 2006).

**Relationship between theory and method**

Gregor (2006) suggests that research begins with a problem to be solved or a question of interest. The type of theory that is to be developed or tested depends on the nature of this problem and the questions the researcher wishes to address (Gregor, 2006). This connection is made on the basis of the primary goals of theory (Gregor, 2006). Assuming this image of the research process it seems
logical that, after the identification of which theory type is of interest, the next step is the selection of research methods most appropriate for the selected theory type. Such a practice does not suggest that there is a one-to-one correspondence between a particular theory type and a particular method or paradigm. Gregor (2006) argues that none of the theory types necessitate a specific method however, proponents of specific paradigms do favour certain types of theory over others. While there is no necessary correspondence between theory types and methods/paradigms, it is suggested that certain methods/paradigms are better suited to certain types of theory, research problems and researchers. Recognising different types of theory makes it possible to see the differences as complementary and consequently enable integration into a larger whole (Gregor, 2006). It is possible for research to make a contribution to more than one type of theory. Baskerville (2008) argues that there is clearly more to design research than design theory alone. Kuechler and Vaishnavi (2008) show how a design research project contributes to both design theory (Gregor’s Type V) and kernel theory (Gregor’s other types). The possibility for a research project to make contributions to different types of theory suggests that a research project may draw upon several different methods or paradigms.

3.2.3. **The role of research paradigms**

Having briefly summarised the perspective on research, theory and method in previous sections, this section makes some connections between this perspective and the views on research paradigms expressed by Mingers (2001) as well as the pragmatic research paradigm (Goles & Hirschheim, 2000). The pragmatic research paradigm described here can also be found in work from research in the
field of education (Howe, 1988). It also serves as the basis for mixed-methods research (Tashakkori & Teddlie, 1998).

Reich (1995) defines research methodology – used in the sense of paradigm as used in this chapter – as an attempt to approximate a compatible collection of assumptions and goals which underlay methods, the actual methods, and the way the results of performing those methods are interpreted and evaluated. The assumptions or beliefs about the world, how it works and how it may be understood has been termed a paradigm (Kuhn, 1996). Numerous authors have sought to identify and describe different research paradigms. Within the information systems discipline, Orlikowski and Baroudi (1991) identify three broad research paradigms: positivist, interpretive and critical. Within information systems and in connection with the rise of design research, numerous authors (Hevner et al., 2004; March & Smith, 1995; Nunamaker et al., 1991) have suggested that it is possible to identify two broad research paradigms within information systems: descriptive and prescriptive research: where descriptive research is seen as “traditional” research and where prescriptive research is design research. There are some, however, who take issue with seeing design research as a separate paradigm (McKay & Marshall, 2007b).

Just as there are differing views on the number and labels of different research paradigms, there are differences on how to describe them. Guba and Lincoln (1994) describe the beliefs encompassed by a paradigm through three, interconnected questions: ontology, epistemology and methodology. Mingers (2001) describes a paradigm as being a general set of philosophical assumptions covering ontology, epistemology, ethics or axiology and methodology. Goles and Hirschheim (2000) use ontology, epistemology and axiology.
Mingers (2001) describes three perspectives on paradigms. These are:

- **isolationism**
  
  Where paradigms are based on contradictory assumptions which makes them mutually exclusive and consequently a researcher should follow a single paradigm

- **complementarist**
  
  Paradigms are seen as more or less suited to particular problems and selection is based on a process of choice

- **multi-method**
  
  Paradigms are seen to focus on different aspects of reality and can be combined to provide a richer understanding of the problem.

Minger’s (2001) multi-method perspective seems to fit well with a research project seeking to address a research problem through making contributions to different types of theory (as described in Section 3.2.2). Such a perspective suggests that the question of whether a researcher adopts a positivist, interpretivist or critical perspective is not seen as useful as the question of whether or not there is alignment between the research problem or question; the types of theory being formulated or tested; and, the research methods used to achieve this goal.

Such a perspective seems to have connections with that of the pragmatist research paradigm described by Goles and Hirschheim (2000). Seen as the basis for mix-methods research, pragmatists consider the research question as more important than the worldview meant to underpin the method (Tashakkori & Teddlie, 1998).

Table 3.2 is adapted from Tashakkori and Teddlie (1998), and offers a
comparison of four research paradigms, including pragmatism. Goles and Hirschheim (2000) suggest that pragmatism draws on a philosophical basis of pluralism to undercut the traditional dichotomous battle between conflicting paradigms. The pragmatic research paradigm traces its origins to the pragmatic tradition of James, Pierce, Dewey, Wittgenstein, and Quine in the late 19th and early 20th century, and more contemporary philosophers like Rorty and Davidson (Howe, 1985; Tashakkori & Teddlie, 1998). Howe (1985, p. 10) argues that rather than a paradigm determining the research method, the pragmatic view is that paradigms are evaluated in terms of “how well they square with the demands of research practice” as well as demonstrating value in terms of how they inform and are informed by successful research methods.

If a paradigm must be chosen, then the pragmatic research paradigm seems the best fit for the approach being adopted in this study. Not only because of the perspective expressed here around theory and research method, but also because many authors (Cole et al., 2005; Hevner et al., 2004; Iivari, 2007; Kuechler & Vaishnavi, 2008) have identified a heavily pragmatist perspective within design research. The approach adopted here starts with the question of how to design and support an information system for e-learning within universities. The type of theories developed and the appropriateness of the research methods used should flow from and seek to align with that question. The rest of this chapter aims to provide an explanation of the choices made in this work.
Table 3.2. Comparisons for four important paradigms used in the social and behavioural sciences.

<table>
<thead>
<tr>
<th>Paradigm</th>
<th>Positivism</th>
<th>Postpositivism</th>
<th>Pragmatism</th>
<th>Constructivism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>Quantitative</td>
<td>Primarily quantitative</td>
<td>Quantitative + Qualitative</td>
<td>Qualitative</td>
</tr>
<tr>
<td>Logic</td>
<td>Deductive</td>
<td>Primarily deductive</td>
<td>Deductive + Inductive</td>
<td>Inductive</td>
</tr>
<tr>
<td>Epistemology</td>
<td>Objective point of view, Knower and known are dualism.</td>
<td>Modified dualism. Findings probably objectively “true.”</td>
<td>Both objective and subjective points of view</td>
<td>Subjective point of view. Knower and known are inseparable</td>
</tr>
<tr>
<td>Axiology</td>
<td>Inquiry is value-free</td>
<td>Inquiry involves values, but they may be controlled</td>
<td>Values play a large role in interpreting results</td>
<td>Inquiry is value-bound</td>
</tr>
<tr>
<td>Ontology</td>
<td>Naïve realism</td>
<td>Critical or transcendental realism.</td>
<td>Accept external reality. Choose explanations that best produce desired outcomes</td>
<td>Relativism</td>
</tr>
<tr>
<td>Causal linkages</td>
<td>Real causes temporally precedent to or simultaneous with effects</td>
<td>There are some lawful, reasonably stable relationships among social phenomena. These may be known imperfectly. Causes are identifiable in a probabilistic sense that changes over time.</td>
<td>There may be causal relationships, but we will never be able to pin them down.</td>
<td>All entities simultaneously shaping each other. It’s impossible to distinguish causes from effects.</td>
</tr>
</tbody>
</table>

Note: Adapted from Mixed methodology: combining qualitative and quantitative approaches (p. 23), by A. Tashakkori and C. Teddlie, 1998, Thousand Oaks, California: SAGE.
3.3. Perspectives adopted in this research

The previous section provided an overview of the perspective on research adopted within this thesis. This section seeks to describe how that perspective translates into specific choices in terms of the research method adopted in this work. In keeping with the “pragmatist” perspective expressed in the previous section this section draws on the four inter-related classes of questions around theories described by Gregor (2006) to do so. These four classes of questions are:

1. Domain questions (Section 3.3.1)
   
   What is the phenomena (or question) of interest in this study? What is the problem? Is it of interest and importance to the information systems discipline and the broader community?

2. Ontological questions (Section 3.3.2)

   What is theory? What type(s) of theory is relevant to the research problem? How are those theories expressed?

3. Epistemological questions (Section 3.3.3)

   How can the identified type(s) of theory be developed and tested? What criteria should be used to judge the soundness and rigour of these methods?

4. Socio-political questions (Section 3.3.4)

   Is the resulting knowledge relevant and useful in a practical sense? Are there social, ethical or political issues concerning this knowledge?
3.3.1. **Domain questions**

Gregor (2006, p 611) describes domain questions and considerations as

What phenomena are of interest in the discipline? What are the core problems or topics of interest? What are the boundaries of the discipline?

Benbasat and Zmud (2003) suggest that the focus of the information systems discipline should be on how to best design IT artefacts and IS systems to increase their compatibility, usefulness, and ease of use, or, on how to best manage and support IT or IT-enabled business initiatives. Lee (2000) defines the Information Systems (IS) field as concerning itself with research and practice about the problems and solutions that emerge from the interactions at the interface between the technological and the behavioural. Keen (1987) suggests that the main aim of research in information systems is the study of the effective design, delivery, use and impact of IT in organisations and society. For Weber (1997), the goal within the field of information systems is to understand better how individuals, groups, organisations and society can use information systems more effectively and more efficiently. Information systems researchers and practitioners attempt to understand the use of IT artefacts in order to be able to develop “better” ones (Iivari, 2003). Information systems research aims to improve the ability of information systems to achieve their goals (Hevner et al., 2004).

du Plooy (2003) describes an information system as consisting of three subsystems: the hardware, software and “otherware.” It is the consideration of all three subsystems, and in particular “otherware,” which differentiates information systems from other related disciplines such as computer science and information
technology. Hardware and software are designed artefacts intended to be deterministic and reliable. “Otherware” involves people, who may have agendas and goals that differ vastly from those of the organisation (Markus, 1983). For this, and other reasons, “otherware” is non-deterministic (duPlooy, 2003). The inadequacy of computer science in addressing problems associated with the use of computers in organisational contexts has played a large part in the emergence of the IS discipline (Fitzgerald & Adam, 1996).

Research into how to design, develop, and support university e-learning fits well within the domain of interest for the information systems discipline. It is a context that requires better insight into how to effectively design the use of IT within an organisation. It has been recognised by Alavi and Leidner (2001) that there is a need for research that considers the organisational processes and structures necessary to effectively coordinate university level implementation of technology mediated learning (Alavi & Leidner, 2001). This thesis aims to provide this advice in the form of an information systems design theory for e-learning within universities.

3.3.2. **Ontological questions**

Gregor (2006, p 612) describes ontological questions and considerations as including:

- What is theory? How is this term understood in the discipline? Of what is theory composed? What forms do contributions to knowledge take?
- How is theory expressed? What types of claims or statements can be made? What types of questions are addressed?
It is this class of questions that has created the greatest consternation and
discussion during the course of this thesis, especially during the formative stages.
As mentioned in the introduction to this chapter, this particular consternation
arose from a number of factors including: uncertainty about the importance or
place of design research within information systems (Gregor, 2002); early (and
on-going) suggestions that theory had no part in design research (March & Smith,
1995); and questions about – if design theory was accepted – the best way to
express an information systems design theory (Gregor & Jones, 2004; Venable,
2006; Walls et al., 1992).

As a consequence significant energy was expended in attempting to understand,
examine critically and improve upon the many and varied perspectives embedded
within these debates. As a result early publications describing this work as a
design theory (Jones & Gregor, 2004, 2006; Jones, Gregor et al., 2003) used the
design theory structure formulated by Walls et al. (1992, 2004). This experience
and other insights led to the formulation and suggestion of an improved anatomy
for information systems design theories (ISDTs) published in Gregor and Jones
(2004, 2007). The improved anatomy of an ISDT is one of the contributions
arising from this thesis.

This section starts by summarising some of the divergent perspectives of the role
and purpose of theory in design research. It then briefly explains the improved
anatomy of an information systems design theory proposed in Gregor and Jones
(2007).
Theory in design research

The nature and necessity for a design theory remains a matter of debate (Baskerville, 2008). For example, March and Smith (1995) suggest that rather than posing theories, design scientists strive to create models, methods and implementations that are innovative and valuable. Lee (2000) suggests that it is still important in design science for a theory to explain a phenomenon, but it is less important than the instrumental use of a theory to build a system that is efficient and effective in the eyes of the potential users of the information system. Hevner et al. (2004) agree with March and Smith (1995) in recognising design science as a research activity that is not directly involved in the production of theory. More broadly, Vaishnavi and Kuechleer (2004) identify a lack of consensus around the precise objective and desired outputs of design research.

The view adopted in this thesis agrees with the contention of a number of authors (Venable, 2006; Walls et al., 1992) that the aim of research is the creation and testing of theory. Venable (2006) suggests that design research should have theory as a primary output and that theory and theorising should play a central role in the advancement of design research. Adams and Courtney (2004) suggest that design research is a theory building technique which when combined with the development of an instantiation can become a theory testing technique. Cole et al. (2005) argue that design research is not atheoretical tinkering, but that the development of the artefact should incorporate theory and make a theory-building contribution. Gregor and Jones (2007) argue that design knowledge is of vital concern to industry and that improvements to design theorising should increase the relevance of information systems research. Gregor and Jones (2007) also argue that the unambiguous recognition of design knowledge as theory provides a
sounder base for the rigor and legitimacy of IS as an applied discipline and for its continuing progress.

If it is accepted that the production and testing of theory is the aim of research, and thus, that design research should seek to make contributions to theory, what type of contribution to theory can design research make? It is suggested that Gregor’s (2006) Theory Type V – theory for design and action – is generally the main, but not only, contribution to theory made by design research. Design research can make contributions of other types of theory through its formulation and testing. Kuechler and Vaishnavi (2008) show how a design research project can contribute to both design theory and inform “kernel theories” (defined below) that are typically theories of other types. This thesis has made three contributions to theory consisting of: a design theory for e-learning within universities and the two theories for analysis. The first theory for analysis is the Ps Framework (Jones et al., 2008) though it is accepted that the Ps Framework is, at best, a nascent skeleton of a theory for analysis. The second and more complete theory for analysis is the improved anatomy of a design theory (Gregor & Jones, 2007).

**Representation of ISDTs**

The previous section argued that design research should aim to make a contribution to theory, and that this theory, while primarily aimed at design theory, can also include other types of theory. The aim of this section is to provide an overview of perspectives on how design theory should be represented.

It is suggested that Information Systems Design Theories (ISDT) are an example of theories for design and action, an example of Gregor’s (2006) Theory V (Table 3.1). The primary focus of design theory is on general principles that inform
practice (Gregor, 2002). Guidance about how to achieve specific goals is intrinsic to a design theory (Walls et al., 1992). Design theory provides guidance about how to build an artefact (process) and what the artefact should look like when built (product/design principles) (Gregor, 2002; Walls et al., 1992). The first representation of an ISDT and its components was developed by Walls et al. (1992) and is summarised in graphical form in Figure 3.1 below. A tabular summary appears in Table 3.3.

![Figure 3.1. Components of an Information Systems Design Theory. Adapted from “Assessing information system design theory in perspective: How useful was our 1992 initial rendition”, by J. Walls et al., 2004, Journal of Information Technology, Theory and Application, 6(2), p. 46.](image)

Walls et al. (1992) see an ISDT as an integrated set of prescriptions consisting of a particular class of user requirements (meta-requirements), a type of system solution with distinctive features (meta-design) and a set of effective development practices (meta-design). Each of these components of an ISDT can be informed by kernel theories, either academic or practitioner theory-in-use (Sarker & Lee, 2002), that enable the formulation of empirically testable predictions relating the
design theory to outcomes (Markus et al., 2002). It should be noted that, Iivari (2007) questions the value and place of practitioner theory-in-use theories as kernel theories.

Table 3.3. Components of an Information System Design Theory (ISDT).

<table>
<thead>
<tr>
<th>Design Product</th>
<th>ISDT Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meta-requirements</td>
<td>Describes the class of goals to which the theory applies</td>
</tr>
<tr>
<td>Meta-design</td>
<td>Describes a class of artefacts hypothesised to meet the meta-requirements</td>
</tr>
<tr>
<td>Kernel theories</td>
<td>Theories from natural or social sciences governing design requirements</td>
</tr>
<tr>
<td>Testable design product hypotheses</td>
<td>Used to test whether the meta-design satisfies the meta-requirements</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design Process</th>
<th>ISDT Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design method</td>
<td>A description of procedure(s) for artefact construction</td>
</tr>
<tr>
<td>Kernel theories</td>
<td>Theories from natural or social sciences governing the design process itself</td>
</tr>
<tr>
<td>Testable design process hypotheses</td>
<td>Used to verify whether the design method results in an artefact which is consistent with the meta-design</td>
</tr>
</tbody>
</table>


As described earlier, some writers (Hevner et al., 2004; March & Smith, 1995) did not regard theory as a product of design science. Hevner et al. (2004) suggest that the ISDT format described by Walls et al. (1992) is actually a combination of March and Smith’s (1995) – non-theory related – design science outputs. Table 3.4 is a summary of the mapping suggested by Hevner et al. (2004).

Table 3.4. Hevner et al.’s (2004) mapping of design science research outputs with ISDT components.

<table>
<thead>
<tr>
<th>ISDT components</th>
<th>Design Science Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kernel Theories</td>
<td>Not specified</td>
</tr>
<tr>
<td>Meta-requirements</td>
<td>Model of design problems</td>
</tr>
<tr>
<td>Meta-design</td>
<td>Instantiation</td>
</tr>
<tr>
<td>Development practices</td>
<td>Methods</td>
</tr>
<tr>
<td>Hypotheses</td>
<td>Not specified</td>
</tr>
</tbody>
</table>
While there is value in attempting to establish connections between these two views of design research, there appears to be some weaknesses with the mapping summarised in Table 3.4. First, the design science outputs in the table provide no equivalent to the ISDT components: kernel theories and design hypotheses. This limits the ability to build cumulatively on prior work and test design research. The ability to build cumulatively on prior work and test design research are important, even essential, requirements for research. The next potential weakness concerns the interpretation of the meta-design ISDT component as an instantiation. The original definition provided by Walls et al. (1992) for the meta-design component suggests that it should describe a class of instantiations that are able to meet the meta-requirements, not a single instantiation. van Aken (2004) suggests that rather than a specific prescription for a specific situation (an instantiation), the intent should be for a general prescription for a class of problems.

Additionally, the perceived need for this mapping may arise from definitional differences around what is theory. A broader view of theory would interpret the first three of March and Smith’s (1995) design science outputs – constructs, models and methods – as components of theory (Gregor & Jones, 2007). Alternatively, a broader view of theory may also interpret these design science outputs as examples of theory. For example, Berente and Lyytinen (2006, n.p.) seek to “reveal and refine the concept of iteration and formulate it as a well-defined construct” upon which to base future research. Berente and Lyytinen’s (2006) work on iteration identifies and describes four levels of iterating artefacts and uses these descriptions to group and evaluate empirical research. It could be argued that rather than a construct, this work has formulated a Theory of Type I, a theory for analysis.
While initially accepting and using the Walls et al. (1992) representation of an ISDT, overtime it appeared that there were some weaknesses. It was these weaknesses that led to iterative improvements in the representation of ISDTs (Gregor & Jones, 2004, 2007). The perceived weaknesses identified by Gregor and Jones (2007) include:

- two of Dubin’s (1978) mandatory theory components – units and system states – were missing
- an incomplete capturing of the full range of Simon’s (1996) ideas
- a lack of an explicit discussion of specifying an ISDT for methodologies
- suggestions that the depiction of design theory and its components may be too unwieldy for use (Walls et al., 2004) and could be improved by drawing on other work.

As well as addressing these problems, the proposal by Gregor and Jones (2007) is also arguably more complete and usable. Table 3.5 describes each of the eight components of the Gregor and Jones (2007) representation of an ISDT. Figure 3.2 provides a graphical representation of the ISDT that is adapted from Lyytinen (2008). The Gregor and Jones (2007) representation adds the components of constructs, artefact mutability and an expository instantiation and merges the kernel theories for both product and process into a single component, justificatory knowledge.
Table 3.5. *Eight components of an Information Systems Design Theory (ISDT).*

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core components</strong></td>
<td></td>
</tr>
<tr>
<td>1. Purpose and scope (the causa finalis)</td>
<td>“What the system is for,” the set of meta-requirements or goals that specifies the type of artefact to which the theory applies and in conjunction also defines the scope, or boundaries, of the theory.</td>
</tr>
<tr>
<td>2. Constructs (the causa materialis)</td>
<td>Representations of the entities of interest in the theory</td>
</tr>
<tr>
<td>3. Principle of form and function (the causa formalis)</td>
<td>The abstract “blueprint” or architecture that describes an IS artefact, either product or method/intervention</td>
</tr>
<tr>
<td>4. Artefact mutability</td>
<td>The changes in state of the artefact anticipated in the theory, that is, what degree of artefact change is encompassed by the theory</td>
</tr>
<tr>
<td>5. Testable propositions</td>
<td>Truth statements about the design theory.</td>
</tr>
<tr>
<td>6. Justificatory knowledge</td>
<td>The underlying knowledge of theory from the natural or social or design sciences that gives a basis for explanation for the design (kernel theories)</td>
</tr>
<tr>
<td><strong>Additional components</strong></td>
<td></td>
</tr>
<tr>
<td>7. Principles of implementation (the causa efficiens)</td>
<td>A description of processes for implementing the theory (either product or method) in specific contexts.</td>
</tr>
<tr>
<td>8. Expository instantiation</td>
<td>A physical implementation of the artefact that can assist in representing the theory both as an expository device and for purposes of testing</td>
</tr>
</tbody>
</table>


Others are now adopting this new perspective on design theory. A common usage is the adoption of something like Table 3.5 to provide an overview of the formulated design theory. Examples of this type of use can be found in Moody (2009) and Carlsson et al. (forthcoming).
3.3.3. Epistemological questions

Gregor (2006, p. 12) describes epistemological questions and considerations as including:

- How is theory constructed? How can scientific knowledge be acquired?
- How is theory tested? What research methods can be used? What criteria are applied to judge the soundness and rigour of research methods?

This section does not offer a full description of epistemological questions surrounding information systems design research as the debate is on-going.

Niehaves (2007) argues that there has not yet been a comprehensive, integrated discussion of epistemology of information systems design research. Furthermore, it is suggested that what discussion has occurred has often been dominated by an
implicit assumption of a positivist epistemology. Niehaves (2007) also argues that
a pluralist approach to design research offers great potential in solving relevant
real world problems as well as the internal problems of the IS discipline. It is
possible that the pragmatic research paradigm described earlier (Table 3.2) may
offer some support for this argument for a more pluralist approach. For this
reason, this section seeks to focus on the research method this work has adopted
and criteria that may be used to judge this work. In terms of research method this
work uses an action-research-like method similar to that used by Markus et al.
(2002). In terms of criteria there appears to be value in the dual approach taken by
Cole et al. (2005) that combines criteria from design science research and
canonical action research.

**Research method**

It has been suggested that the core of any IS design research methodology is the
design-build-evaluate cycle (Kuechler & Vaishnavi, 2008). It is not surprising that
design research and action research are often seen as similar as both are
interventional, and both involve problem-solving and evaluation (Baskerville,
2008). Jarvinen (2007) argues that both aim to create knowledge through the
intentional modification of a real setting and the careful evaluation of the results.
Cole et al. (2005) suggest that there are interesting parallels and similarities
between action research and design research and suggest that the merging of ideas
between the two may be useful for IS research as well as design and action
research.

Not all are in agreement about the similarities between action research and design
research. Baskerville (2008) suggests that there are fundamental differences in
that action research is centred on discovery-though-action, while design research
is centred on discovery-through-design. Ilivari (2007) argues that action research and design research differ historically, practically, ontologically, epistemologically and methodologically. At least in part, it appears that the origins of these disagreements arise from definitional differences. For example, Ilivari and Venable (2009, n.p.) suggest that Jarvinen’s (2007) analyses of action research and design research are “based on somewhat biased” conceptions of both.

Baskerville (2008, p. 442) describes the difference as

Action research is a methodology. Design science is a paradigm.

Similarly, Ilivari and Venable (2009) suggest equating action research to design research suffers from the category problem, in that action research is a method while design research is more a research orientation. The goal of action research is the resolution of a practical problem while simultaneously contributing to theory (Cole et al., 2005). Action research aims to contribute to practice and research at the same time, through the involvement of a concrete client, and consequently making it highly context dependent (Ilivari & Venable, 2009). Action research is suited to social situations in which the researcher must be engaged (Cole et al., 2005).

While recognising the interest in, and on-going nature of this debate the perspective in this work is that whether or not design science is a paradigm is not seen as directly useful in terms of formulating an ISDT. Instead, the more useful question is whether or not the research method adopted here is appropriate for the type of knowledge this work seeks to generate. The intent of this work is to make a contribution to knowledge in the form of an ISDT for university e-learning. The
method adopted to achieve this goal is an iterative, action-research-like process. A process that has significant similarity with the approach adopted by Markus et al. (2002) and shown in Figure 3.3.

Figure 3.3. Iterative action research process for formulating an ISDT. Adapted from “A design theory for systems that support emergent knowledge processes”, by M. Markus et al., 2002, *MIS Quarterly*, 26(3), p. 207.

As described in more detail in Chapter 4, this work commenced as an attempt to design an e-learning information system – called Webfuse – for a particular university (Jones & Buchanan, 1996). Over the next 13 years, the design and support of this information system led to a cycle very much like that shown in Figure 3.3. Through this cycle changes to the information system arose from a combination of observation of system use (or lack thereof) and insights provided by theories. A cycle that continued over 13 years, was documented in over 20 publications, and is explained in some detail in Chapters 4 and 5. This cycle has enabled the development and support of a real-world information system that has been used by over 45,000 staff and students for a range of e-learning activities.
A part of the process shown in Figure 3.3 is the attempt to abstract the knowledge gained into a better ISDT. In this research the formulation of an ISDT commenced in 2001/2002 when work on the PhD commenced. Given the iterative nature of the action research process and the novelty of the ISDT approach there have been a number of ISDTs formulated. The first were documented in three publications (Jones & Gregor, 2004, 2006; Jones, Gregor, et al., 2003) all of which used the Walls et al. (1992) ISDT representation. As outlined above, this research developed an improved ISDT representation. It is this improved representation that is used for describe the ISDTs used to describe the two major phases of the Webfuse action research process in Chapters 4 and 5.

It is the use of action research to intervene in a real-world situation that sets this work apart from the majority of design research. Iivari (2007) views design research as usually being performed in laboratories clearly removed from potential clients. Similarly, Hevner et al. (2004) suggest that it is rare for the artefacts resulting from design research to be fully-grown information systems that are used in practice. The method used here, like that used by Markus et al. (2002), seeks to abstract design theory from an information system being used to solve real organisational problems. As argued in Jones and Gregor (2006), the use of a real-world instantiation enables research to respond to and be influenced by the unexpected events that are not readily visible when limited to a prototype or theoretical instantiation. It also provides one way to respond to the call of Hevner et al. (2004) to align information systems design research with real-world production experience.
**Evaluation criteria**

The IS design research literature contains numerous suggestions for evaluation criteria. Nunamaker et al. (1991) identify five criteria based around importance of the problem, significance, testability, provision of a better system and that the experience and expertise can be generalised for future use. They suggest that the transfer of technology into organisations is the ultimate success for design research and the theories, concepts and systems that result (Nunamaker et al., 1991). Lukka (2000), in describing constructive research, develops a list of evaluation criteria including: relevance and contribution, illustration of familiarity with relevant theory, a clear research design, credibility in terms of validity and reliability, making a new theoretical contribution and clear reporting. Gregg et al. (2001) develop their three phase (conceptual, formal and developmental) software engineering research methodology and specify a series of ratings (high, medium, low) and suggest that rigorous research must address the conceptual phase and one other phase. Hevener et al. (2004) propose seven guidelines for conducting and evaluating good prescriptive research, which are summarised in Table 3.6.

Gregg et al. (2001) identify two cases in which systems development may not be considered serious research: where a program is written to solve a trivial problem; and where existing software is applied to varied contexts. This perspective is echoed by Hevner et al. (2004) who suggest that system building relies on using existing knowledge while design research addresses important unsolved problems in unique or innovative ways or solved problems in more effective and efficient ways. It is the contribution to the established knowledge base of foundations and methodologies that is the key differentiator between system building and prescriptive research (Hevner et al., 2004).
Table 3.6. *Design research guidelines.*

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Design as an artefact</td>
<td>Design-science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation.</td>
</tr>
<tr>
<td>2. Problem Relevance</td>
<td>The objective of design-science research is to develop technology-based solutions to important and relevant business problems.</td>
</tr>
<tr>
<td>3. Design Evaluation</td>
<td>The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.</td>
</tr>
<tr>
<td>4. Research Contributions</td>
<td>Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.</td>
</tr>
<tr>
<td>5. Research Rigor</td>
<td>Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.</td>
</tr>
<tr>
<td>6. Design as a Search Process</td>
<td>The search for an effective artefact requires utilising available means to reach desired ends while satisfying laws in the problem environment.</td>
</tr>
<tr>
<td>7. Communication of Research</td>
<td>Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.</td>
</tr>
</tbody>
</table>


Cole et al. (2005) show how a design research exemplar be can evaluated using criteria for action research exemplars, and vice-versa. As an illustration, Cole et al. (2005) evaluate the exemplar design research by Markus et al. (2002) using the action research criteria adapted from the work of Davison et al. (2004). As shown in the previous section there are a number of authors (Baskerville, 2008; Iivari & Venable, 2009) who do not think that action research and design research are comparable. On the other hand, for design research work that uses action research as the method – as in the case of Markus et al. (2002) – using action research evaluation criteria seems appropriate. While this work has much in common with Markus et al. (2002) in terms of method, given the uncertainty around the relationship between design research and action research and the widespread
acceptance of the Hevner et al. (2004) criteria, the design research guidelines appear more appropriate.

3.3.4. Socio-political questions

Gregor (2006, p. 612) describes social-political questions as including consideration of:

How is the disciplinary knowledge understood by stakeholders against the backdrop of human affairs? Where and by whom has theory been developed? What are the history and sociology of theory evolution? Are scholars in the discipline in general agreement about current theories or do profound differences of opinion exist? How is knowledge applied? Is the knowledge expected to be relevant and useful in a practical sense? Are there social, ethical or political issues associated with the use of the disciplinary knowledge?

This section limits itself to briefly re-stating a consistent theme throughout this section (Section 3.3) that discipline level knowledge of design theory and design research is an on-going process yet to reach broad consensus. It then examines the views of axiology so far presented within that literature and identifies this work as taking an increasingly interpretive ethical perspective as defined by Iivari (2007).

Understanding of design research and design theory

As previously discussed, there remains some significant level of diversity in opinion around the nature of design research as well as how questions relating to domain, ontology, epistemology and socio-political questions are answered. Such diversity of opinion suggests that information systems as a field is still coming to terms with questions of design research and design theory. As such it is beyond
the scope of this chapter to offer a summary. Previous sections in this chapter, however, have identified the perspectives adopted in this work and shown that all are based on perspectives that have some level of acceptance within the discipline. Where appropriate, the previous sections have pointed to some of the literature in which further diversity of opinion around these questions has been expressed (Baskerville, 2008; Hevner et al., 2004; Iivari, 2007; Jarvinen, 2007; McKay & Marshall, 2005; Niehaves, 2007; Venable, 2006). Previous sections have also indicated where this thesis has contributed potential answers to these questions (Gregor & Jones, 2004, 2007).

**Axiology and ethics**

Iivari (2007, p. 39) argues that “Information Systems as design science” cannot be value-free, in particular because design research embodies a change in purpose from describing and explaining the world to a purpose of shaping it. Based on this perspective, it is important to express as explicitly as possible the basic values of research (Iivari, 2007). Cole et al. (2005) suggest that the axiology of both design research and action research is evident in the way both value the relevance of the research problem as well as a simultaneous emphasis on practical utility and theoretical knowledge. Kuechler and Vaishnavi (2008) suggest that design research has an implicit axiology that is utilitarian and pragmatic. Iivari (2007) drawing on earlier work (Chua, 1986; Iivari, 1991) identifies three ethical positions for design research: means-end oriented, interpretive, and critical. These are summarised in Table 3.7.
Table 3.7. Three ethical positions for design research.

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means-end oriented</td>
<td>Aim to achieve given ends with specific means</td>
</tr>
<tr>
<td>Interpretive</td>
<td>The ends are not so clear, suggesting a need to focus on unintended consequences</td>
</tr>
<tr>
<td>Critical</td>
<td>The ends need to be examined critically to enable the identification and removal of domination and ideological practice</td>
</tr>
</tbody>
</table>


Much of the discussion around design research follows an implicit (Niehaves, 2007), or more or less (McKay & Marshall, 2005), positivist epistemology. The often acknowledged origins of design research in architecture and engineering influence the perspective that design research is about the technical side of artefacts (McKay & Marshall, 2005). Hevner et al. (2004, pp. 82-83) use a definition of the IT artefacts produced by design research that does not include people or elements of organisations nor the processes by which these artefacts evolve over time. Such a view of the artefact suggests a perspective on design research that concerns itself with the building of artefacts, which Iivari (2007) sees as naturally means-end oriented. McKay and Marshall (2005) argue that if the information systems discipline is seen as a sociotechnical discipline then the artefact of interest should encompass the people and contexts in which the IT artefact operates. Designers are not objective or value-free (McKay & Marshall, 2007b).

The values underpinning the current work have shifted over time due to increased experience with what works within a specific context. At the same time there have also been increasing advances in knowledge concerning alternative perspectives summarised by Iivari (2007) and in Table 3.7. Evident in early writings (Jones &
Buchanan, 1996) is a mainly means-end oriented – and from the viewpoint of today, a somewhat naïve – perspective focusing on the question “How do we build a tool that enables e-learning?”. Later writings (Jones, Jamieson et al., 2003; Jones & Lynch, 1999; Jones, Lynch et al., 2003) show greater recognition of the value and importance of the interpretive position. Iivari and Venable (2009, p. 7) describe how action research, the method employed here to formulate the ISDT, can be interpretive when it focuses on “rich understandings of the meanings attached to the executed action and its intended and unintended consequences.”

This view is especially important in the phase of this work that is described in Chapter 5. This is the view, which led to the formulation of the final ISDT for emergent university e-learning systems. A particular focus of this ISDT is on having a system (process and product) that engages with and responds to the diversity of interpretations associated with university e-learning. To some extent, a focus on intended and unintended consequences can also be seen in the importance placed on the mutability of the artefact in the anatomy of a design theory proposed by Gregor and Jones (2007).

### 3.4. Conclusions

This chapter has explained and justified the research method adopted within this work. This has been done by outlining the broader perspective on research (Section 3.2) underpinning this work and seeking to describe the specific set of perspectives adopted within this research (Section 3.3). The broader perspective can be summarised as adopting a pragmatic research paradigm. An approach that places prime importance on the research question (How to design and support e-learning within universities?) and from this seeks to generate and test the
appropriate types of theory – in this case drawing on Gregor’s (2006) five types of theory (Table 3.1) – to answer that question, and the research methods best suited for the chosen theory.

The primary contribution of this work is the formulation of *An ISDT for emergent university e-learning systems*. Other types of theory created for this work include two theories for analysis – the Ps Framework (Jones et al., 2008) (developed to an early stage) and the Gregor and Jones (2007) anatomy of a design theory. The method used to formulate this knowledge is an action-research-like process very similar to that used by Markus et al. (2002). The on-going process of action research used in this work, while initially informed by means-oriented ethical position, moved increasing towards an interpretivist position.

The action-research-like process adopted in this work, contains at its core, an on-going cycle through four stages that sought to continually improve a system through insights from theory and observation of use. For this work, this cycle commenced in 1996 and continued, at varying levels of intensity, through to 2009 when the Webfuse information system ceased directly supporting online learning.

Work commenced on the PhD in 2002. From this point onwards the on-going action research process included an additional layer of reflection that sought to abstract the knowledge gained into an ISDT. Reflection on the pre-2002 work was necessary to understand the latter stages. Chapters 4 and 5 provide an “after the event” description of action-research-like process in terms of the evolution of the both the system and the associated ISDTs. The creation of Chapters 4 and 5 formed an integral part of the reflection and abstraction that led to the formulation of the two different ISDTs for e-learning. Chapter 4 describes the initial design of
the Webfuse system in 1996 and its support and use through to 1999. From this experience Chapter 4 formulates an initial ISDT. Chapter 5 describes the on-going evolution of the system from 2000 through 2009 and the formulation of the final ISDT, *An ISDT for emergent university e-learning system.*
Chapter 4 - Build it and they will come?

4.1. Introduction

The aim of this thesis is to formulate an Information Systems Design Theory (ISDT) for e-learning within a university setting. It seeks to achieve this – as outlined in Chapter 3 – by abstracting from an iterative, action-research process that designed, implemented and supported the Webfuse information system from 1996 through to 2009. It is possible to observe two very different phases in the development and support of Webfuse. These different phases were informed by very different insights into the problem of providing an information system for university e-learning. Chapters 4 and 5 described these two different phases and formulate ISDTs to represent the insights that informed each phase. This chapter seeks to describe the first of the phases. This phase has been labelled “Build it and they will come?” The phase lasted from 1996 through 1999/2000. During this phase, the initial design of Webfuse was completed and it was used for over three years albeit with somewhat limited success. The second phase – emergent development – lasted (to varying levels) from 2000 through 2009 and is documented in Chapter 5.

The description of both phases in Chapters 4 and 5, draws on a common structure adapted from the synthesised design and action research approach proposed by Cole, Purao, Rossi and Sein (2005). Table 4.1 maps the stages of Cole et al.’s (2005) research approach against the sections of this chapter.
This chapter starts with a definition of the problem faced in 1996 when the design of Webfuse commenced. The problem is defined through a description of the organisational context (Section 4.2) from which the design of Webfuse arose and the subsequent high-level requirements that were identified (Section 4.3). The chapter then describes the intervention that was undertaken. The description examines how the requirements identified in Section 4.3 were fulfilled through the implementation and support of the Webfuse information system (Section 4.4). The success of this implementation in terms of fulfilling these identified requirements is then evaluated and described in Section 4.5. Finally, the chapter seeks to reflect upon this experience and develop some insights into what was learned. This process of reflection leads to the formulation of an interim ISDT for e-learning titled “An ISDT for Web-based learning systems” (Section 4.6) and the identification of a number of lessons learned (Section 4.7) from the implementation and support of Webfuse from 1996 through 1999.

4.2. Problem definition

In 1996, the Department of Mathematics and Computing (M&C) at Central Queensland University (CQU) was facing the problem of how to encourage and support the use of e-learning within its courses. The perceived need to increase adoption of e-learning was being driven by a number of factors. Perhaps the most
pressing was that a majority of the department’s students were studying via
distance education. The initial solution to this problem was a project that
commenced in mid-1996 and subsequently led to the development of Webfuse.
This section seeks to define the problem faced by this project. It starts by
describing the institutional context (Section 4.2.1) within which this research
takes place. As part of this description it examines prior experience with
e-learning (Section 4.2.2). It is from this context and experience that a collection
of requirements for an e-learning information system is derived. These
requirements are described in Section 4.3.

4.2.1. The institution
CQUUniversity Australia is an Australian university based in the town of
Rockhampton. Starting life as the Queensland Institute of Technology
(Capricornia) in 1967, the institution became the Capricornia Institute of
Advanced Education in 1971 then the University College of Central Queensland
in 1990 (Central Queensland University, 2006). The 1990 name change was part
of the abolition of the binary system within Australian higher education and
marked the institution’s transition to full university status. That status was
achieved in January 1992 with its initial name the University of Central
Queensland which was later changed to Central Queensland University in 1994
(Central Queensland University, 2006). More recently, in 2008 the institution
changed its name to CQUUniversity Australia. For the purposes of this thesis, the
acronym CQU will be used to refer to the university.

Organisational structure
In 1996 CQU’s academic units were organised into six Faculties (Arts, Applied
Science, Business, Education, Health Science and Engineering) each containing
several different departments. The Department of Mathematics & Computing (M&C) at CQU was part of the Faculty of Applied Science. The Department had a history of teaching programs in Mathematics and Information Technology (applied computing) to students studying on-campus or via print-based distance education. M&C had significant experience in print-based distance education. M&C claims to have become amongst the first in the world to offer a professional computing course via print-based distance education when it offered Computer Science I in 1975 (Hinz, 1977). The work to develop Webfuse arose from within M&C and the Faculty of Applied Science.

By 1996, CQU was essentially a second generation distance education (Nipper, 1989) dual-mode provider. Second generation distance education relied predominantly on print, in the form of study guides, textbooks and resource materials books, as the primary teaching medium (Jones, 1996b). As a dual-mode provider a course could include students studying via both modes of delivery – on-campus and distance education. CQU’s distance education provision was supplemented by a collection of study centres and increasingly the use of computers. The study centres were part of a shared network with other learning providers. These centres were intended initially to provide a space for students and staff to meet face-to-face. They evolved, however, into places that provided access to other scarce resources such as computers (Kember & Dekkers, 1987).

The reputation of CQU’s predominantly paper-based distance education resources was a result of a collaborative effort between academics, instructional designers, editors, printery staff and other employees such as maintenance workers and administrative staff (Davison, 1996). In 1996, the Division of Distance and Continuing Education (DDCE) was responsible for the production and
distribution of all distance learning material and consequently the specification of
deadlines and the style of distance education material (Jones, 1996a). University
policy required that all courses offered by distance education pass through the
DDCE system (Macpherson & Smith, 1998). DDCE offered a range of services
including instructional design, editing, management of assignment submission,
and various other student support services. A wide range of computing and
communications facilities were provided and maintained by the Information
Technology Division (ITD). In addition, a small number of academic
departments, such as the Department of Mathematics and Computing, funded and
maintained their own information technology resources and support staff.

During 1997 and 1998 the institution undertook a comprehensive review of
academic structures. The primary intent was to make the institution more
competitive in an increasingly aggressive higher education marketplace
(Macpherson & Smith, 1998). As a result of this review, a new structure of
faculties was created, with each faculty containing a number of schools. Faculties
were created to ensure innovative combinations of complementary disciplines that
in turn would provide potential synergies which could be exploited to improve
both teaching and research programs (Higher Education Division, 1999). The
original six CQU faculties were reduced to five. The Department of Mathematics
and Computing (M&C) moved from the Faculty of Applied Science to the Faculty
of Informatics and Communications (Infocom). The use of Webfuse moved with
M&C to Infocom. Infocom brought together the discipline areas of information
technology, information systems, communication, cultural studies, journalism,
mathematics and health informatics (Condon, Shepherd, & Parr, 2003) At the
same time, the institution introduced a change from a two-semester academic year
to a four-term academic year. The intent was to attract new students by enabling them to complete degrees over shorter periods of time (Macpherson & Smith, 1998).

**Changes in student cohort**
Throughout the 70s, 80s and 90s significant changes were made to how and where the institution drew its students. These changes arose from a combination of institutional need, environmental and sector influences, and an on-going need to increase student enrolment to ensure long-term viability. The significant shifts in student population and methods of learning and teaching experienced by CQU included: the adoption of distance education; development of additional Central Queensland campuses; and expansion into international campuses through commercial partnership. Each of these shifts in student enrolment is briefly explained in the following sub-sections.

**The adoption of distance education.** The large geographic distances and small population based within the institution’s local area made distance education an appropriate response to community needs for higher education (Oliver & Romm, 2001). In 1974 the institution became the first Australian provider of a Bachelor of Applied Science via distance education (Oliver & Van Dyke, 2004) with Biology, Mathematics and Management following in subsequent years. By 1983 the number of students enrolled to study via distance education exceeded the number enrolled as on-campus students (Cryle, 1992). By 1995 of the approximately 9000 students enrolled with CQU, 4500 were studying by distance education with many of these unable to easily access the various sites supporting distance education (Davison, 1996).
The development of additional Central Queensland regional campuses. From the mid-1980s a variety of community pressures contributed to the establishment of additional campuses in the Central Queensland towns of Mackay (350 kilometres to the north of Rockhampton), Gladstone (120 kilometres to the south), Bundaberg (330 kilometres to the south) and Emerald (280 kilometres to the west). This growth led to the network of CQU campuses covering a geographical area of some 616,121 square kilometres (Oliver & Romm, 2001). Until 1996, these campuses only offered the first year of courses with students having to move to Rockhampton or study by distance education to complete their studies (Luck, 1999). The inability to complete studies locally resulted in some students transferring to other universities after their first year. To address this attrition and become a true regional institution, the second and third years of some degrees were introduced on other regional campuses (Oliver & Van Dyke, 2004). The resulting need to support multi-campus teaching of advanced courses was supported, in part, through the introduction of interactive videoconferencing facilities (discussed in more details in the Section 4.2.2) (Luck, 1999).

The development of the international campuses through commercial partnership. During 1998, CQU’s Vice-Chancellor argued that the survival of regional university, like CQU, was dependent on it being able to raise funds from non-government sources. At this time CQU had commenced planned growth into overseas student markets, both internationally and within Australia, in order to strengthen CQU’s local campuses (Singh, 1998, pp. 13-14). Through the 1990s CQU formed partnerships with a small number of overseas companies to teach students within Singapore, Hong Kong, Fiji and Dubai. In the early 1990s, through a commercial partnership with a private company, the institution
established a number of campuses in major Australian cities – Sydney (1994), Melbourne (1996), Brisbane (1998), Fiji (1998) and the Gold Coast (2001) – to cater specifically for overseas students (Oliver & Van Dyke, 2004). Students at these campuses were tutored by locally appointed academic staff, specifically employed for teaching rather than research, giving face-to-face tutorials and lectures supplemented with distance education materials (Marshall & Gregor, 2002, p. 29). Consequently, it was possible that some courses with large enrolments at multiple campuses could have 40 or more academic staff teaching the course, at the same time, in different locations.

Table 4.2 provides an overview of the student cohort at CQU during the time period 1996 through 1999. The overview shows the percentage of individual students enrolled at CQU through the various modes. Distance education students relied on primarily print-based materials and rarely attended a campus. Regional campus students attended one of the institution’s Central Queensland campuses. International campus students attended one of the other campuses (Sydney, Melbourne, Brisbane) within Australia, created by CQU’s commercial partner primarily for international students. Overseas international students were studying in Dubai, Singapore, Fiji, or Hong Kong using CQU learning materials and supported by a local, commercial partner of CQU.

Table 4.2. Overview of CQU student numbers (1996–1999) by mode.

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance education</td>
<td>59.4%</td>
<td>55.6%</td>
<td>53.7%</td>
<td>52.3%</td>
</tr>
<tr>
<td>Regional campus</td>
<td>34.7%</td>
<td>34.7%</td>
<td>32.6%</td>
<td>31.1%</td>
</tr>
<tr>
<td>International campus</td>
<td>4.4%</td>
<td>7.7%</td>
<td>10.5%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Overseas international</td>
<td>1.6%</td>
<td>3.1%</td>
<td>3.3%</td>
<td>3.6%</td>
</tr>
</tbody>
</table>
**Problems with distance education**

The nature of a dual-mode, second generation distance education institution, the capabilities of the existing technologies, and the resulting organisational policies and processes necessary to support this practice across a large number of courses created a range of problems. These problems were widely recognised within the distance education literature (Caladine, 1993; Galusha, 1997; Jones, 1996a; Keegan, 1993; Sherry, 1995) and included, amongst others: high attrition in initial courses; loss of student motivation; significant up-front costs; limited interaction, collaboration or active learning; inflexibility in processes and materials; limited recognition and reward for staff; the out of sight, out of mind problem; and constraints of the print medium. The existence of these problems and the increasing availability of numerous different technologies and media led members of the CQU community to undertake a range of experiments with e-learning. A brief overview of these experiments leading up to the start of this project in 1996 is provided in the following section.

In 1996, almost 66% (654) of M&C’s computing students were studying by distance education. The majority of these students were mature, highly motivated people many of whom had already completed previous tertiary studies or had worked in the computing industry. The majority (87%) of CQU’s distance computing students studied part-time while working full-time (Farrands & Cranston, 1993) and in many cases supporting a family. Given the significant proportion of computing students studying via distance education, the problems associated with distance education, and the interest in computing inherent in computing staff and students, it is not surprising that staff from M&C were well represented in these experiments with e-learning.
4.2.2. Use of e-learning

In defining e-learning, this thesis draws on the OECD (2005c) definition in which e-learning is “the use of information and communications technology to enhance and/or support learning in tertiary education.” By 1996 there was a long history at CQU of individuals experimenting with e-learning (Buchanan & Farrands, 1995; Chernich, Jamieson, & Jones, 1995; Clayton, Farrands, & Kennedy, 1990; Farrands & Cranston, 1993; Farrands & Lynch, 1996; Gregor & Cuskelly, 1994; Jones, 1994, 1996b; Oliver, 1985, 1994; Zelmer & Pace, 1994). The limitations, problems and lessons learned from these experiments contributed to the understanding and definition of the problem to be solved by the work described in this thesis. This section offers a brief overview of this problem organised by the technology used, and includes: audio and video; multimedia and computer simulations; and computer-mediated communication and the Internet.

Audio and video

For much of its existence the nature of learning and teaching at CQU has been characterised by significant geographic distance between individual students and teaching staff. Given the established expectation of learning and teaching involving face-to-face interactions this geographic distance has created significant disquiet amongst both students and staff. As a consequence CQU has a history of relatively significant usage and experimentation with various technologies intended to provide students with audio and video and in some way re-create the face-to-face learning experience.

For CQU distance education students audio teleconferencing and telephone tutorials have been used to provide better access and support (Davison, 1996). For many distance education students the telephone remained the main form of
interaction with academic staff. The importance of this medium led to a variety of hotline services, first provided by the central distance education division and subsequently by at least one academic department. These hotline services provided a managed approach to answering student queries (Jones, 1996a). By the mid-1990s, the installation of an institutional telephone voicemail system enabled some academics to create short lectures and responses to study questions on the voicemail system that students could access as the need arose (Davison, 1996).

During the early 1990s conditions, mostly in the form of available technology, became conducive to more widespread consideration of audiographics (Rehn & Towers, 1994). Ellis, Debreceny, and Crago (1996) define audiographics as the linking of educational sites into a distributed classroom implemented through a combination of a phone line for audio and multimedia, mostly graphics, provided by modem linked computers. During the mid-1990s there was some use of audiographics at CQU (Crock & Andrews, 1997; Thompson, Winterfield, & Flanders, 1998). There were, however, some problems with the preparedness of students and staff and the accessibility and cost of the required technology. As experienced elsewhere, these problems and the increasing availability of the Web led to the disappearance of audiographics (Rowe & Ellis, 2008).

From the 1980s a range of different technologies were used at CQU in an attempt to broaden the reach of face-to-face teaching. Tutored Video Instruction (TVI) used video tape to record face-to-face lectures which were then played back to on-campus students with a tutor present (Andrews & Klease, 1998) and were eventually lent out to distance education students. TVI was first experimented with in 1983 and was used more broadly thereafter (McConachie, Harreveld, Luck, Nouwens, & Danaher, 2006) During the early 1990s, audio cassettes were
used in a first year programming course, primarily for distance education students, to provide example tutorial sessions between lecturer and student (Jones, 1996a). By 1992, interactive video-conferencing facilities were introduced, initially using a ‘rollabout’ system in which all the technology was located on a trolley that could be wheeled in and out of rooms as required (Luck, 2009). In 1996, the interactive videoconferencing facilities were significantly expanded to support the necessary multi-campus teaching of advanced courses (Luck, 1999).

**Multimedia and computer aided learning**

By the late 1980s and early 1990s, in keeping with the broader history of technology-mediated learning, a number of CQU-based projects were experimenting with computer-mediated and computer-assisted learning (CML/CAL). Zelmer and Pace (1994) report on such work in disciplines including biology, chemistry, mathematics and health science. Around the same time, many CQU staff, especially those within M&C developed a number of computer aided learning packages to assist student learning (Jones, 1996a). Concepts covered included calculus (Clayton et al., 1990), procedures and parameter passing (Buchanan & Farrands, 1995) and the internals of operating systems and the operation of concurrent programming (Chernich et al., 1995; Chernich & Jones, 1994). By the mid-1990s the CQU distance education centre had created an Interactive Multimedia Unit that included a combination of instructional and multimedia designers (Macpherson & Smith, 1998). The unit was tasked to aid in the production of multimedia resources used as a supplement to traditional print-based distance education resources (e.g., Stewart & Cardnell, 1998) and the development of multimedia training materials for external clients (Bennett & Reilly, 1998). While some useful resources were developed, there
remained problems with multimedia resources including: inadequate development tools; incompatible computer platforms; large development costs; and, concerns about equity and access (Zelmer, 1995; Zelmer & Pace, 1994). Even with the use of computing project students the development of quality computer-aided learning tools still required considerable resources in order to provide suitable documentation and integrate the tools into teaching and learning (Jones, 1996a). By the mid-1990s, with growing recognition of the benefits of the World-Wide Web, such personal computer based applications were no longer considered state of the art (Zelmer, 1995).

**Computer-mediated communications and the Internet**

There are three identifiable phases in how Australian university students, especially those studying by distance education, have gained access to applications of computer-mediated communication for learning: dial-up terminal access; ADEnet; and, ISPs and GUI applications.

**Dial up terminal access.** As early as 1985, institutions like CQU provided access to mainframe computers for information technology students via dial up access (Oliver, 1985). Regardless of location, students would direct dial a university phone number and gain access to a mainframe computer. Difficulties associated with this practice arose from the poor quality of telephone exchanges and the high cost (time and distance-based) charging for telephone connections (Oliver, 1985).

**ADEnet.** In the early 1990s, the Australian Distance Education Network (ADEnet) was formed to provide low cost computer communications capabilities for distance education students from anywhere in Australia (Atkinson & Castro, 1991). ADEnet reduced costs to students by allowing them to be connected to
their closest university and then passed to their host institution over the Internet. CMC was still provided by text-based applications, mostly proprietary, but with some initial use of Internet email and Usenet news (e.g., Oliver, 1994). Gregor and Cuskelly (1994) report on the use of similar technologies within a postgraduate information systems course. While experiencing high levels of participation there remained significant usability problems with the primitive software and consequently low amounts of social student/student and student/instructor interaction (Gregor & Cuskelly, 1994).

**ISPs and the Web.** By 1996, increasing numbers of students were using GUI-based applications for email and the World-Wide Web. While much access was still provided through dialup access provided by universities, there was an increasing availability of local Internet Service Providers (ISPs). The rise of ISPs and GUI applications reduced the cost of access and helped improve the ease-of-use. The use of this technology, however, still represented a significant burden for many students. The necessary costs of having a computer and using an ISP being equivalent to the deposit on a reasonably priced car and the subsequent higher purchase repayments (Davison, 1996). It was promising enough, however, that some saw the Internet as enabling CQU to evolve into, what was defined as, a fourth generation distance education university through the incorporation of interactive multimedia and computer-mediated communication technologies (Crock & Andrews, 1997).

By 1996, M&C courses were using the Internet for a variety of applications including: direct email exchange for individual student/teacher communication; 22 course-wide mailing lists in the first term of 1996 for course level discussion (Jones, 1996a); use of email for automated assignment submission (Jones &
Jamieson, 1997); and, starting in 1994 the use of the World-Wide Web for the
distribution of learning material. By 1995, M&C had 11 courses with a Web
presence. By 1996 at least three of these courses were making significant use of
“hand-coded” Web sites to distribute course material including the institution’s
first fully online course (Jones, 1996b). It was through this experience that the
Web and online learning was recognised as an approach that could address
problems with existing teaching media and methods, improve the overall learning
experience of the students, and possibly expand the student base (Jones &
Buchanan, 1996).

Beyond problems associated with questions of student access there was a problem
with limited technology use by teaching staff. By 1996, many CQU academics
used no more than the written word for distance education, with some making
little or no attempt to utilise other existing technologies such as teleconferencing,
audio-cassettes or even pictures within study materials (Davison, 1996).

Furthermore, while there were pockets of expertise and experimentation, the
majority of academics and administrators had little or no idea of what this new
approach to teaching was all about (Macpherson, Bennett, & Priest, 1997).
Outside of CQU it was broadly recognised that it was still perceived to be too
difficult for educators lacking a technical background to create sophisticated
WWW-based courses (Goldberg et al., 1996).

Given the difficulties and time-consuming nature of Web-based learning, it was
believed that for Web-based learning to become widespread within M&C it would
be necessary to implement appropriate tools, automated systems, procedures,
documentation and training to reduce the burden (Jones & Buchanan, 1996). The
author was given teaching relief for the second half of 1996 and set the task of
providing these tools and systems. The task was to lead the development of a system and associated processes and resources to support the use of Web-based learning (Jones & Buchanan, 1996). From the perspective of M&C it was expected that the resulting system would enable the use of online learning in all department courses and provide M&C with a distinct advantage over its competitors (Jones & Buchanan, 1996). As an additional requirement it was expected that the same system would be used to provide the organisational website for the Faculty of Applied Science, the broader faculty to which M&C belonged.

4.2.3. Why build another system?

By the second half of the 1990s, the recognition that non-technical academic staff did not have the skills to create sophisticated WWW-based courses (Goldberg et al., 1996) led to the development of a number of different systems designed to solve the problem expressed above. For example, the World-Wide Web Course Tool (WebCT) was developed at the University of British Columbia (Goldberg et al., 1996) and went on to be a successful commercial product used at many universities throughout the world. Still others were adaptations of CML-based systems to the Internet. For example, Web Educational Support Tools (WEST) was developed at the University College Dublin and during 1996 was being used at the University of Western Sydney (Pennell, 1996). Why then build another system at CQU? Wouldn’t developing another system for M&C result in the reinvention of the wheel (Simon, 1991, p. 130). Even at this stage, the “not invented here” problem was recognised as a growing problem with the development of multimedia learning resources (Bryant, 1998; Zelmer, 1996).
There were three main reasons why it was decided to build another system in M&C:

1. The perceived novelty of online or Web-based learning
   Writing within the CQU context, Macpherson et al. (1997) suggested that experience in online learning continued to be fragmentary and that few teaching staff had the knowledge to fully assess the implications of online learning or realistically determine possible future applications. Online learning remained a new area of potential research interest. So while there were existing systems, there remained significant possibilities for further insights. For example, Macpherson et al. (1997) discovered that one of the existing systems (WEST) had a strictly sequential and linear course structure embedded into the system design. This structure was a significant restriction that required the designers to discover ways to subvert it (Macpherson et al., 1997)

2. The unique teaching context within M&C
   As a dual-mode, second generation distance education provider CQU had significant experience with blending different delivery modes into a single offering and a desire to improve through the application of technology. M&C, especially in its teaching of information technology, had a staff and student cohort that was significantly more technically literate than most disciplines. Information technology students were more likely to have access to the required technology. Furthermore, these students saw the relevance of gaining experience with the Internet to their future job prospects. This combination of factors
created a context, which promised to enable experimentation and research

3. The skills, backgrounds and interests of M&C academic staff

M&C included academic staff with interests and expertise in software development and a history of research into e-learning (Carter et al., 1995; Chernich & Jones, 1994; Jones, 1994, 1995). These academic staff were expected to do research, especially research that could inform their teaching.

The combination of these factors meant that even in the early days of this work it was possible to identify features, approaches and ideas that had not yet been implemented in existing systems (Jones & Buchanan, 1996). It was felt that the design, implementation and use of another online learning environment within the M&C context would, as well as providing support for online learning by M&C staff and students, provide an opportunity to experiment with new services, enable a comparison to be drawn between different systems, identify mistakes to avoid and practices to replicate and hopefully identify unique possibilities for e-learning (Jones & Buchanan, 1996). Lastly, a key guideline identified early in the design of the system was “do not reinvent the wheel” (Jones & Buchanan, 1996).

4.3. Requirements

The design of a system, Webfuse, to support learning and teaching within the Department of Mathematics and Computing (M&C) and the broader Web site for the Faculty of Applied Science (AppSci) commenced in mid-1996. The design guidelines or requirements that underpinned Webfuse and the associate rationale were outlined in publications written at the time (Jones & Buchanan, 1996;
McCormack & Jones, 1997) and others reflecting back on that design after the fact (Gregor, Jones, Lynch, & Plummer, 1999; Jones, 1999a, 1999b; Jones & Gregor, 2004, 2006). This section provides an overview of those requirements while the following section (Section 4.4) explains how those requirements were fulfilled in Webfuse. The requirements are summarised in Table 4.3. These requirements were gathered through a variety of means, including: reflection on prior experience within M&C (as described above); insights offered by the research literature on e-learning and related fields; and, requests for input from M&C teaching staff.

Table 4.3. Summary of Webfuse requirements.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Web publishing tool</td>
<td>The tool will help in the design, implementation and management of Web pages and Web sites. It will not be used just for e-learning.</td>
</tr>
<tr>
<td>An integrated online learning environment (OLE)</td>
<td>The OLE will provide in a single integrated, interface, access to and support for all resources and activities required for teaching and learning.</td>
</tr>
<tr>
<td>Eclectic, yet integrated</td>
<td>The services will be provided by an eclectic collection of tools and resources brought together into an integrated whole.</td>
</tr>
<tr>
<td>Flexible and support diversity</td>
<td>The tool will be as flexible as possible and aim to support a diversity of aims and processes around Web publishing and e-learning.</td>
</tr>
<tr>
<td>Encourage adoption</td>
<td>As much as possible the design of the tool will seek to encourage adoption by staff and students.</td>
</tr>
</tbody>
</table>

4.3.1. **A Web publishing tool**

Webfuse was required to not only provide online learning services to the students and staff of M&C, but also to support the web site for the Faculty of Applied Science (and later the Faculty of Informatics and Communication). This requirement to support a web site meant that from the start Webfuse was envisaged as a Web publishing tool. That is, a system that helps people create and maintain Web pages and Web sites. Webfuse was designed as a general Web
publishing tool that also provided a number of specific tools and facilities to support the creation and maintenance of Web-based classrooms (McCormack & Jones, 1997, p. 362).

The intent for Webfuse to be a general Web publishing tool was somewhat different to most of the other e-learning systems available at that time. Systems such as TopClass and WebCT were designed only for learning and teaching. A consequence of this design was that these systems had a more firmly defined purpose and structure and, as found by Macpherson et al. (1997) a somewhat reduced level of flexibility. As a more general Web publishing tool, capable of supporting an organisational web site, Webfuse had to satisfy a broader set of requirements.

4.3.2. An integrated online learning environment (OLE)

It was intended that Webfuse would be a totally integrated online learning environment. Specifically in that it should provide all of the features and systems required by both students and teachers using a consistent and easy-to-use interface (Jones & Buchanan, 1996). An integrated online learning environment encapsulates a set of tools, systems, procedures and documentation that supports any and all parts of the learning and teaching experience. The implication was that students and teachers could perform all necessary tasks via Webfuse.

As part of this view e-learning was seen as more than converting lecture overheads and other course resources into HTML and placing them on the Web (Jones & Buchanan, 1996). An integrated online learning environment could be expected to provide support for tasks including, but not limited to, assignment
submission, automated (self-)assessment, evaluation as well as both synchronous and asynchronous communication. As an integrated online learning environment Webfuse also had to provide appropriate support for non-Web e-learning. For example, by 1996 M&C was making increasing use of course mailing lists as a means of communication. Rather than require the use of mailing lists to cease, Webfuse should integrate with this practice and preferably provide additional functionality.

4.3.3. **Eclectic, yet integrated**

The majority, if not all, of the e-learning systems available in 1996 were tightly integrated systems produced and supported by a single vendor. All additions and modifications to these systems had to be made by the single vendor. The tightly, integrated nature of these tools meant they were reasonably easy to install, manage and use. It also meant that they were less than responsive to new developments from either the broader online community or the local context, as any such changes had to be implemented by the single vendor.

It was recognised from the start of the Webfuse project that it would not be possible for M&C to provide all the necessary human resources to build and maintain a Web authoring tool (Jones, 1999b). A tightly integrated structure with M&C providing all tools would not be possible. M&C would run the risk of either retaining an out of date system because it was too expensive to replace, or having to throw away the investment in a system because it had not kept up with change (Jones & Buchanan, 1996). The inertia created by existing systems was seen as a significant problem because of the then recent observations of the difficulties CQU and other institutions were having in moving from text-based,
computer-mediated communications systems to the more modern Internet-based systems. It was also seen as a problem because it was assumed that rapid, on-going change would be a key characteristic of the Internet (Jones & Buchanan, 1996). That is, it was recognised that much of the innovation in terms of improved tools would arise from the broader, Internet community than from within a single educational institution or commercial vendor.

Consequently, the focus of the integrated online learning environment would be on providing the infrastructure necessary to integrate existing and yet to be developed Internet and e-learning tools developed by the broader Internet and open-source communities (Jones & Buchanan, 1996). The M&C OLE would provide the management infrastructure and consistent interface to combine existing tools such as WWW servers, online quizzes, assignment submission, discussion forums and others into a single integrated whole (Jones & Buchanan, 1996). While some components would be developed specifically for the local context, the emphasis should be on integrating existing tools into the OLE (Jones & Buchanan, 1996).

4.3.4. **Flexible and support diversity**

From the start, an ability to handle the diversity and continual change inherent in Web-based learning (Jones, 2004) was seen as the key requirement of any Web-based learning system. Freedom of choice, for both staff and students, was seen as one of the important advantages provided by e-learning (Jones & Buchanan, 1996). In part, this was a reaction to the inflexibility inherent in second-generation distance education that required all materials to use the same processes and designs. This consistency created a number of problems and issues
due to the diversity present in the disciplines, courses, academics and students (Jones, 1996a; Jones & Buchanan, 1996). Similar less than user-friendly requirements for conformity were also prevalent at this time around Computer-Managed Learning (CML) and Computer-Assisted Learning (CAL) based solutions. It was not uncommon in the mid-1990s for a CAL or CML application to require that potential users should have a specific type of computer or operating system. In addition, flexibility and the ability to change was also seen as important since one purpose of Webfuse was to enable research and experimentation with different applications of e-learning. It was important that the design of Webfuse was not frozen before experience gained in using the system was able to inform on-going change.

To achieve the desired levels of flexibility and support for diversity a number of guidelines were adopted. These included (Jones & Buchanan, 1996):

- do not specifically support any one educational theory
  There is a large variety of possible learning theories with different theories being more appropriate depending on the context and individuals involved (Leidner & Jarvenpaa, 1995). Rather than seek to embody the principles of a single learning theory, Webfuse should enable individual academics to use those theories they deem most suitable, and also handle change in preferred learning theories as experience and knowledge expand. Rather than limit the functionality of the system to only those features judged appropriate by a particular learning theory, the system should rely on a more generic set of functional requirements. These are outlined in more detail in Section 4.4.5.
• separation of content and presentation

One of the drawbacks with HTML in 1996 was that both the content of a page and its presentation were tightly integrated. Such tight integration made it very difficult to display the same content in different ways and subsequently limited flexibility. It was intended that Webfuse separate the presentation of a Web page from the underlying content so that different versions of the page could be generated automatically for different purposes.

• platform independence and standards

Unlike common CAL and CML systems of the time, Webfuse should allow users access regardless of their computer platform. Similarly, Webfuse should be able to run on the broadest possible choice of servers. Dependence on a single or limited number of platforms would restrict choice, limit the number of people that could use the system, and could influence future use of the system as platforms became dated. It was intended that the M&C OLE would use platform independent technologies such as scripting languages and broadly accepted standards.

• provide the tools, not the rules.

Computer systems, unlike human organisations, are rigid and incapable of adaptation on their own and consequently tend to better support the regularities than the particularities of a situation (Harris & Henderson, 1999). For an activity like learning and teaching that is characterised by diversity, rigid computer systems that expect consistent, regular practices are less than appropriate. Strict procedures leave little room for the unique characteristics of individual disciplines, courses, academics and students (Jones & Buchanan, 1996). Where possible, Webfuse should aim to provide the tools to assist in
the development of Web-based classrooms, but have sufficient flexibility to enable staff and students to adapt these tools to their personal situation (Jones & Buchanan, 1996).

4.3.5.  Encourage adoption

In 1996, it was recognised that “if you build it, they will come” was not an approach likely to work within an academic environment where staff development and improvements in learning and teaching has been described as “herding cats” (Jones & Buchanan, 1996). It was recognised that once the system is built staff must be: encouraged to use the system, convinced of the system’s usefulness, and provided with appropriate training and documentation (Jones & Buchanan, 1996). Design guidelines intended to help encourage use of the system included (Jones & Buchanan, 1996):

- consistent interface
  The eclectic, yet integrated principle (Section 4.3.3) suggests that Webfuse should provide a consistent user interface and system metaphor for all tools. Limiting non-required diversity should help increase ease-of-use and subsequently adoption.

- increased sense of control and ownership
  One rationale for requiring Webfuse to support diversity and flexibility was so that staff and students could adapt the system to their needs and subsequently encourage a greater sense of control and ownership.

- minimise new skills
  Even in 1996, the students and staff with M&C brought existing experience with computers, software and the Internet. For example, many students
already had email accounts and associated email programs. Academics were already using mailing lists and other aspects of the Internet. Rather than reinvent the wheel and force these people to learn new skills and tools, Webfuse should leverage these existing skills, software and processes to minimise the need for new skills and reduce workload.

- **Automate.**

  Where possible the system should automate those tasks possible while maintaining a balance with other guidelines. Such automation would include both support or administrative services specific to the Web (e.g., HTML validation and link checking) and other higher level tasks such as creating an initial course web site.

### 4.4. Implementation

This section outlines how the requirements outlined in Section 4.3 were implemented in Webfuse and how Webfuse was supported from 1996 through 1999. Table 4.4 offers a summary of the major components of the requirements implementation. Prior to describing the components within Table 4.4, the section first briefly outlines the process, people and technology used during this implementation (Section 4.4.1).
Table 4.4. *Summary of how the requirements (Section 4.3) were fulfilled in Webfuse.*

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Web publishing tool (Section 4.4.2)</td>
<td>A web site is a hierarchical collection of Web pages. Each page is defined as a particular type. Authors do not directly edit page, instead use an edit form provided by the page type (page update process). Page types are based on concept of hypermedia templates (Catlin, Garrett, &amp; Launhardt, 1991) and implement the page update process. Other services enable sharing of non-Webfuse page via the managed web site. Access to resources on web site is open by default, but can be limited to specific groups and specific operations.</td>
</tr>
<tr>
<td>A comprehensive OLE (Section 4.4.3)</td>
<td>All services provided through either the Web site managed by Webfuse or through the page update interface.</td>
</tr>
<tr>
<td>Eclectic, yet integrated (Section 4.4.4)</td>
<td>Page types can (and normally should) be implemented as software wrappers, typically around open source applications. Page types and the page update process provides an integrated interface to modify pages and also to other management services. The page types and page update process are built upon a “micro-kernel” of services.</td>
</tr>
<tr>
<td>Flexible and support diversity (Section 4.4.5)</td>
<td>Separation of content and presentation in styles and page types. Platform independence, standards through open source software and use of a scripting language. Any use of a specific educational theory for design limited to page types, not the whole system. Page types can be added, changed and removed independently of each other.</td>
</tr>
<tr>
<td>Encourage adoption (Section 4.4.6)</td>
<td>Consistent interface – page types. Place as much control in hands of academics. Minimise new skills – leverage existing practice. Automate as many tasks as possible.</td>
</tr>
</tbody>
</table>

### 4.4.1. Process, People and Technology

The author was given a teaching free term in the second half of 1996 to design and implement a system that would manage the faculty web site and enable Web-based learning. Over the next 12 months, the initial design and implementation of Webfuse occurred with the author performing most of the
initial design and implementation work. Additional assistance came in the form of a small number of project students who worked on particular components. At the end of this time, responsibility for supporting Webfuse was taken over by the faculty IT support staff and the author returned to teaching duties. Eventually, the Faculty of Informatics and Communication appointed a full-time Webmaster who – along with a small number of other IT staff – was responsible for helping staff use Webfuse and the faculty web site.

The Webmaster did engage in some on-going development of Webfuse to add or improve features. The primary focus of the position, however, was on aiding staff to use the system and the Web site. The author, along with some project students, did undertake some additional development. Such development was primarily limited to innovations used in the author’s own teaching. The development and governance processes used around Webfuse from 1996 through 1999 were fairly ad hoc to non-existent. During 1998 there were some faculty-based projects to implement certain features, but these were rarely embedded into operation. Much of this uncertainty arose from the complexity of forming a brand new faculty within an organisation undergoing a range of significant changes. One symptom of this organisational uncertainty was that Infocom was being led by an acting-Dean until mid-1999.

From 1996 through 1999, Webfuse was implemented primarily as a collection of Perl CGI scripts and various support libraries and tools. The Perl scripting language was chosen because it was platform independent and scripting languages like Perl allowed rapid development of application via the gluing together of existing applications. In addition, system development with scripting languages like Perl was 5 to 10 times faster than that achieved through the use of traditional
systems programming languages (Ousterhout, 1998). An Apache Web server served the Webfuse CGI scripts and the resulting Web pages. For information storage, Webfuse used the file system and a variety of relational databases. All of the applications used in Webfuse were open source. During this period the available open source relational databases were not full-featured. The lack of a full-featured relational database influenced some design decisions.

4.4.2. **A Web publishing tool**

From the start, Webfuse was seen as a tool that would aid authors in creating and managing Web pages and sites. Its initial design was very much influenced by a publishing metaphor. In order to function as a Web publishing tool there were three abstractions to make:

1. **Page authoring**
   
   How would Web pages be created and managed?

2. **Web site structure**
   
   How would individual Web pages be combined into entire web sites?

3. **Access control**
   
   How would access to individual Web pages be controlled?

The rationale and design of each of these abstractions within Webfuse is described in the following sections.

**Page authoring**

By 1996 it was becoming widely recognised that there were a number of known problems with the authoring process of web sites. The World-Wide Web, at this stage, was a particularly primitive hypermedia system where the lack of
functionality made the authoring process more difficult (Gregor et al., 1999). The authoring process was often carried out without a defined process, lacked suitable tool support, and did little to separate content, structure and appearance (Coda, Ghezzi, Vigna, & Garzotto, 1998). The process also made limited reuse of previous work (Rossi, Lyardet, & Schwabe, 1999) and required better group access mechanisms as well as online editing tools (Andrews, 1996b). The difficulty of authoring on the Web made it difficult to create and maintain large web sites and often the management of such content was, at this stage, assigned to one person or group who became the bottleneck for maintenance (Thimbleby, 1997).

To address these problems it was decided that Webfuse would make use of the concept of hypermedia templates (Catlin et al., 1991; Nanard, Nanard, & Kahn, 1998). Hypermedia templates (Catlin et al., 1991) are an approach to simplifying the authoring process while still ensuring the application of good information design principles. Hypermedia templates enable content experts to become responsible for maintaining Web sites and thus increase ownership, decrease costs and address the authoring bottleneck problem (Jones, 1999b). Hypermedia templates also aid in reuse which is a strategic tool for reducing the cost and improving the quality of hypermedia design and development (Nanard et al., 1998). The initial purpose of hypermedia templates was to improve the application of information design principles to hypermedia collections (Catlin et al., 1991).

In their initial development hypermedia templates were sets of pre-linked documents containing both content and formatting information used by authors to create a new set of information (Catlin et al., 1991). The intent was that graphic
designers would create the templates, which would subsequently be used by content experts to place material into hypermedia (Catlin et al., 1991). The content experts would not need to become experts in information design, nor would the graphic designers need to become content experts. Editing a template did not require learning any new software or knowledge.

Nanard, Nanard, and Kahn (1998) extended the idea into constructive templates with the intent of extending reuse in hypermedia design beyond information and software component reuse into the capture and reuse of design experience. A constructive template is a generic specification which makes it easier for a developer to build a hypermedia structure and populate it with its data (Nanard et al., 1998). While a model describes a structure, a constructive template helps produce instances of that structure by mapping source data into a hypertext structure (Nanard et al., 1998). Template-based hypermedia generation can be implemented using either programming or declarative means. Constructive templates are built on the principle of separating source data from hypermedia presentation. They enable work on the structure to be done independently from the content, reducing the burden of production. Through automating large parts of the production process constructive templates drastically reduce cost (Nanard et al., 1998).

As a Web-publishing system the primary output of Webfuse was seen as Web pages. In Webfuse it was decided that each Web page would be of a specific type. The type of page specified which Webfuse hypermedia template – known as page types – would be used to produce and manage the Web page. A page type was implemented as a collection of pre-defined Perl functions that would obtain the necessary content from the author, then convert that content into the HTML
necessary to display the body of a Web page. Figure 4.1 is an example of a Web page produced by Webfuse. The page type for this page produced the content that appears between (and includes) the two links labelled \[Years\].

Figure 4.1. A simple Web page produced by Webfuse

On each Web page produced by Webfuse there is an “Edit” link. If an authorised person clicks on this link they are presented with a Web form – called a page update form – that allows them to provide, edit and modify the content used to produce the Web page. The structure and features of the page update form, as well as the conversion process applied to the content, are unique to the page type.

Figure 4.2 shows the part of the page update form for the Web page from Figure 4.1.

A page type called TableList produces the Web page shown in Figure 4.1 and the page update form shown in Figure 4.2. As the name suggests this page type is used to manage a series of lists containing individual items. Each list of items is displayed in separate tables. Each item points to another Web page, normally (but not necessarily) a page that is created and managed through Webfuse.

In Figure 4.1 there is one list called “Years” which consists of two items: “2008” and “2009”. Figure 4.2 contains HTML form elements to manage two lists. One
for the existing list called “Years” and one that can be used to add a new list. As well as managing the items of lists, the form in Figure 4.2 also provides some formatting options that specify: how to sort the list elements; how many columns to have in the table; and, how big the table borders should be. Each of these options influences the design of the Web page produced by the page type Lists

Add a new list

![Image of a form with options for adding a new list]

Two characteristics of Web usage in late 1996 influenced the initial design of Webfuse page authoring. First, Web access for most people was via slow dial-up connections and a number were still limited to text-only Web browsers. Second, frames-based Web design had recently been introduced and was going through a
period of experimentation. For these reasons, Webfuse page types initially produced three different Web pages for each page: a normal page (Figure 4.4); a text-only page (Figure 4.6); and, a frames-based page. Visitors to a Webfuse page could then choose which page was most appropriate for them.

**Web site structure**

The design of Webfuse as a Web publishing system made it necessary to embed within Webfuse an abstraction of how a Web site was structured. Hypermedia and hypertext, of which the World-Wide Web is an example, have been defined on the basis of their support for non-linear traversal and navigation through a maze of interactive, linked, multiple format information (Kotze, 1998). The “disorientation problem” – getting “lost in space” – refers to the greater potential for the user to become lost or disoriented within a large hypertext network (Conklin, 1987, p. 38). The topology or structure of a hypertext directly affects navigation performance (McDonald & Stevenson, 1996).

Oliver, Herrington, and Omari (1999) identify three main hypermedia structures: linear, hierarchical and non-linear or networked. Shin, Schallert and Savenye (1994) suggests that the most popular structure for hypertexts are hierarchical and network (non-linear) structures. Garzotto, Paolini, and Schwabe (1993) point to the observation of many authors that hierarchies are very useful in helping user orientation when navigating in a hypertext. Advantages of hierarchies include: a strong notion of place; documents have clear superior/inferior relationships that are sometimes augmented with linear precedence relationships between nodes; they are familiar due to their use in other domains; and the rigidity, which creates some inflexibility, aids comprehension (Durand & Kahn, 1999). Hierarchical
structures have also been recommended as the most appropriate structures for large web sites (Sano, 1996).

Beyond the research-based benefits of a hierarchical structure there was also a pragmatic reason behind the adoption of a hierarchical structure for Webfuse managed web sites. One intent with Webfuse was, where possible, to use open source software. The open source relational databases available in 1996 were not capable of storing the type and quantity of data likely to be embedded in a large organisational web site. As a result of this Webfuse had to limit the use of relational databases to storage of authentication and authorisation data. The content of the web sites hosted by Webfuse would need to be stored within the file system of the Webfuse server computer. The file systems of computers did, and continue to use, a hierarchical structure of directories and files. In order to simplify implementation, the structure of a Webfuse web site matched the structure of the file system in which the site content was stored. Each Web page managed by Webfuse, resided in its own directory. That directory included any HTML (Web) page(s) produced by Webfuse and a file named CONTENT, which stored the content and meta-data used by Webfuse to construct the Web page(s).

A Webfuse web site represented a traditional tree structure sprouting from a single node, the web site home page. Figure 4.3 is a partial, graphical representation of the hierarchical structure of the Faculty of Applied Science (AppSci) web site created and managed via Webfuse during 1997. At the top level is the main AppSci home page. The next level down has five main sections including one for the Faculty’s research centres and one for each of its four departments – Maths and Computing, Applied Physics, Biology and Chemistry. Each of the department web sites followed a similar structure with main sections for information, staff,
academic programs, students, research and community. The web sites for
individual courses – prior to 1998 these were called units – are all contained in
their own folders with names based on the course codes (e.g., 84100).

Figure 4.3. A partial hierarchy of the Faculty of Applied Science web site in
1997.

Each of the boxes shown in Figure 4.3 represents an individual Web tree and the
collection of related resources. For example, The “Units” box represents the
“Units” Web page (Figure 4.4) and the folder “Units” that contains all of the Web
sites for the units offered by the Department of Mathematics and Computing in
1997. By default all Webfuse pages were freely available to anyone on the Web. It
was necessary, however, to provide a mechanism for access control that would
allow authors to restrict access to specific people or groups.
Access control

Since it was intended that Webfuse would help in the management of large web sites used by a large number of people for many different purposes, an essential requirement would be ability to control what operations different users of the system could perform. The complexity of security administration in distributed multimedia environments is challenging and prone to error (Barkley, Cincotta, Ferraiolo, Gavrilla, & Kuhn, 1997). For Webfuse, this requirement was provided by the access control system, which used an approach based on the idea of access control lists (ACL). An ACL approach creates an association between an object, a group of users and a set of operations that may be performed on the object (Barkley, 1997). A particular user could only perform an operation on an object if
they were a member of a group with permissions for that operation. Table 4.5 summarises how these three abstractions were used in Webfuse.

Table 4.5. ACL abstractions as implemented in Webfuse.

<table>
<thead>
<tr>
<th>Abstraction</th>
<th>Webfuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>The username that uniquely identifies each person using the website.</td>
</tr>
<tr>
<td>Operation</td>
<td>Actions that could be performed on a resource. The initial set included: access, update and all. Each page type could specify their own operations.</td>
</tr>
<tr>
<td>Object</td>
<td>An identifier for each resource on the Web site. Implement as the directory path to the resource. If the object had a trailing /, then it represented that object and everything underneath it. Without a trailing /, it represented just the object.</td>
</tr>
</tbody>
</table>

Initially, there were three valid operations that could be performed on an object (McCormack & Jones, 1997, p. 366):

- access;
  The ability to access or view the page. By default all objects are able to be viewed by anyone on the Web.

- update; and
  The ability to modify the page using the page update process.

- all.
  The ability to perform any and all operations on the object.

Some page types recognise additional operations that are specific to the operation of the page. For example, an early assignment management page type recognised a “mark assignment” operation (McCormack & Jones, 1997).

By default, the ability to view (defined by the operation access) all Webfuse Web pages and sites was unrestricted. Editing a page was restricted to users that had
been allocated permissions to perform the *update* operation on a page. When editing the page, an author could use the access control system to specify which users could perform which operation. In order to perform a particular operation on a restricted resource, the user had to have a valid user account (username and password) for the web site. Initially, these Webfuse accounts were distinct from the accounts given to staff and students for other institutional systems. Over time this distinction was removed.

The identifier for an object matched the path where the object was stored on the Web server. A path that ended with a slash was used to represent the page and any and all pages underneath it in the Webfuse site hierarchy. A path without a slash at the end represented just that page. Table 4.6 provides an example of two different Webfuse permissions, including identifiers. The first, gives permission for members of the group “jonesd” to perform all operations on the entire web site for the unit 85321, Systems Administration. The second, gives permission for members of the same group to edit just the home page for the 85321 web site.

Table 4.6. Example Webfuse permissions.

<table>
<thead>
<tr>
<th>Object</th>
<th>Modify 85321 Web site</th>
<th>Modify 85321 Web page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/mc/Academic_Programs/Units/85321/</td>
<td>/mc/Academic_Programs/Units/85321</td>
</tr>
<tr>
<td>Operation</td>
<td>All</td>
<td>Update</td>
</tr>
<tr>
<td>Group</td>
<td>Jonesd</td>
<td>Jonesd</td>
</tr>
</tbody>
</table>

**Page update and appearance**

When a user clicked on the edit link at the bottom of a Webfuse page, a Perl script called the page update script would be run. The page update script would: check the permissions system to determine if the user could edit the requested page; identify the type of page being edited; run the appropriate code from the page type to generate part of the update form; and, combine the HTML produced by the
page type with other HTML providing access to other services. The other services available on the page update form fall into two main categories:

1. Webfuse services; and
   A number of support services such as HTML validation, link checking, access control, file management and hit counters could be accessed via the page update form.

2. Page characteristics.
   As well as the content managed by the page type each Web page also contained a number of the characteristics including the page type, title, colours used and the style template.

Using the Webfuse generated HTML form, the author would make any necessary changes to the content, and then hit an “update” button. As a result, the page update script would run again and then: check permissions require to perform the operation; identify the appropriate page type; execute the page type code that would examine and respond to the users changes on the HTML form; modify the HTML page in response to those changes and in combination with the chosen style; and, present the modified page update form for the user to make further changes. The page update script, in combination with the specific page type, would notify the author of any errors.

The Webfuse notion of a style or style template was used to further separate the appearance of a page from the content. Due to this, the appearance of the same page, containing the same content, could evolve over time for whatever reason (this feature was added before the concept of cascading style sheets – CSS – was widely used). Figure 4.5 is the same Web page as shown in Figure 4.1; however,
it is using a 1998 style for the Faculty of Informatics and Communication. This change in presentation was done by editing the page, changing the style template and updating the page. By 1999, Webfuse came with over 10 different styles.

![Guides Web page](image.png)

*Figure 4.5. Guides Web page (Figure 4.1) with a different style*

### 4.4.3. A comprehensive OLE

As A comprehensive OLE, it was intended that Webfuse would provide a consistent, easy-to-use interface; that all tools and services would be available via that interface; and that the system would, where possible, automate tasks for the teachers and students. For Webfuse, the entire interface was provided via the Web site and Web browser. For “readers” or visitors to a web site all the necessary services were provided by the Web pages generated by Webfuse. For the “authors” of a web site (typically teaching staff, but not necessarily), the services required to create and manage a web site were all provided by the page update process, the page types, and associated services. The page update process is described in the previous section (Section 4.4.2). The associated services are described in the discussion of micro-kernel architecture in the next section.
(Section 4.4.4). A description of the functionality offered by the Webfuse page types up to the end of 1999 follows.

**Page Types**

This section seeks to provide a summary of the functionality available in the Webfuse page types as at the end of 1999. The summary uses the four functional requirements for online learning (Table 4.7) identified by McCormack and Jones (1997, p. 367) and used by others (Avgeriou, Papasalouros, & Retalis, 2003; Psaromiligkos & Retalis, 2003; Tetiwat & Huff, 2002). For each requirement set, the following provides a brief description and a table summarising the available Webfuse page types. The tables also indicate which of the page types were implemented as wrappers around existing software (COTS). The use of software wrappers is described in more detail in the next section (Section 4.4.4).

**Table 4.7. Four functional requirements for online learning.**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>Distribution, value-added conversion, creation and sharing of information.</td>
</tr>
<tr>
<td>Communication</td>
<td>Support for one-to-one, one-to-many, many-to-one and many-to-many communication and collaboration</td>
</tr>
<tr>
<td>Assessment</td>
<td>Method for evaluating the progress and experience of students, including evaluation of the course and teachers.</td>
</tr>
<tr>
<td>Management</td>
<td>The clerical, administrative and support tasks necessary to support learning and teaching.</td>
</tr>
</tbody>
</table>

With the initial design of Webfuse informed by the metaphor of the Web as a publishing environment, *information distribution* was seen as a major task for Webfuse. The Web was seen to be extremely useful for the distribution of information (McCormack & Jones, 1997, p. 13). By the end of 1999 Webfuse had a collection of 11 page types providing information distribution related services. Table 4.8 provides a summary of these page types, their purpose and what, if any, COTS products the page types used for implementation of their purpose. The
FAQ page, like a number of other page types, was written by a project student (Bytheway, 1997).

Table 4.8. *Webfuse information distribution related page types by 1999.*

<table>
<thead>
<tr>
<th>Page Type</th>
<th>COTS</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture + Lecture slide</td>
<td>Webify (Ward, 2000) for Postscript conversion to slides. SoX (SoX, 2009) for conversion of audio into various formats raencoder (RealNetworks, 1996) for audio conversion into Real Audio format</td>
<td>Convert Postscript file of a lecture (usually generated by PowerPoint) into an integrated collection of lecture slides. Each lecture slide could have audio converted into any one of four available formats.</td>
</tr>
<tr>
<td>Study guide + Study guide chapter</td>
<td>None</td>
<td>Conversion of a study guide into chapters of online material broken up into individual pages, single chapter print versions and the production of table of contents and index</td>
</tr>
<tr>
<td>PersonContent, PersonDetails</td>
<td>None</td>
<td>Display information about teaching staff</td>
</tr>
<tr>
<td>FAQ (Bytheway, 1997)</td>
<td>None</td>
<td>Creation and management of lists of frequently asked questions</td>
</tr>
<tr>
<td>Content</td>
<td>None</td>
<td>Enable simple management of HTML content</td>
</tr>
<tr>
<td>FileUpload</td>
<td>None</td>
<td>Allow just about anyone to upload files to the Web site</td>
</tr>
<tr>
<td>Table list, Index, ContentIndex</td>
<td>None</td>
<td>Provide mechanisms to create index and associated child nodes in a hierarchical Web structure.</td>
</tr>
<tr>
<td>Search</td>
<td>Htdig (The ht://Dig group, 2005)</td>
<td>Search content of site</td>
</tr>
</tbody>
</table>

*Communication* is an essential part of the learning experience and a task for which the Web offers a number of advantages and supports through a number of forms (McCormack & Jones, 1997, p. 15). Table 4.9 provides a summary of the five different communication related page types provide by Webfuse at the end of 1999. This list of page types illustrates two points: there are fuzzy boundaries and
overlap between these categories; and it was possible to have multiple page types performing similar roles. The FormMail page type listed in Table 4.9 could be used as a form of communication but was also heavily used to perform surveys of students and thus can fit easily under the Assessment category. Table 4.9 also shows that there were two page types providing Web-based discussion boards. Within a few years a third would be added. Each additional discussion board was added as it improved upon the previous functionality. Even with this improved functionality, some teaching staff had a preference for the older discussion boards. The eclectic, yet integrated structure provided by the page types meant that multiple discussion boards could exist within the system at the same time.

Table 4.9. Webfuse communication page types by 1999.

<table>
<thead>
<tr>
<th>Page Type</th>
<th>COTS product</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ewgie chat</td>
<td>Ewgie (Hughes, 1996)</td>
<td>An interactive chat-room and shared whiteboard system</td>
</tr>
<tr>
<td>WWWBoard</td>
<td>WWWBoard (Wright, 2000)</td>
<td>Web-based asynchronous discussion board</td>
</tr>
<tr>
<td>WebBBS</td>
<td>WebBBS (AWSD, 2009)</td>
<td>Web-based asynchronous discussion board</td>
</tr>
<tr>
<td>Email2WWW</td>
<td>MHonArc (Hood, 2007)</td>
<td>Searchable, Web-based archives of mailing list discussions</td>
</tr>
<tr>
<td>FormMail</td>
<td>FormMail (Wright, 2002)</td>
<td>HTML form to email gateway, implementation of surveys</td>
</tr>
</tbody>
</table>

Assessment is an important part of every course, it is essential for knowing how well students are progressing (student assessment) and also for being aware of how well the method of instruction is succeeding (evaluation) (McCormack & Jones, 1997, p. 233). Table 4.10 provides a summary of the four Webfuse page types associated with assessment that were in place by the end of 1999. Two of these page types (online quiz and assignment submission) are connected with student assessment, while the other two (UnitFeedback and Barometer) are associated with evaluation. The FormMail page type mentioned in Table 4.9 was
also primarily used for evaluation purposes and is somewhat related to the far more CQU specific UnitFeedback page.

Table 4.10. *Webfuse assessment page types by 1999.*

<table>
<thead>
<tr>
<th>Page Type</th>
<th>COTS product</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online quiz</td>
<td>None</td>
<td>Management and delivery of online quizzes – multiple choice and short answer</td>
</tr>
<tr>
<td>Assignment submission</td>
<td>None</td>
<td>Submission and management of student assignments</td>
</tr>
<tr>
<td>UnitFeedback</td>
<td>None</td>
<td>Allow paper-based CQU course survey to be applied via the Web</td>
</tr>
<tr>
<td>Barometer</td>
<td>No software, but concept based on idea from Svensson et al. (1999)</td>
<td>Allow students to provide informal feedback during a course.</td>
</tr>
</tbody>
</table>

*Class management* involves the clerical, administrative and miscellaneous support tasks necessary to ensure that a learning experience operates efficiently (McCormack & Jones, 1997, p. 289). Table 4.11 summarises the three Webfuse page types associated with class management by the end of 1999. There is some overlap between this category and that of assessment in terms of the management and marking of student assignments.

Table 4.11. *Webfuse class management page types by 1999.*

<table>
<thead>
<tr>
<th>Page Type</th>
<th>COTS product</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results management</td>
<td>None</td>
<td>Allows the display and sharing of student progress and results</td>
</tr>
<tr>
<td>Student tracking</td>
<td>Follow (Nottingham, 1997)</td>
<td>Session analysis of student visits to course Web page</td>
</tr>
<tr>
<td>TimetableGenerator</td>
<td>Data “screen-scraped” from institutional system</td>
<td>Allow students and staff to generate a personalised timetable of face-to-face class sessions</td>
</tr>
</tbody>
</table>

**4.4.4. Eclectic, yet integrated**

This requirement sought to move the design of Webfuse away from the tightly integrated, single vendor nature of the majority of e-learning systems. Instead it required that Webfuse, while providing to users what appeared to be a single
integrated interface, enabled the incorporation of software from a variety of sources. The eclectic, yet integrated structure of Webfuse was informed by a combination of concepts including: micro-kernel architecture for operating systems, hypermedia templates, and software wrappers.

**Micro-kernel architecture**

The kernel of an operating system is the part that is mandatory and common to all software. The idea of a micro-kernel is to minimise the kernel in order to enforce a more modular system structure making the system more flexible and tailorable (Liedtke, 1995). The micro-kernel approach helps meet the need to cope with growing complexity and integrate additional functionality by structuring the operating systems as a modular set of system servers sitting on top of a minimal micro-kernel (Gien, 1990). The micro-kernel should provide higher layers with a minimal set of appropriate abstractions that are flexible enough to allow implementation of arbitrary services and allow exploitation of a wide range of hardware (Liedtke, 1995).

The initial design of Webfuse included the idea of establishing a core “kernel” of abstractions and services relevant to the requirements of Web publishing. These abstractions were built on underlying primitives provided by a basic Web server. Continuing the micro-kernel metaphor, the Webfuse page types were the modular set of system services sitting on top of the minimal micro-kernel. The initial set of Webfuse “kernel” abstractions were implemented as libraries of Perl functions and included:

- authentication and access control

  The services of identifying users as who they claimed to be and checking
if they were allowed to perform certain operations was seen as a key component of a multi-user Web publishing system. The functionality was built on the minimal services provided by Web servers and supplemented with institution specific information, for example, the concepts of courses.

• validation services

In the early days of the Web the primitive nature of the publishing tools meant that there was significant need for validation services. For instance, such as validating the correctness of HTML code and identifying missing links.

• presentation

This encapsulated the Webfuse style functionality that allowed the representation of pages to be changed independent of the content.

• data storage

Content provided by content experts was a key component of the Webfuse publishing model. Page types needed to be able to store, retrieve and manipulate that content in standard ways.

• page update.

The page update process was the core of the Webfuse publishing model. It involved how the content experts provided and managed content and how that content was then converted into Web pages. A part of this aspect of the Webfuse architecture was a specification of how the Webfuse page types would communicate and interact.
Hypermedia templates as software wrappers

As described above the management and production of Web pages within Webfuse was performed by page types, an abstraction based on the idea of hypermedia templates. If Webfuse was to provide a particular type of functionality a new page type had to be written. In many cases (e.g., the TableList page type used to produce Figure 4.1 and Figure 4.2) these were entirely written by Webfuse developers. From the start, however, it was recognised that this practice would not scale, especially for complete requirements such as synchronous, interactive chat rooms. The solution to this problem was the idea of implementing the Webfuse hypermedia templates as software wrappers around commercial-off-the-shelf (COTS) software – mostly open source software.

In software engineering, the term wrapper refers to a type of encapsulation whereby a software component is encased within an alternative abstraction. It is only through this alternative interface that clients access the services of the wrapped component (Bass, Clements, & Kazman, 1998, p. 339). A wrapper leaves the existing code of the encapsulated component and new code is written around the component to connect it to a new context (Sneed, 2000). In the case of Webfuse, the hypermedia templates – in the form of Webfuse page types – were used to encapsulate a variety of existing open source software applications and connect them to the Webfuse and CQU context.

Sneed (2000) identifies the introduction of the concept of wrappers with Dietrich, Nackman, and Gracer (1989) and its use to re-use legacy applications within an object-oriented framework. Wrappers have also been
used in reverse engineering (Sneed, 2000) and security. Wrappers were also one method used by the hypermedia community to integrate complex hypermedia systems with the World-Wide Web (e.g., Bieber, 1998; Gronbaek & Trigg, 1996). Additionally, wrappers were also used to integrate third-party applications into open hypermedia systems that emphasised delivery of hypermedia functionality to the applications populating a user’s computing environment (e.g., Whitehead, 1997).

By 2001, Sommerville (2001) describes it as more normal for some sub-systems to be implemented through the purchase and integration of COTS products. During the mid to late 1990s government shifted away from custom-developed software towards the use of commercial software, in part, due to the spiraling cost of custom-developed software (Braun, 1999). Increasingly solutions were built by integrating COTS products rather than building from scratch (Braun, 1999).

Boehm (1999) identifies four problems with the integration of COTS products: lack of control over functionality and performance; problems with COTS system interoperability; no control over system evolution; and support from COTS vendors. The use of software wrappers to encapsulate COTS products into the CQU context and the general reliance on using open source COTS products was intended to help Webfuse address these issues. Another issue that arises when using a diverse collection of COTS products is the significant increase in the diversity and duplication in the user and management interfaces for each of the COTS products. It was intended that the Webfuse page types, in their role as software wrappers, would also be
designed to provide Webfuse users with a consistent user interface. In addition, this interface would also, where possible, use terms and labels specific to CQU, rather than those of the COTS product.

Harnessing hypermedia templates, software wrappers and COTS products allowed Webfuse to combine the benefits of hypermedia templates – simplified authoring process, increased reuse, and reduced costs (Catlin et al., 1991; Nanard et al., 1998) – with the benefits of the COTS approach – shorter development schedules and reduced development, maintenance, training and infrastructure costs (Braun, 1999). While the use of open source COTS products provided access to source code and removed the influence of a commercial vendor (Gerlich, 1998), it did increase the level of technical skills required.

One example of the type of COTS product included into Webfuse through the use of software wrappers is the MHonArc email to HTML converter (Hood, 2007). As mentioned previously M&C courses were already making increasing use of Internet mailing lists as a form of class communication. An obvious added service that Webfuse could provide was a searchable, Web-based archive of these mailing lists for use by both staff and students. Rather than develop this functionality from scratch an Email2WWW page type was written as a wrapper around MHonArc. The wrapper (page type) increased the abstraction level of MHonArc by connecting it with the CQU mailing list system. It also combined MHonArc with the presentation services provided by the Webfuse “micro-kernel.” This combination enabled the HTML generated by MHonArc to be automatically integrated into the look and feel used by Webfuse web sites. The Email2WWW page type encapsulated MHonArc and brought it into the Webfuse context.
4.4.5. **Flexible and support diversity**

The aims which flexibility and support for diversity (Section 4.3.4) were meant to achieve included: enabling a level of academic freedom; being able to handle the continual change seen as inherent in the Web; and, providing a platform to enable Webfuse to change in response to increased knowledge arising from experience and research. A number of guidelines for this principle were outlined in Section 4.3.4. This section uses those guidelines to structure discussion of how they were implemented.

**Do not specifically support any one educational theory**

The design of Webfuse as a Web publishing system and integrated online learning environment gave no consideration to educational theory. Initially, the design of the functionality offered by the page types was informed by the four categories of tasks required by a Web-based classroom as summarised in Table 4.7:

- information distribution;
- communication;
- assessment; and,
- class management.

These requirements, and the subsequent page types fulfilling the requirements, were seen as the building blocks that could be used to implement a number of different educational theories.

This “building block” approach could be seen from two perspectives:

1. **author, and**

   An author or user of Webfuse could combine existing page types to fulfil the desired educational theory. For example, an application of e-learning drawing on a social constructivist perspective of learning might use a combination of a discussion board and an interactive chat room as the primary tools on the course site.
2. developer.

On the other hand, a Webfuse developer could develop new page types, or combine existing page types, to develop services that explicitly support a particular educational theory. If this approach was adopted, the eclectic Webfuse structure would mean that those not interested in this educational theory could simply ignore these specific page types.

**Separation of content and presentation**
The separation of content and presentation was achieved through the presentation services briefly described in Section 4.4.4. These services, in conjunction with page types, enabled a Web page managed by Webfuse to change appearance independently of the content. An example of this is given by a single Webfuse Web page with two different appearances shown in Figure 4.1 and Figure 4.5.

**Platform independence and standards**
This guideline was achieved through an emphasis on the use of platform independent open-source software, the use of the Perl scripting language, and active support for compliance with Web standards. Webfuse was written in the Perl scripting language with user interaction occurring via the Webfuse CGI scripts. To run a copy of Webfuse it was necessary to have a Web-server, simple relational database, a version of Perl and a small number of other open source products used to implement some of the “micro-kernel” services and page types (e.g., Ewgie required Java). As an example of this platform independence, two project students successfully ported Webfuse to the Windows platform during 1997 (Walker, 1997).
Provide the tools not the rules

The basic aim with this guideline was to provide flexibility of choice to the users – both students and teaching staff – of Webfuse. Implementation of these guidelines was an absence of restrictions around course web sites, the separation of presentation from content, and some experimental services.

In terms of a course web site, there was no formal specification of what form a course web site might take. It was not even necessary for a course web site to be implemented using Webfuse. As shown in Table 4.13, a small number of course web sites were managed by academics using HTML editors to produce static Web pages. For the majority using Webfuse for their course web sites, it was up to them how they used the page types to structure their course site. In addition, it was possible to develop specific presentation styles for individual course web sites.

The separation of presentation and content, through the automatic provision of text-only, graphical, and frames-based versions of all pages, also provided flexibility to users of web sites to choose how they wished to interact with a course web site. Figure 4.4 shows a graphical version of a page from the original science.cqu.edu.au site and near the top of the page it is possible to see navigation links to the three versions of the page. Figure 4.6 is the text only version of the page shown in Figure 4.4. The text only version was intended to address issues with slow Internet connections, large file sizes and time based charging for Internet access. At the time of the development of Webfuse, Internet access for the majority of students was through fairly slow modem access, charged on a time basis. As a result time online meant money and large downloads meant more money (Jones & Buchanan, 1996). A similar feature allowed students to
download compressed versions of entire web sites and view them without being connected to the Internet.

![Image](image.png)

*Figure 4.6. The Units Web page (text version) for M&C for Term 2, 2007.*

### 4.4.6. Encourage adoption

In order to encourage adoption of Webfuse four separate design guidelines were established and described in Section 4.3.5. The following seeks to explain how those guidelines were realised in the implementation of Webfuse.

**Consistent interface**

Webfuse was designed to use the Web – via a Web browser – as the single interface for both readers/visitors and authors. For visitors to a Webfuse managed web site all information and services were accessed via the web site and its interface. An interface generally kept consistent through use of the Webfuse presentation services. Authors used the same interface to view the site. The page update process and the page types provided a consistent interface for creating and
managing web sites. Regardless of the page type, the page update process looked and behaved in a consistent way.

**Increased sense of control and ownership**
While it was unlikely that technology alone could achieve this guideline, Webfuse sought to move towards fulfilling this guideline. It did this by providing academics with the ability to control their own course sites. This ability was previously out of reach for many. It was also hoped that the flexibility and support for diversity provided by Webfuse would help encourage a sense of ownership.

**Minimise new skills**
In 1996, the Web was for many people a brand new environment. Any Web-publishing tool was going to require the development of new skills. Beyond providing a simple, consistent interface, Webfuse sought to minimise the need for new skills. It did this by supporting and enhancing existing practice and by using common institutional terminology. The use of page types enabled this in two ways. First, by acting as wrappers, the page types could wrap a specific institutional abstraction (i.e., the use of institutional terminology) around other software. Second, a number of page types were written specifically to wrap around existing institutional practice. Such page types included Lecture, StudyGuide and Email2WWW. Each of these page types wrapped around existing institutional practices and brought them onto the Web.

**Automate**
The automation of a range of tasks was intended to reduce workload and increase perceived advantage. An example of this that underpinned all of Webfuse was the automatic production of both text-only, graphical, and frames-based versions of Web pages. Individual page types provided more specific automation. For
example, the Lecture page type automatically converted PowerPoint slides into individual lecture slides and created a navigation interface through the lecture. The LectureSlide page type was provided to manage each individual slide within a lecture. This included the ability to automatically create audio narration of the slide into four different, common audio formats of the time.

**4.5. Evaluation**

The previous sections have outlined the requirements (Section 4.3) for Webfuse and how they were implemented (Section 4.4). This section seeks to evaluate how effectively the requirements were fulfilled. To do this, this section examines each of the requirements from Section 4.3 and draws on Web server logs, archives of web sites and other data generated by Webfuse use during the period 1996 through 1999. Table 4.12 provides a summary of the results of this evaluation. The following sub-sections provide more detail.

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Web publishing tool (Section 4.5.1)</td>
<td>Webfuse used to create/maintain 3 organisational web sites (including one for a professional sports team), 1 research project and 1 personal site.</td>
</tr>
<tr>
<td>A comprehensive OLE (Section 4.5.2)</td>
<td>Webfuse used to create and maintain 424 course web sites, with over 28,000 Web pages. These course sites were managed by almost 100 staff and used by 1000s of students and other visitors. These sites were implemented using 21 unique page types. Webfuse provided functionality for all 4 widely used LMS feature categories Feature adoption on a par, or exceeded, usage of other systems reported years later</td>
</tr>
<tr>
<td>Eclectic, yet integrated (Section 4.5.3)</td>
<td>Of the 21 unique page types, 8 were implemented as software wrappers and 1 wrapped around an existing data source.</td>
</tr>
<tr>
<td>Flexible and support diversity (Section 4.5.4)</td>
<td>Webfuse provided features not available in other systems. Able to supply different versions of discussion forums for different requirements. Appearance of some Webfuse sites re-branded Three very different approaches to course web sites supported by Webfuse</td>
</tr>
<tr>
<td>Encourage adoption (Section 4.5.5)</td>
<td>1999 Webfuse course sites, received over one million hits, and edited by 37 different staff over 36,000 times.</td>
</tr>
</tbody>
</table>

4.5.1. A Web publishing tool

The initial requirement for Webfuse was to serve as the Web-publishing tool that would be used to implement the web site of the Faculty of Applied Science at Central Queensland University (CQU). That this guideline was achieved is supported by the use of Webfuse to implement and maintain that web site and a number of others as summarised in Table 4.13. By early 1997, Webfuse was being used to maintain web sites with over 55,000 individual Web pages.

<table>
<thead>
<tr>
<th>Web site</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science.cqu.edu.au</td>
<td>Organisational web site for Faculty of Applied Science</td>
</tr>
<tr>
<td>Infocom.cqu.edu.au</td>
<td>Organisational web site for Faculty of Informatics and Communication</td>
</tr>
<tr>
<td>Webfuse.cqu.edu.au</td>
<td>Web site for the Webfuse project</td>
</tr>
<tr>
<td>Cq-pan.cqu.edu.au/david-jones</td>
<td>Personal web site for the author</td>
</tr>
<tr>
<td>Broncos.com.au</td>
<td>Web site for the Brisbane Broncos a team in Australia’s professional rugby league competition (See Figure 4.7)</td>
</tr>
</tbody>
</table>

Figure 4.7. Wayback machine archive ([http://bit.ly/9iXAQq](http://bit.ly/9iXAQq)) of Brisbane Broncos web site from 1998 (broken images not available from Wayback machine)

### 4.5.2. A comprehensive OLE

Beyond managing the faculty web site, Webfuse was aimed at supporting the use of e-learning within the Department of Mathematics and Computing (M&C), and
then in 1998 the Faculty of Informatics and Communication (Infocom). This section presents statistics outlining the number of course sites produced within and externally to Webfuse; the features available and used within course sites – including comparisons with usage at other institutions; and, details of usage by staff and students. A latter section (4.5.5) comments further on the overall adoption of Webfuse.

**Course sites**

Both M&C in 1997, and Infocom in 1998, made the decision that all courses they offered should have a Web presence. Webfuse was the primary tool for the creation of these course web sites. From 1997, administrative staff created the initial Webfuse course sites using a simple, standard structure. The content of these sites were typically conversions of existing learning resources. The conversions were performed either manually by the administrative staff or via automation within Webfuse. Once the default course sites were created, the academic staff teaching the course could then make any modification they thought necessary. There was the option for academics to create their own course sites, without using Webfuse. For these courses, an empty directory was created and staff could upload HTML and related files authored using readily available HTML editors.

Table 4.14 summarises the number of course sites for M&C and Infocom in the period 1997 through 1999. The significant increase in numbers of course sites in 1998 represents the adoption of Webfuse by Infocom, a faculty which includes courses offered by M&C and a number of other schools.
Table 4.14. *Number of course sites managed by Webfuse: 1997-1999.*

<table>
<thead>
<tr>
<th>Year</th>
<th>Outside Webfuse</th>
<th>Within Webfuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>3</td>
<td>107</td>
</tr>
<tr>
<td>1998</td>
<td>7</td>
<td>135</td>
</tr>
<tr>
<td>1999</td>
<td>8</td>
<td>184</td>
</tr>
</tbody>
</table>

*Note: Archives of course sites for 1 term in 1998 are not available.*

**Features used in course sites**

An integrated online learning environment like Webfuse, provides a broad number of different features, not all of which are used by all courses. As shown in Section 2.5.2, the adoption of specific features is an important way of examining the use of e-learning systems. To examine the adoption of features within Webfuse course sites, this section first examines the nature of feature provision in Webfuse and examines the number of pages and page types used by the Webfuse course sites summarised in Table 4.14. It then uses the Malikowski, Thompson, and Theis (2007) framework (Figure 2.2) for LMS feature usage to compare and contrast adoption of Webfuse features with other systems, both at CQU and other institutions.

Webfuse features were provided as page types (Section 4.4). Table 4.15 summarises the number of page types used, and the total number of Web pages created in Webfuse course sites in each year from 1997 through 1999. It also shows the number of Web pages used in the five course web sites (Top 5 course sites) for those years in terms of number of pages. This “Top 5” figure shows that just five of the course web sites produced at least 68% of all the Web pages in Webfuse course sites in any given year. While certain Webfuse page types did create significantly more pages than others, this figure does point to an imbalance in usage. This imbalance in usage is evident in other statistics and will be discussed more, especially in Section 4.5.5.
From 1997 through 1999 there were – as shown in Table 4.15 – between 15 and 21 different page types that could be used in Webfuse course sites. Table 4.16 groups these Webfuse page types into the Malikowski et al. (2007) model for LMS feature research. The Malikowski et al. (2007) category “computer-based instruction” is not included in Table 4.16 as Webfuse did not provide this functionality. Allocation of Webfuse page types to these categories, enables a comparison between Webfuse feature usage from 1997 through 1999 and feature adoption levels found by Malikowski et al. (2007) in literature from 2000 through 2004, and feature usage of the Blackboard LMS in 2005 at CQU.

Table 4.15. Number of pages and page types in Webfuse course sites (1997-1999).

<table>
<thead>
<tr>
<th>Year</th>
<th>Webfuse courses</th>
<th># page types</th>
<th># pages</th>
<th># pages – top 5 course sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>110</td>
<td>15</td>
<td>2767</td>
<td>1853 (67%)</td>
</tr>
<tr>
<td>1998</td>
<td>138</td>
<td>17</td>
<td>2926</td>
<td>2285 (88%)</td>
</tr>
<tr>
<td>1999</td>
<td>190</td>
<td>21</td>
<td>4375</td>
<td>3001 (69%)</td>
</tr>
</tbody>
</table>

Note: Archives of course sites for 1 term in 1998 are not available.


<table>
<thead>
<tr>
<th>Category</th>
<th>Page Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitting content</td>
<td>Various content and index page types</td>
</tr>
<tr>
<td></td>
<td>Lecture and study guide page types</td>
</tr>
<tr>
<td></td>
<td>File upload and search page types</td>
</tr>
<tr>
<td>Creating class interactions</td>
<td>Email2WWW</td>
</tr>
<tr>
<td></td>
<td>EwgieChatRoom</td>
</tr>
<tr>
<td></td>
<td>WWWBoard and WebBBS</td>
</tr>
<tr>
<td>Evaluating students</td>
<td>AssignmentSubmission</td>
</tr>
<tr>
<td>Evaluating course and instructors</td>
<td>Barometer</td>
</tr>
<tr>
<td></td>
<td>UnitFeedback/FormMail</td>
</tr>
</tbody>
</table>

Table 4.17 summarises the level of feature adoption within Webfuse course sites from 1997 through 1999 using Malikowski et al.’s (2007) categories. The 1997, 1998 and 1999 columns report what percentage of Webfuse courses for that year, used Webfuse features within a given category. The “Malikowski %” column is the representative feature adoption rate found by Malikowski et al. (2007) from a
literature review on feature adoption covering 2000 through 2004. The “Blackboard %” column summarises feature adoption of the Blackboard LMS at CQU during 2005, the first full year of its implementation.

It should be noted that these external benchmarks are from between two and six years after the Webfuse usage period shown in the table (1997-1999). It should also be noted that because of faculty policy, 100% of Webfuse course sites were actually used to transmit information through the creation of minimal course sites by administrative staff. The percentages for information transmission shown in Table 4.17 represent those course sites in which the academics in charge used Webfuse to distribute additional information above and beyond the default.

Lastly, the figures in the column titled “Blackboard %” represent the percentage of Blackboard course sites adopting a feature. The other percentages represent a percentage of all possible courses, not all courses using the LMS, that is, the total population of Blackboard courses was significantly smaller than the total number of all courses offered.

Table 4.17. Feature adoption in Webfuse courses (1997-1999).

<table>
<thead>
<tr>
<th>Category</th>
<th>Malikowski %</th>
<th>Blackboard %</th>
<th>1997</th>
<th>1998*</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitting content</td>
<td>&gt; 50%</td>
<td>94%</td>
<td>45%</td>
<td>40.6%</td>
<td>41.2%</td>
</tr>
<tr>
<td>Class interactions</td>
<td>20–50%</td>
<td>28%</td>
<td>16.5%</td>
<td>21%</td>
<td>43.7%</td>
</tr>
<tr>
<td>Evaluating students</td>
<td>20–50%</td>
<td>17%</td>
<td>1.8</td>
<td>1.5%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Evaluating course and instructors</td>
<td>&lt; 20%</td>
<td>2%</td>
<td>9.2%</td>
<td>1%</td>
<td>9.5%</td>
</tr>
</tbody>
</table>

*Note: Archives of course sites for 1 term in 1998 are not available.*

Drawing on the data presented in Table 4.17, it is possible to make a number of observations about Webfuse feature adoption for each category. These observations include:
• transmitting content

The optional use of content transmission in Webfuse courses sits at between 40 to 45% of courses, not quite at the level found by Malikowski et al. (2007) a number of years later. It should be noted, however, that by default, 100% of courses did use some form of content transmission.

• class interactions

Prior experience with course mailing lists meant that Webfuse adoption of class interaction features reached a fairly high 43% by 1999. This figure is at the upper-end of the range found in the reported literature from 2000 through 2004 and double the use at CQU within the Blackboard LMS six years later.

• evaluating students

The very low adoption of student evaluation features illustrates the limited or late arrival of such features in Webfuse. An online assignment submission feature was in use in a limited number of courses from 1997 (Jones & Jamieson, 1997), but was not suitable for widespread usage until 2000. An online quiz facility was not provided until late 1999.

• evaluating course and instructors

The 1997 and 1999 Webfuse adoption of features in this category are significantly higher than those found in Blackboard at the same university six or seven years later. It is also greater than the Malikowski et al. (2007) figures, which typically find adoption of this category as much less than 20%.

As shown in Table 4.17, the majority of Webfuse course sites were used to transmit content with a growing number using class interaction features. Only a small number of courses used other feature categories. A number follow a similar
pattern to the Top 5 figure Table 4.15, that is, the majority of courses used the Webfuse features to some limited extent, while another smaller set of courses made heavy use of Webfuse features. In fact, during the time frame from 1997 through 1999, there were only two courses that drew on the Webfuse features to create a truly integrated online learning environment. These course sites transmitted information in terms of online study guides, online lectures including streaming audio, and general course information. These sites used both interactive, synchronous chat facilities and asynchronous mailing lists with Web-based archives. For both courses, students were expected to submit assignments via the Web. The assignments were managed, marked and also returned via the Web. Both courses made significant use of the Web to gather student feedback on the course and teaching staff. Figure 4.8 is a screen shot of the study schedule page – the main navigation page – for the 1999 offering of the course 85349, Operating Systems.

Figure 4.8. Study schedule page for the 1999 offering of the course 85349

The academic responsible for both these “exemplar” courses was the author of this work and the chief designer of Webfuse. On return to full-time teaching in 1997 the author developed two course sites to make heavy use of Webfuse
features. It can be observed that the other courses, which made heavy use of Webfuse features were typically taught by academics with significant technical background. Additionally, these academics also had an intrinsic motivation to use technology to improve student learning. This imbalanced adoption of Webfuse is examined in more detail in the following sections, especially the “Encourage Adoption” section (4.5.5).

**Usage of course sites by staff and students**

Having looked at the level of feature adoption within Webfuse course sites, this section seeks to examine how much staff and students used the Webfuse course sites. Identifying how much a course web site was used by students is made difficult by one of the assumptions built into Webfuse. By default, Webfuse Web sites were, unlike most e-learning systems, accessible by anyone on the World-Wide Web without the need to login. Consequently, for most usage of Webfuse course sites it is impossible to determine whether a visit to a course site is from a staff member, student or member of the general public. The one common exception to this rule is the page update feature, which did require users to login with a valid account and was generally used by staff members to modify a course site.

Table 4.18 provides a summary of the usage of Webfuse course sites from 1997 through 1999. It starts by showing the number of web sites hosted by Webfuse and the number of student/courses for those courses (a student enrolled in 3 different courses in a given year is counted as 3 student/courses). Course site hits show the number of successful requests for a Web page or some other content file, excluding navigation and interface resources such as navigation button images. Authors refer to the people who have successfully used the page update facility.
Page updates are the number of successful updates initiated by authors. The work done by administrative and technical support staff has been removed from both the page updates and unique authors. These numbers represent activity by academic staff.

Table 4.18. Usage of Webfuse course sites: 1997-1999.

<table>
<thead>
<tr>
<th>Year</th>
<th># Sites</th>
<th># Stud/Courses</th>
<th>Course site hits</th>
<th>Page Updates</th>
<th>Unique authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>110</td>
<td>7453</td>
<td>780,651</td>
<td>1418</td>
<td>19</td>
</tr>
<tr>
<td>1998</td>
<td>229</td>
<td>14703</td>
<td>905,326</td>
<td>2835</td>
<td>34</td>
</tr>
<tr>
<td>1999</td>
<td>190</td>
<td>16726</td>
<td>1,378,699</td>
<td>6081</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 4.18 clearly shows the impact of Webfuse being adopted by Infocom for 1998. The number of student/courses and course sites almost doubles. A similar increase is also seen in the number of page updates and authors between 1998 and 1999. The increase in hits on course sites is not of the same magnitude. This limited increase is perhaps indicative of how a range of context factors – such as the settling in period after organisational restructure and the still somewhat novel nature of the Web – limited adoption by students.

From 1998 to 1999, Table 4.18 shows a decrease in course sites as Infocom rationalises some courses. At the same time, however, there remains an increase in student/courses of about 12%. While there is only a minor increase in teaching staff editing course sites, however, there are significant increases in the number of page updates by those staff. Additionally, there is a significant increase (34%) in the number of hits on course sites. The increase in hits on course sites is almost three times that of the increase in student numbers. It should, however, be noted that almost 47% of the hits on course sites in 1999 were for the course sites belonging to only two courses. These two courses are special cases since they were taught and the course websites created by the Webfuse designer.
4.5.3. **Eclectic, yet integrated**

As described in Section 4.4.4 Webfuse was successfully implemented as an eclectic, yet integrated information system. This implementation was done through a “micro-kernel” of Webfuse services working with page types implemented as software wrappers. The success of this strategy is primarily one of proof by existence. The services provided by the “micro-kernel” were essential to the operation of Webfuse and the page types. As shown in Table 4.18 use of the page update service increased each year and this drew heavily on each of the other services. The validation services (i.e., link checking and HTML validation) were, as the Web evolved, used less and less.

Of the 21 page types available by 1999, eight of them were written as software wrappers around a variety of open source software. The tables (Table 4.8, Table 4.9, Table 4.10, and Table 4.11) in section 4.4.3 provide details of these page types and the software wrapped. Another page type, the Timetable generator, was wrapped around an existing institutional data source. While the eclectic, yet integrated structure adopted by Webfuse worked well, there were a number of limitations described in the following sections.

**A poor metaphor**

The structure of Webfuse described thus far, worked well within the confines of the Web publishing metaphor that informed the initial Webfuse design. It was, however, less suited for the growing requirements of dynamic Web applications. While the page update process and some of the other micro-kernel services were dynamic Web applications, these were limited to the micro-kernel. Early work on dynamic Web application including online assignment submission, the timetable
generator, and the online quiz feature revealed a need for better support for integrating dynamic Web applications into Webfuse.

**Poor implementation**

Initial Webfuse design occurred in 1996, a time when Web development was in its infancy and little was known about creating large-scale Web information systems. The initial implementation of the Webfuse structure was based on this limited knowledge and problems soon became apparent. The use of a procedural programming paradigm resulted in a system that was not as flexible or maintainable as it should have been. Perhaps the best example of this was the poor separation between content and presentation within the page types. This poor separation led to a number of different page types performing the same task, but only with slightly different presentation (for the figure of 21 page types discussed above, these “similar” page types have been counted as 1 page type).

**Organisational barriers**

Webfuse was implemented within one faculty of CQU. The institution also had a central information technology division and a central distance education division, both of which provided and supported information systems related to learning and teaching. The ability to access and integrate with these existing information systems would have opened up some interesting capabilities for Webfuse. For a variety of reasons gaining such access to these systems was not readily possible. In some cases, this was due to the limitations of the technology of the time, for which integration with external applications was not a common requirement. In other cases, it was due to political reasons associated with questions of why a faculty was “duplicating” functionality that should be provided by a central division.
4.5.4. Flexible and support diversity

Each of the approaches outlined in Section 4.4.5 to achieve flexibility and support diversity were implemented in Webfuse. The provided page types did not specifically support any particular educational theory. This lack of a connection with educational theories was seen to link, in part, with the idea of providing the tools (i.e., the page types and services) and not the rules. Academic staff could create any course web site structure they wished, even if it meant not using Webfuse at all. The combination of page types and the Webfuse presentation services separated content and presentation (as shown in Figure 4.1 and Figure 4.5). Additionally, the Webfuse server environment was used on a number of UNIX and Windows platforms, illustrating platform independence.

Further examples of the flexibility of Webfuse included:

- very different approaches to course web sites
  
  Webfuse supported, to varying levels, three very different approaches to course web sites:

  - hand-crafted HTML sites
    
    The HTML sites did not use any Webfuse functionality beyond uploading and managing files produced by a HTML editor.

  - default Webfuse sites
    
    Default sites made limited extensions to an existing default site and were by far the majority of sites.

  - advanced Webfuse sites
    
    These sites made complete use of the Webfuse features to create
purpose designed online learning environments (e.g., Figure 4.8). The flexibility of Webfuse was a double-edged sword in that it provided more freedom to shape a course web site but also required more skill and experience to do so effectively (McCormack & Jones, 1997, p. 362). The need for skill and experience is one possible explanation for why so few of the advanced Webfuse sites were created.

- Re-branding of web sites

From 1997 through 1999, the Infocom web site was re-branded a number of times with a different corporate identity. These re-brandings were achieved by running a script that, for each page, modified the corporate style and then re-ran the page update process without any change in content.

- Changes in authentication

During the early days of Webfuse operation there was no institutional authentication system, so Webfuse provided users with Webfuse specific accounts. By 1999, the institution introduced an institutional authentication system. The Webfuse authentication service was modified to use this system without any changes to other Webfuse components.

In terms of diversity, Webfuse was used to manage and support a range of different web sites including that of a professional sports team, an educational institution, a research project, and a personal web site. By 1999, the page types designed specifically for education provided support for four of the five widely used categories of LMS features identified by Malikowski et al. (2007). Options for computer-based instruction, the one feature category not provided by Webfuse, remain limited within other LMS (Malikowski et al., 2007). By 1999
the flexibility provided by the page type structure allowed the implementation and use of a Barometer page type. This page type provides a unique approach to course evaluation (Svensson et al., 1999) that is not commonly found in any LMS.

4.5.5. Encourage adoption

As outlined in Section 4.4.6 strategies adopted to encourage adoption of Webfuse included: the provision of a consistent interface; encouraging an increased sense of control and ownership; minimising new skills; and automation. As shown in Table 4.18 these strategies were somewhat successful in that by 1999 Webfuse was being used at reasonably significant levels. For example, during 1999 the course web sites received over one million hits, and were edited by 37 different staff over 6,000 times.

There was, however, a significant imbalance in Webfuse adoption. The majority of Webfuse use was limited to a small number of courses and academics. For example, by 1999, of the 60 full-time staff employed by the organisation only 5 were making significant use of the Web in learning and teaching (Jones & Lynch, 1999). As shown in Section 4.5.2, and in particular around Figure 4.8, only 2 courses taught by the Webfuse designer created significantly complete online learning environments with the Webfuse page types. In 1999, these two course sites accounted for almost 47% of all hits on course sites. Table 4.15 shows that between 1997 and 1999 the top 5 courses accounted for between 60–80% of the Webfuse pages created by Webfuse course sites.
4.6. **An ISDT for Web-based learning systems**

Cole et al. (2005) identify the lack of a clear stage for reflection to specify learning as a shortcoming of design research. Such a process requires reflection on the outcomes to understand how they have contributed to the change sought and to understand the observed success or failure within the organisational setting (Cole et al., 2005). This section and the following are intended to allow for some reflection and learning upon the experience of designing and using Webfuse from 1996 through 1999. This section seeks to formulate an ISDT based on this experience, while the next section seeks to identify the lessons that have been learned through the application of this ISDT.

The ISDT presented in this section is titled “An ISDT for Web-based learning systems” and draws on the description of Webfuse from 1996 through 1999 given above. This ISDT uses the components of an ISDT identified by Gregor and Jones (2007) which are described in some detail previously in Chapter 3 and, in particular, Table 3.5. A summary of “An ISDT for Web-based learning systems” is given in Table 4.19 and expanded upon in the following sections as specified in the table.
Table 4.19. *Summary of the ISDT for Web-based learning systems.*

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core components</strong></td>
<td></td>
</tr>
<tr>
<td>Purpose and scope (Section 4.6.1)</td>
<td>Support the design and maintenance of Web-based learning environments for university-based learning and teaching.</td>
</tr>
<tr>
<td>Constructs (Section 4.6.2)</td>
<td>A range of constructs summarised in Table 4.20.</td>
</tr>
<tr>
<td>Principle of form and function (Section 4.6.3)</td>
<td>The tool manages a hierarchical web site that is divided into numerous small sub-sites. Each site is made up of Web pages organised into a tree-like hierarchy. Each page is managed and created through a page type. Other services enable the management of other resource on the site. Access to certain operations and resources are limited by access-control lists. Page types can act as wrappers around COTS and provide a consistent interface to author and visitor. Page types draw on a collection of services provided by the system. Implemented should be in a rapid development environment (e.g., scripting language)</td>
</tr>
<tr>
<td>Artefact mutability (Section 4.6.5)</td>
<td>Flexibility and support for diversity are key requirements for the ISDT. Implemented primarily through the eclectic, yet integrated structure.</td>
</tr>
<tr>
<td>Testable propositions (Section 4.6.6)</td>
<td>It is possible to construct and use a Web-publishing system as described by the ISDT. Such a system will be flexible, open and customisable for the given context. It will be able to respond to change readily. Such a system will be seen to be attractive for use by both staff and students.</td>
</tr>
<tr>
<td>Justificatory knowledge (Section 4.6.4)</td>
<td>Hypermedia templates (Catlin et al., 1991; Nanard et al., 1998); other insights from the hypermedia literature (Andrews, 1996b; Garzotto et al., 1993; Gronbaek &amp; Trigg, 1996; Thimbleby, 1997); and, access control lists (Barkley et al., 1997) Micro-kernel architecture (Liedtke, 1995); software wrappers (Dietrich et al., 1989) and open source software (Gerlich, 1998)</td>
</tr>
</tbody>
</table>

**Additional components**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principles of implementation (Section 4.6.7)</td>
<td>Naïve to non-existent. Essentially, build it and they will come.</td>
</tr>
<tr>
<td>Expository instantiation (Section 4.6.8)</td>
<td>Webfuse information system used from 1997 through 1999.</td>
</tr>
</tbody>
</table>
4.6.1. **Purpose and scope**

The purpose and scope of an ISDT is meant to define what the system is for, what are the goals that specify the type of system to which the ISDT applies and provides some delineation of the boundaries of the system (Gregor & Jones, 2007, p. 325). This ISDT seeks to provide guidance in the implementation of information systems that are intended to create Web-based learning environments for use within university-based learning and teaching.

4.6.2. ** Constructs**

Constructs within an ISDT offer representations of the entities of interest in the theory (Gregor & Jones, 2007, p. 322). Table 4.20 offers a summary of the constructs of interest to this ISDT.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web site</td>
<td>A hierarchical collection of directories and files containing Web pages and other resources.</td>
</tr>
<tr>
<td>Web page</td>
<td>A collection of HTML, usually generated via a page type</td>
</tr>
<tr>
<td>Page type</td>
<td>A software service that provides functionality necessary to create and manage a Web page, or part thereof. Typically implemented as a software wrapper.</td>
</tr>
<tr>
<td>Kernel services</td>
<td>A collection of services (e.g., authentication, access control, link validation, data storage, styles etc.) upon which hypermedia templates are built.</td>
</tr>
<tr>
<td>Page update process</td>
<td>Process through which the page type and kernel services combine to allow an author to create or modify a Web page.</td>
</tr>
<tr>
<td>Access control list</td>
<td>A collection of three bits of information (group, operation and resource) that specifies which collection of users can perform a specific operation on a particular resource.</td>
</tr>
<tr>
<td>Operation</td>
<td>A defined action (e.g., access, update, all etc.) that can be performed on a Web page or other resource. Only users with permission can perform a given operation.</td>
</tr>
<tr>
<td>Resource</td>
<td>A part of the web site such as a Web page, web site or some other content or service. A resource will typically have some valid operations that can be performed upon it.</td>
</tr>
<tr>
<td>User</td>
<td>A combination of unique username and a password allocated to an individual in order to identify them when using the system. Required to provide access to restricted operations.</td>
</tr>
</tbody>
</table>
### Construct | Definition
--- | ---
Group | A collection of users, typically used as part of an access control list.
Styles | A collection of HTML and graphics used to wrap around the HTML produced by a page type. A style typically defines a unique look and feel. Styles can be changed without changing content of a page type.

#### 4.6.3. Principles of form and function

The principles of form and function provide the abstract “blueprint” or architecture that describes an IS artefact (Gregor & Jones, 2007). Drawing on the constructs defined in Table 4.20 this section abstracts the implementation decisions described in Section 4.4 and summarised in Table 4.4 in the following set of principles of form and function. These principles are introduced using the collection of requirements initially described in Section 4.3.

**A Web publishing tool**

- The tool should aid in the creation and modification of a web site by multiple authors who are responsible for different parts of the web site.

- The web site has a hierarchical structure.

- Each Web page managed by the tool is of an identifiable type that matches one of the provided page types.

- The services necessary to allow the creation and modification of a page are provided by the appropriate page type and managed by a page update process.

- Other services enable the uploading of other resources, including HTML files, to be distributed by the web site.
Access to resources and services on the web site can be restricted on the basis of access-control lists, which specify object, operation and group of users.

A comprehensive OLE

- The services and page types of the tool are designed to provide the complete range of services (information distribution, communication, assessment and evaluation, and class management) required for education within the specific context.

- All functionality should be available via a consistent, integrated Web-based interface.

Eclectic, yet integrated

- The tool provides a core set (micro-kernel) of services necessary for Web publishing and e-learning (e.g., authentication and access control, presentation services, validation and checking etc.).

- The page types and the page update process are built on top of this core set of services.

- Page types are implemented so they can act as software wrappers.

- The page types, micro-kernel services and page update process all work together to provide a common interface to all services.

Flexible and support diversity

- The system should support the separation of content from presentation.
Where appropriate, page types and the core set of services should be provided by open source, platform-independent, or standards-based software.

The system should be implemented in a development environment (e.g., a cross-platform scripting language) that maximises flexibility and the ability to respond to diversity.

Use of educational theory or any other sort of overarching design principle should be limited to the design of individual or groups of page types. The entire system should not specifically support any particular educational perspective.

As much as possible, individual page types should be able to be added, removed and modified independently of other page types.

**Encourage adoption**
The tool should:

- provide a consistent management/authoring interface regardless of tool implementing the page type or service
- automate tasks and provide additional functionality
- minimise the requirements for new skills
- support and extend existing practice.

**4.6.4. Justificatory knowledge**
Justificatory knowledge is the underlying knowledge that provides a basis and an explanation for the structure of the ISDT (Gregor & Jones, 2007). Much of the
justificatory knowledge for “An ISDT for Web-based learning systems” has been explained in Sections 4.3 and 4.4. The following briefly summarises this justificatory knowledge using the same six requirements used throughout this chapter. Some of the decisions or principles mentioned in this chapter were not based on formal justificatory knowledge.

**A Web publishing tool**
The need for the tool to support the publication of Web pages arose from the specific context in 1996 as well as the understanding of the Web as a medium at that time. The principles for form and function (Section 4.6.3) of this ISDT are directly informed by: the idea of hypermedia templates (Catlin et al., 1991; Nanard et al., 1998); other insights from the hypermedia literature (Andrews, 1996b; Garzotto et al., 1993; Gronbaek & Trigg, 1996; Thimbleby, 1997); and, access control lists (Barkley et al., 1997).

**A comprehensive OLE**
The integrated nature of the OLE arose in part from the benefits of integration provided by the Web and how it enabled the integration of previous internet protocols (FTP, gopher etc.) into a single application (Relihan, Cahill, & Hinchey, 1994). It was also motivated by related observations about the reduction in complexity offered by other integrated systems. The lack of specific and detailed functionality for online learning arises from the belief that online learning was still developing and that on-going change would be a fundamental characteristic of online learning (Jones & Buchanan, 1996). Some guidance is provided by the four functional requirements for e-learning identified by McCormack and Jones (1997): information distribution, communication, assessment and evaluation, and class management.
**Eclectic, yet integrated**

The intent to develop a system that was integrated and yet enabled the addition of an eclectic range of additional services was informed by the micro-kernel architecture work within the operating systems literature (Liedtke, 1995). For this system, the pluggable modules that rely on the services provided by the micro-kernel were provided by hypermedia templates (Catlin et al., 1991; Nanard et al., 1998). The literature around COTS (Braun, 1999), software wrappers (Dietrich et al., 1989) and open source software (Gerlich, 1998) influenced the intent that hypermedia templates should also, where possible, be implemented as software wrappers.

**Flexible and support diversity**

The need for the system to support the full diversity of learning and teaching, in part, came from frustrations with inappropriate levels of enforced consistency experienced with teaching within a second-generation, print-based distance education institution (Jones, 1996a, 1996b). Similarly, the need for flexibility was informed by observations of how long it took institutions to move from mid-1980s, text-based computer-mediated communication systems to Internet based systems (Jones & Buchanan, 1996) and the rapid development of Web-based technology in the mid-1990s. The adoption of a “micro-kernel” architecture combined with hypermedia templates was seen to provide good support for flexibility and supporting diversity.

The need for the separation of content from presentation was informed by the hypermedia literature, in particular the critical examinations of the World-Wide Web (Andrews, 1996a; Bieber, Vitali, Ashman, Balasubramanian, & Oinas-Kukkonen, 1997).
In 1996, as design of Webfuse commenced it was becoming increasingly obvious that open source software provided more flexibility than traditional, proprietary software. At around the same time interest and use of scripting languages such as Perl and Tcl/Tk for developing systems was also becoming more popular. In particular, this is supplemented with insights from open source software and scripting languages (Ousterhout, 1998).

**Encourage adoption**

The need to encourage adoption was identified by (Jones & Buchanan, 1996). This need arose from experience at CQU and observations that academic staff were making limited use of existing technologies such as print or the phone (Davison, 1996). It was also informed by the broader recognition that creating sophisticated WWW-based courses was technical and too difficult for many academics (Goldberg et al., 1996). The principles adopted in addressing these problems were not informed by any formal literature or theory.

4.6.5. **Artefact mutability**

The artefact mutability component of an ISDT specifies what degree of artefact change is encompassed by the theory (Gregor & Jones, 2007, p. 322). A design guideline for Webfuse, and subsequently a key feature of this ISDT is the ability to be flexible in order to respond to change, that is, artefact mutability is a key aspect of this ISDT. The ISDT assumes that a key characteristic of the World-Wide Web is change. It assumes that the combination of this change and increasing experience with and understanding of how to use online learning will lead to changes in the practice of online learning. The “flexible and support diversity” principle represents the importance of artefact mutability as a first-class consideration in this ISDT. The “eclectic, yet integrated” principle is the primary
method used in this ISDT to support artefact mutability. As explained in Section 4.6.7; however, the ISDTs principles of implementation do not respond explicitly to artefact mutability.

4.6.6. Testable propositions

Testable propositions within an ISDT offer truth statements about the design theory (Gregor & Jones, 2007, p. 322). The testable propositions encompassed in this ISDT include:

- it is possible to construct a Web-publishing system supporting multiple authors based on: a hierarchical web site model; implemented using hypermedia templates as software wrappers around COTS products; and, drawing on a kernel of services.

- a system built following this ISDT will be more flexible, open and customisable for the given context. It will be able to respond to change more readily.

- a system arising from this will be seen to be attractive to use by both staff and students.

4.6.7. Principles of implementation

The principles of implementation provide a description of the process for implementing the theory in specific contexts (Gregor & Jones, 2007, p. 322). In the development of Webfuse from 1996 through 1999 little explicit consideration had been given to the design method. It has been suggested previously that a naïve “build it and they will come” approach was adopted (Jones & Gregor, 2006). For example, the Webfuse designer was only given 6 months to design and implement
the system before returning to normal teaching duties. After this time, on-going support for Webfuse was in the form of people employed to help academics use the existing system, rather than continue on-going design and development. Such an approach embodied many of the traditional steps associated with general software development methodologies such as those expounded by Jones (2000): analysis and design; implementation; sign-off; use and maintenance; and eventually a return to analysis and design.

4.6.8. Expository instantiation
An expository instantiation is an implementation of the ISDT that assists in representing the theory both as an expository device and for purposes of testing (Gregor & Jones, 2007, p. 322). The ISDT described here has been abstracted from the design and implementation of the Webfuse information system and its use within Central Queensland University from 1996 through 1999. As described in the evaluation section (Section 4.5) Webfuse was used significantly by the host organisation and generated some interesting comparative results. As demonstrated in the evaluation section (Section 4.5) and reflected upon in the following section (Section 4.7) the instantiation was not without its problems.

4.7. Lessons learned
This section seeks to identify lessons that can be learned from the implementation and use of Webfuse from 1996 through 1999. It continues the process expressed by Cole et al. (2005) by reflecting on the outcomes of the intervention in order to understand how they have contributed to the change sought and to understand the observed success or failure within the organisational setting. As with the rest of this chapter, the lessons learned during the implementation of Webfuse during this
period have been grouped below using the requirements for Webfuse first described in Section 4.3. The “eclectic, yet integrated” requirement does not appear because there are lessons fitting that requirement.

On reflection, the major lesson learned could be summarised as:

there is a need to develop both the product and the process – as embodied within the system and its support practices – to better integrate with the requirements and practice of academic staff and students.

Webfuse did not integrate well with the changing Web practices of authoring by editing Web pages or using the Web as an interface to dynamic Web applications. As implemented during this period, Webfuse did not provide until late in this time period important functionality (e.g., Web-based mailing list archives and online quizzes) that integrated well with existing or desired teaching practice. It did not integrate well with the institutional need to work at the course level, rather than the Web page or activity level. Responding to the need to provide better integration was hampered by limitations in the implementation of the product and the traditional process. Product limitations made it difficult to make the necessary modifications. Process limitations meant that the focus was on helping people use the existing product, rather than on further developing the product to make it easier.

A Web publishing tool

1. There is a need to support more than one tool per page.

Within Webfuse, each Web page is managed through a single hypermedia template or page type. Consequently, a Web page is either a discussion forum
or a lecture slide. It is not possible for a single Web page to contain both, or more components. This need was increasingly recognised but could not be responded to easily.

2. There is poor support for interactive Web applications.

Viewing the Web as a publishing platform contributed to a somewhat static view of the Web and how people interacted with it, similar to a book. The characteristics and limitations of this metaphor negatively influenced the implementation of Webfuse and made it difficult to provide interactive Web applications, a growing requirement. These limitations slowed down the development of a number of important required Webfuse services.

3. A disconnect with broader Web development practices.

The common Web development practice during 1996-1999 was the use of a HTML editor application to edit static Web pages. The hypermedia template approach used in Webfuse was not a good match for this practice. This mismatch contributed to problems where some users would edit the Webfuse produced HTML page directly, only to have those changes ignored and overwritten by Webfuse at the next Webfuse update to the page. This lack of connection increased confusion amongst academic users and the perception that Webfuse was different and difficult.

**An integrated online learning environment**

4. Limited integration with broader institutional systems limited Webfuse services.

Responsibility for the support and implementation of learning and teaching at CQU spread across a number of organisational boundaries. As an initiative of
a single faculty, Webfuse was not seen as a whole of institution service. Consequently, it was difficult, if not impossible, to integrate Webfuse with those educational services that were the responsibility of other organisational units. These integration difficulties were a significant barrier in achieving the aim of Webfuse being a comprehensive OLE in terms of encompassing functionality regardless of where it lay within the institution’s organisational structure.

**Flexible and support diversity**

5. Product problems limited flexibility and support for diversity.

The implementation of Webfuse suffered a number of limitations that increased the workload inherent in adapting the system in response to identified needs. The workload involved is a partial explanation for the late delivery of important services such as the online quiz and Web-based mailing list archive. These problems were the result of various factors including: the novelty of developing Web applications, the author’s limited knowledge and experience of good practice for large-scale software systems, limited support for such practices in the technology used, and the “learn as you go” nature of the task.

6. Limitations in support process limited flexibility and support for diversity.

The traditional, or perhaps ad hoc, approach to the process used to support and maintain Webfuse limited the ability to be flexible and support diversity.

**Encourage adoption**

7. System characteristics were not enough to encourage adoption.

Simply having a system with a consistent interface that required a minimum
of new skills is not sufficient to encourage adoption and change in long held practices. User perceptions of the system and the broader context play a significant role.

8. The majority of staff were not interested in understanding or harnessing the full complexity of the tool.

There were at least three common groups of staff interacting with Webfuse. A very small number of heavy users who wanted to use the tool to the full and in some cases move beyond it. There were another small group who simply did not engage with the tool at all. Finally, there was a large group with a fairly fixed and limited set of expectations or requirements from online learning who wanted those implemented as quickly and easily as possible.

9. There was a need for better support of the course concept.

Webfuse did not offer any specific support for the concept of a course. A course site was simply a collection of Web pages within a broader collection of Web pages. Users were assigned to groups and those groups happened to have names that matched course names. Only limited components of Webfuse recognised the concept of a course. In terms of organisational operations, a course is a significant object and Webfuse’s limited support, especially during the start and end of term, limited its functionality.

10. Contextual reasons.

At this time, the nature of the Web and its use in general remained fairly primitive and unsettled. Being on the Web was not an accepted part of the broader society, the infrastructure to get “on the Web” remained limited in its spread. The value and use of online learning was still open to question within
the higher education community with some well-publicised arguments (Noble, 1998) against its adoption gaining traction. Many universities, like CQU, had still not decided, or in some cases even started to consider, what institutional or strategic plans they might take around the question of online learning. Similarly, few institutions had started to deal with the long-term problem of academics being rewarded more for research than teaching. Finally, within the specific CQU context, the period from 1997 through 1999 saw a number of large organisational changes (e.g., development of new faculties and significant modifications to the academic year) that limited to some extent the capability and desire of academic staff to engage in the adoption of online learning. It was also observed that during these years Infocom did not have an appropriate model for resourcing the development of non-traditional learning and teaching (Jones, 1999a; Zelmer, 2000).

4.8. Conclusions

This chapter has described the first iteration of an action research cycle used to design, build and support the Webfuse e-learning system at Central Queensland University (CQU). It has drawn on that experience to formulate “An ISDT for Web-based learning systems” for university learning and teaching. As described above, while this cycle resulted in a system that was being used by significant numbers of staff and students, usage was significantly unbalanced. That is, a majority of usage arose from a small number of courses and academics. There was significant room for improvement.

The next chapter offers a description of the second iteration of this project’s action research cycle and covers the period from 2000 to 2004 and beyond.
Showing what steps were taken to modify Webfuse in response to the lessons learned during the 1997 through to 1999 period and also by changes within the context from 2000 onwards. At the end of the next chapter the final version of the ISDT for e-learning formulated within this thesis is presented.
Chapter 5 - Emergent development

5.1. Introduction

This chapter describes the final iteration (2000 through 2009) of the action research process for the on-going development and support of the Webfuse information systems, and the subsequent formulation of An ISDT for emergent university e-learning systems. To offer this description, the chapter uses the same basic structure used in Chapter 4 that was derived from the synthesised design and action research approach proposed by Cole et al. (2005). This approach and the chapter structure is summarised in Table 5.1.

Table 5.1. The stages of the Cole, Purao, Rossi & Sein (2005) synthesised research approach mapped to chapter sections.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Chapter Section</th>
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<tr>
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The chapter starts with the problem definition (Section 5.2). Unlike Chapter 4, the problem definition here does not define specific a priori requirements. Instead, it describes changes in the context in which Webfuse operated. The chapter then describes (Section 5.3) the six categories of changes that were adopted to improve the operation of Webfuse from 2000 through 2009. The success of these strategies is then evaluated in Section 5.4 and a number of lessons from this experience are derived (Section 5.5). Finally, this experience is abstracted and combined with other insights to formulate An ISDT for emergent university e-learning systems (Section 5.6).
5.2. Problem definition

The basic problem faced in this work was how to support the use of e-learning within, first, the Department of Mathematics and Computing (M&C), and later the Faculty of Informatics and Communication at Central Queensland University (CQU). Section 4.2 outlined the nature of this problem as of 1996. By 2000, however, the situation had changed significantly. This section seeks to focus solely on those changes that most impacted the evolution of Webfuse. As such, it describes these changes in three groups: societal changes (Section 5.2.1); changes within CQU (Section 5.2.2); and changes in how Webfuse was supported (Section 5.2.3).

5.2.1. Societal changes

For much of the 1990s onwards, the CQU context was characterised by many of the changes in society described in Section 2.8.1. The following focuses on a small subset of these changes. Specifically, the ones that most directly influenced the re-framing of what Webfuse was and how it should be supported.

Increasing Internet access

One of the issues facing Webfuse development from 1996 through 1999 was the limited adoption of Internet access. By 2000, however, this was starting to change. Household Internet access within Australia quadrupled from 16% in 1998 to 64% in 2006/7 (Australian Bureau of Statistics, 2008, p. 1). This rapid increase, mirrored in other advanced countries, represented the growing penetration of the Internet and the World-Wide Web into everyday life. While Internet access was growing it was still quite slow. By 2004/5, only 16% of Australian households had a broadband Internet connection, increasing to 43% by 2006/7 (Australian
Bureau of Statistics, 2008, p. 2). In addition, cost remained a significant barrier with only 34% of people in the bottom income quintile households have home Internet access compared with 77% in the top income quintile (Australian Bureau of Statistics, 2007). The growing availability of the Internet is but one of the factors behind Dhanarajan’s (2001, p. 66) observation that debates about equity and access were disappearing as “institutions rush[ed] to embrace the technologies and the market.”

**Dot-com boom, reduced funding and full-fee paying students**

Beyond the increasing penetration of the Internet into homes, the growing adoption of information and communications technologies (ICTs) contributed other broader societal impacts. Fuelled by the dot-com boom and the perceived Y2K crisis, universities faced an almost overwhelming demand for information technology (IT) skills in the years leading up to 2002 (Smyth & Gable, 2008, p. 188). Shortages of appropriately skilled graduates led in 1999 to the introduction of an Australian government initiative to address this problem through skilled migration. As part of this initiative, former full-fee paying overseas students graduating within a specified set of programs, including IT, were allowed to apply for permanent residence within the first six months after course completion, even if they did not have work experience (Birrell, 2000).

At around the same time Australian universities were dealing with reductions in government funding by looking for sources of private funding (Danaher, Gale, & Tony, 2000). Changes to how government grants to universities were indexed resulted in a cumulative effective cut of 17% by 2005 (Burke & Phillips, 2001). Moodie (2008) observes that Universities responded to these cuts in two ways: increasing revenue from non government sources and cutting costs. Full-fee
paying overseas students became a significant source of non-government income. As a consequence, the percentage of international students as total enrolments within Australian higher education grew from 4% in 1988 to 25% in 2005 (Moodie, 2008). Most Australian universities have built a large enrolment of foreign fee-paying students with some committing to a high exposure to foreign markets (Marginson, 2006). For example, the Australian University Quality Agency’s (AUQA) 2006 report on CQU (AUQA, 2006, p. 3) identified the institutions international student operations as “now essential to the University’s existence.” CQU is one of the five Australian universities which Marginson (2005) identifies as deriving over 20% of their revenues from full-fee paying students.

McGown and Potter (2008) suggest that this situation has created an unhealthy dependence on full fee income from international students. This situation is especially troubling given the volatility of demand. After significant increases, the global downturn in IT from 2002 led to a decline in demand for IT courses (Smyth & Gable, 2008, p. 191) and an increase in interest in other disciplines. By 2004, half of the overseas undergraduates enrolled in Australian universities were enrolled in courses in management and commerce (McGowan & Potter, 2008). By 2005 there were reports of slackening demand in traditional overseas student markets (Rood, 2005). By 2010 the education export industry was being hit by more restrictive rules on student visas, a high Australian dollar, bad publicity about attacks on Indian students, aggressive recruitment campaigns from other countries and concerns about quality (Lane & Akerman, 2010). This combination of factors is contributing to a 40% drop in applications from international students (Healy, 2010).
The rise of flexible learning
Reduction in government funding was also influencing the conceptions of teaching, especially distance education and flexible learning. The creation of a network of eight national distance education centres (including CQU) in the mid-1980s by the Australian government arose from the understanding that distance education could make a significant difference in servicing unmet demand (King, 2010). By the late 1990s, however, Moran and Myringer (1999) argued that declining funds, advancing technology, and the demography of students had triggered a process of change where distance education methods and systems were converging with those of face-to-face teaching. There was a move underway from ‘distance education for some’, toward ‘flexible learning for all’ (King, 2010).

Bigum and Rowan (2004) suggest that the term flexible learning arose from perceptions of it being: a more effective and efficient means of getting teaching resources to students, and through online teaching offering the possibility of generating revenue from overseas fee-paying students. As a result, King (2010) explains how rise of flexible learning resulted in effects such as: blurred distinctions between on-campus and off-campus delivery; the relocation of several functions from the domain of the organisation to the individual teacher; and, enabled what were options for distance student to become common place for all.

Accountability and quality
As noted in Section 2.8, there has been an increasing pressure on universities to be accountable and to be seen as efficient and effective. One example of this move was the creation of the Australian Universities Quality Agency (AUQA) in March 2000. AUQA was assigned the responsibility of providing public assurance of the quality of Australia's universities and other institutions of higher education
(AUQA, 2000). In addition to five yearly AUQA audits, Australian government policy requires universities to demonstrate quality in learning and teaching through other mechanisms such as an annual Course Experience Questionnaire and a Learning and Teaching Performance Fund (Radloff, 2008). Woodhouse (2003) reports that feedback on trial and substantive AUQA quality audits in 2001 and 2002 was positive, with universities reporting beneficial effects through the audits and self-reflection triggered by prospective audits. In a review of contributions to the journal Quality in Higher Education, however, Harvey and Williams (2010, p. 3) suggest that “external quality evaluations are not particularly good at encouraging improvement especially when they had a strong accountability brief.”

### 5.2.2. Institutional changes

As outlined in Sections 2.8.2 and 2.8.3, the types of societal changes and influences described in the previous chapter (and in Section 2.8.1) resulted in responses from universities. The following provides an overview of some of the many CQU changes and responses generated by the societal factors described in the previous section.

**Vice-chancellors and organisational changes**

Within the Australian higher education sector, the Vice-Chancellor plays the role of “chief executive officer”. During the Webfuse period (1996 through 2009), CQU has had four Vice-Chancellors, each of whom has left their mark on the institution. In mid-1996, at the start of the period, CQU appointed a new Vice-Chancellor who advocated a number of new initiatives. These included (Gregor, Wassenaar, & Marshall, 2002): an organisational restructure; introduction of a four-term year; a review of online and distance education;
replacement of most administrative information systems with ERP; and,
increasing emphasis on overseas, full-fee paying students.

While all of these changes commenced prior to 2000, each had on-going
ramifications that were attempting to be understood and handled by CQU
management as well as staff over the coming years. One example of this is the
description of CQU offered by the next Vice-Chancellor (Hancock, 2002) as
being a “work in progress” and “a unique university.” An institution that retained
the vision “to be a unified university, acknowledged universally as a leader in
flexible teaching and learning” (Hancock, 2002, p. 4). In 2004, the third
Vice-Chancellor during the Webfuse period, embarked on another significant
organisational restructure of both faculties and administrative units. This
restructure was completed just before his departure in 2009. In 2009 and 2010,
during the tenure of the fourth Vice-Chancellor still more changes in
organisational structure were being undertaken. Most, if not all, of these
organisational restructures were based on the need to make the institution more
competitive in attracting students, or to respond to shortfalls in projected revenue.

**The Australian International Campuses and other strategies**
As described in Chapter 4, by 1994 CQU had commenced a relationship with a
commercial partner to create a number of campuses. These campuses were
situated within major Australian cities and were aimed at teaching full-fee paying
overseas students. These campuses were known as Australian International
Campuses (AICs). From 1996 onwards, the first CQU Vice-Chancellor of the
Webfuse period built significantly on this partnership. Singh (1998) describes
how this Vice-Chancellor saw the need for regional universities to raise income
from a variety of non-government sources as the primary reasons for increasing
the numbers of full-fee paying students. Beyond the AICs, additional alliances were formed to create CQU delivery centres in Singapore, Malaysia, China and Hong Kong, and a full campus in Fiji. (Marshall & Gregor, 2002)

As a result, the percentage of CQU’s students provided by international students rose from 7.3% in 1996 (Marshall & Gregor, 2002) to 40% in 2004 (Luck et al., 2004). In the same time frame, CQU increased its total student enrolment by almost 50%. By 2002 CQU was, in terms of international students, one of Australia’s fastest growing universities (Marshall & Gregor, 2002). This led one CQU Vice-Chancellor to describe CQU as the “most geographically disparate, ethnically diverse and fastest growing student population of any Australian University” (Hancock, 2002, p. 8).

By 2002, Infocom (the faculty in which Webfuse was used) was teaching about 30% of all CQU students including almost 56% of the students at the AICs (Jones, 2003b). The total number of students in Infocom courses had more than doubled from 1999 to 2002 (Condon et al., 2003). This doubling was largely due to a combination of an increased demand for IT skills described in the previous section, and Infocom being responsible for CQU’s programs in IT and Multimedia. Consequently, the post-2002 decline in interest around IT skills contributed to a fall of 15% in Infocom student enrolments between 2002 and 2003 (Condon et al., 2003). Similar increases and falls in student enrolment existed in accounting and other disciplines. These changes in student enrolment were essentially a response to on-going changes in government regulations around skilled migration.
Flexible learning
Commencing in 1997, CQU undertook a review of distance education and flexible learning producing a green paper in 1999 (McConachie et al., 2006). This review and subsequent developments were aimed at developing “structures and systems that are responsive to the needs of learners and the changing nature of higher education in the 21st Century” (CQU, 2001). An output of this work was the release of a Strategic Plan for Flexible Learning in 2001 that emphasised the need for flexibility (CQU, 2001, p. 2)

The Strategic Plan for Flexible Learning is a ‘living document’. It is imperative that the Strategic Plan be regarded with the same flexibility as the very learning experiences it aims to promote and enhance. To regard the Strategic Plan as anything less will threaten CQU’s position as a market leader in a competitive environment

The stated aim was for CQU to be responsive to a world that was changing fast and needed to provide education that was flexible in terms of delivery time, mode, location and content (Hancock, 2002).

The most obvious artefact of this work on flexible learning was the adoption of various institutional Learning Management Systems during the Webfuse period:

- WebCT in 1999/2000

Following a survey and a simple technical evaluation, WebCT was adopted for a trial in 1999 (Sturgess & Nouwens, 2004). There were, however, reports of major problems in the WebCT trial due to inadequate infrastructure (Gregor et al., 2002). These problems led to the purchase of
a large central Web server, an investment that led to WebCT being the de facto, institutional LMS.

- **Blackboard in 2004**
  In 2004, CQU implemented an evaluation process that resulted in the decision to adopt the Blackboard LMS as the institution’s official LMS (Sturgess & Nouwens, 2004). Danaher et al. (2005) report on how this decision was far from universal as Blackboard was recommended by only two of the four working parties, with one working party recommending Webfuse. The selection of Blackboard did not include any requirement to prevent use of Webfuse. Use of Webfuse for course sites continued for another five years. A subsequent working party reported that problems with the implementation of Blackboard meant that during the first term of full operation, Blackboard was essentially unavailable every weekend.

- **Moodle in 2010**
  During 2008, a process commenced to replace both Blackboard and Webfuse with a single LMS as a means to enhance learning and teaching (Tickle et al., 2009). This process resulted in the adoption of the open source Moodle LMS in 2010.

With the adoption of Moodle in 2010 the course site functionality of Webfuse was no longer used. A number of the other Webfuse services described below, however, continued to be used.

**Enterprise systems**

The goal of being responsive to change led CQU to the adoption of enterprise systems. For the first Vice-Chancellor of the Webfuse period, being able to cope
with increasing complexity faced by the institution required integration of the university’s administrative systems (Jones et al., 2004). As a result, in 1999 CQU’s senior management took the decision to implement the PeopleSoft suite of administrative systems (McConachie, 2001). The implementation of PeopleSoft was seen as a business process re-engineering project which would require second-order structural and policy change at the University (McConachie, 2001). The decision to adopt an ERP system like PeopleSoft was common within the Australian higher education sector at this time. By 2002 almost 90% of Australian universities had adopted at least one module of an ERP from a major vendor with approximately 55% of universities using PeopleSoft (Beekhuyzen, Nielsen, & Goodwin, 2002). There were, however, significant problems with the implementation. Oliver and Van Dyke (2004) report that rather than decreasing staffing costs, the implementation of the new ERP had increased staffing levels. Rather than simplify process, the adoption of an ERP led to processes becoming more complicated and that cited benefits for staff being “difficult to discern in practice” (Oliver & Van Dyke, 2004, p. 136).

**Complexity of teaching**

The increasing number of international students and the rise of flexible learning, amongst other factors, led to a significant increase in the complexity of teaching. The question of how best to teach a course was complicated by the observation that CQU had a diverse student population quite unlike that of a traditional university (Marshall & Gregor, 2002). Kehoe et al. (2004) describe how the development of large undergraduate courses, challenging at any time, became even more complex at CQU where the students in a course would include a combination of internal and distance education students, and domestic and
international students. Complexity was further increased by circumstances where it was not unusual for course enrolments at the international campuses to be considerably greater than those on the Queensland campuses (Oliver & Van Dyke, 2004). By 2001 CQU had 11 course offerings with over 1000 enrolled students in a single term. Typically these courses would be supported by close to 20 academic staff, including a number of casual staff, all managed by a single CQU academic. By 1999 it was already obvious that these changes had significantly increased the complexity in teaching, increased duplication of teaching methods and significantly consumed time and resources (Jones, 1999a).

**Change weariness**

The second Vice-Chancellor of the Webfuse period, writing in 2002, recognised that the institution’s “rapid growth has placed great strain on its staff and its physical and technological infrastructure” (Hancock, 2002, p. 5). In particular, the attempt to increase flexibility by offering year-round teaching had placed great strain on staff and required new approaches to workload and workforce planning (Hancock, 2002, p. 5). Numerous authors (Luck et al., 2004; McConachie, 2001; Oliver & Van Dyke, 2004) describe how CQU staff members increasingly describe themselves as change weary. McConachie (2001) describes how CQU staff perceived the many changes of previous years to have been communicated poorly and badly managed leading to a climate where further change was unwelcome.

5.2.3. **Changes in Webfuse support**

The on-going development and support of Webfuse from 2000 through 2009 was heavily influenced and informed by the changes described in the previous section. Some of these changes had already impacted upon Webfuse. The 1998
organisational restructure resulted in the creation of the Faculty of Informatics and Communication (Infocom), which subsequently adopted Webfuse for the management of its website and e-learning. It was not until the arrival of the foundation Dean of Infocom in 1999, however, that more significant changes commenced. Over the next year, the foundation Dean sought to develop “a ‘glocal’ networked education paradigm” in order to provide a scalable, globally competitive, and flexible model of educational delivery (Marshall, 2001).

An early example of this “glocal” paradigm was the development of a partnership to deliver CQU courses in Singapore. In early 2000, the author was seconded from teaching to help with the implementation of this project. This project included a range of sub-projects around improving the use of ICTs to support the “glocal” paradigm and involved working closely with the Webfuse development team. By August 2001, a new position had been created (Faculty Teaching and Learning Innovation Officer) to which the author was seconded and thus given responsibility for leading the Webfuse development team. By this time, the Webfuse development team had expanded to include a webmaster, three permanent developers, and a contracted developer. This team retained this membership until 2004.

By 2003, largely due to the global downturn in interest in IT based careers, Infocom student numbers were beginning to drop. Previous external perceptions of Infocom as innovative with hard working staff had begun to change to one where Infocom was seen as “greedy” and somewhat less than successful (Condon et al., 2003, n.p.). By late 2003 the foundation Dean of Infocom was seconded to special projects and left the University in early 2004 (Jones et al., 2004). In late 2003 and in line with the drop in student numbers there was an indication that
faculty budgets would be decreased and an increased push for the centralisation of services. By 2004, the Faculty Teaching and Learning Innovation Officer position was removed, and the author returned to teaching. As a result of another organisational restructure in 2004, Infocom was disbanded with disciplines being split up amongst at least two new faculties. Initially, the Webfuse development team moved to one of those faculties. In 2006/7 another organisational restructure resulted in the Infocom Web team moving into CQU’s central IT division. Through redundancies and departures, by 2008 there was only one Webfuse developer working at CQU.

5.3. Intervention

This section describes the numerous changes made to the Webfuse system and how it was supported from 2000 through 2009. These changes were in part a result of the contextual changes described above, the identified limitations of Webfuse described in Chapter 4, and insights gained from theoretical development. Table 5.2 gives an overview of the changes described in the rest of this section.
Table 5.2. Linkage between lessons and Webfuse interventions (2000–).

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Section 5.3.1 – Adopter focused development</td>
<td>Change process to focus on adopter needs, understanding and context to address problems with appropriation, adoption, and evolution (Jones &amp; Lynch, 1999; Surry &amp; Farquhar, 1997).</td>
</tr>
<tr>
<td>Section 5.3.2 – Emergent and agile development</td>
<td>Change process to adopt a more emergent approach (Jones, 2000; Truex et al., 1999).</td>
</tr>
<tr>
<td>Section 5.3.3 – Object orientation and design patterns</td>
<td>Re-design of Webfuse code base based on object-orientation and design patterns (Gamma, Helm, Johnson, &amp; Vlissides, 1995).</td>
</tr>
<tr>
<td>Section 5.3.4 – Wf Framework</td>
<td>OO and design-patterns based framework for developing interactive Web applications</td>
</tr>
<tr>
<td>Section 5.3.5 – Default course sites</td>
<td>New scaffolded, automatic approach to creation of course web sites.</td>
</tr>
<tr>
<td>Section 5.3.6 – Workarounds</td>
<td>A range of ad hoc improvements and additions, at all levels, to Webfuse enabled by process &amp; product changes from previous sections (Jones, 2003b).</td>
</tr>
</tbody>
</table>

5.3.1. Adopter focused development and diffusion theory

As shown in Chapter 4, by 1999 it was obvious that adoption and use of Webfuse features amongst academics was somewhat limited and imbalanced. Jones and Lynch (1999) attribute the problematic nature of Webfuse use to the Webfuse development process being too developer-focused. The process did not have a sufficient focus on the potential adopters system, nor did it actively involve them in the process. Drawing on work by Surry and Farquhar (1997) it is argued that a developer-based approach assumes that a demonstrably better artefact will automatically replace existing products or practices. In addition, Jones and Lynch (1999) argued that the focus of traditional development processes on developing the final or ideal system to meet all possible needs generates little benefit in a context that is always changing: a context like e-learning. Instead, the ideal
system actually becomes a burden preventing adaptation to the changing context (Jones & Lynch, 1999).

To address these issues Jones and Lynch (1999) proposed a new development model that informed changes to the Webfuse development process. The new model drew on insights from diffusion theory (Rogers, 1995), adopter-based development (Surry & Farquhar, 1997), the design patterns community (Alexander, Ishikawa, & Silverstein, 1977; Gamma et al., 1995), and existing links between design patterns and hypermedia templates (Nanard et al., 1998). The model can be summarised as having the following elements:

1. There exists a development team that actively seeks to understand the social context of Web-based learning. The inter-relationships between the developers of the system, the developed system, the potential adopters of the system and the contexts in which the system is developed and used is of significant importance.

2. The development team develops a set of constructive templates (Nanard et al., 1998) that teaching staff can use to create course web sites for use by students.

3. To encourage adoption and use by teaching staff the design of these templates is informed by insights from diffusion theory.

4. Template design is informed by design patterns that encapsulate knowledge around learning, teaching and Web-based services.

5. There is recognition that innovative staff members are likely to do unexpected things with the constructive templates, even ignore them all
together and use other means. This response from staff members is not only allowed, but where possible encouraged and enabled.

6. The development team continue to observe and support staff throughout the use of the course sites to identify what is working and what is not.

7. Based on this observation the development team abstracts new design patterns, retires those no longer appropriate and does the same for constructive templates.

Jones and Lynch (1999) believed that this development model would provide three major benefits:

1. Develop systems that are more likely to be adopted. This is achieved by a major emphasis on context, adopter led development approaches and theory from the diffusion of innovations.

2. Enable the appropriation and reuse of prior experience. Gained by a continual process of evaluating the work of innovators for potential abstraction and storage in a pattern repository and implementation as a constructive template.

3. Enable the continued evolution of the system to meet changing needs. Evolution is provided by the continued application of patterns in a form of piecemeal growth and emphasising design for repair rather than replacement.

The principles and assumptions of the development model described by Jones and Lynch (1999) were to form the basis for how the Infocom Web team operated
from 2000 through 2004. There were, however, further experiments with, and refinements to this understanding. During 2002, it was recognised that the Webfuse development team did not have the resources to address all development requirements. To address this problem, Jones, Jamieson, and Clark (2003) proposed a model that drew on insights from diffusion theory to: identify potential implementation issues; estimate the likelihood of reinvention; and, predict the amount and type of effort required to encourage adoption.

Over time, it was recognised that diffusion theory was not without its limitations. Of particular relevance to Webfuse development was Bigum and Rowan’s (2004, p. 217) argument that the reliance on pre-established categories limited the capacity of diffusion theory to account for new and unanticipated arrangements. McMaster and Wastell (2005) identify a range of flaws with diffusion theory and argue that it is deterministic and positivistic in philosophical orientation which leads its proponents to predict outcomes based on the measurement of a small number of variables. McMaster and Wastell (2005, p. 386) cite numerous authors to argue that while such “factor approaches” can “highlight important influences, they necessarily fail to capture the dynamic, processual character of social-technical innovation.”

The modified Webfuse processes used during this time may have, at times, suffered some of these problems. Yet, the adoption of perspectives from emergent development (described in the next section) helped address these limitations through encouraging a deeper focus on the dynamic, processual character of social innovation. In particular, the emergent approach provided insights that improved the Webfuse development processes ability to offer the third advantage identified by Jones and Lynch (1999): evolution.
5.3.2. **Emergent and agile development**

Chapter 4 describes how the ability to be flexible and adapt to change was seen as a requirement for Webfuse. It also shows, however, that there was a naïve adoption of traditional, teleological, software development processes. Jones and Lynch (1999) picked up on the limitations of this approach through the literature on design patterns (Coplien, 1999). It was from this literature that the idea of design for repair, rather than design for replacement arose. Jones and Lynch (1999) sought to achieve this through a process by which system evolution was enabled by continual reflection and modification of the patterns and constructive templates used by the development team (Jones & Lynch, 1999). During 1999 additional support and expansion of these ideas arose from literature discussing emergent (Truex et al., 1999) and agile (Highsmith, 2000; Highsmith & Cockburn, 2001) development.

By 2000, Jones (2000) argued that numerous benefits were available to e-learning through the adoption of an emergent development approach. Moving Webfuse to a more emergent or agile development approach commenced in late 2000 when the author took on the lead role with the expanded Infocom Web team. This transition adopted the goals of emergent development described by Truex et al. (1999): continual analysis; dynamic requirements negotiation; useful, incomplete specifications; continuous redevelopment; and the ability to adapt. In more concrete terms Webfuse development adopted many of the practices specified by eXtreme Programming (Beck, 2000), including: the planning game; small releases; system metaphor; simple design; continuous testing; refactoring; continuous integration; coding standards; and, collective code ownership. Pair programming was used where possible but this was not often. Since not all of the
practices of extreme programming were adopted it cannot be (strictly) claimed that the Webfuse development process was an example of eXtreme Programming (Beck, 2000). Additionally, there are numerous examples where the development team was unable to maintain the discipline extreme programming requires. It is argued in Jones (2003b), however, that an emphasis on code reuse, flexibility, closeness to the user, a test-driven coding style and various other practices provided Webfuse with an agile development process.

The adoption of this more emergent and agile development approach was enabled by a number of factors. These included:

- **object orientation and design patterns**
  As described in Section 5.3.3 a new object-oriented design for the Webfuse code, heavily influenced by the design patterns literature, was developed around this time. The new OO design was a significant enabler in the adoption of test-driven development, system metaphor, and other practices that made it significantly easier to adapt and continuously redevelop Webfuse.

- **the Wf framework**
  A significant part of the new OO architecture was the Wf framework (described in detail in Section 5.3.4). This framework provided the system metaphor for the development of interactive Web applications and enabled the rapid development of a significant number of important services.

- **default course web sites**
  The default course web sites (describe in detail in Section 5.3.5), as well as addressing problems of adoption, also provided an important part of the system metaphor for Webfuse.
• Webfuse’s existing architecture

The Webfuse “micro-kernel” architecture and its use of page types/hypermedia templates (as described in Chapter 4) provided the foundation for many of the above enablers, in particular the default course sites. The ability to add and modify page types independently of each other was a significant enabler of the ability to design for repair, not replacement.

• support of the faculty Dean.

Perhaps the most important enabler was the support of the faculty Dean. As described in his writings (Marshall, 2001; Marshall & Gregor, 2002), the emergent development approach matched his beliefs about the higher education environment and how to proceed within it. This understanding and agreement meant that the Infocom Web team was provided with the support and resources necessary to undertake this approach.

The results of the changes to the Webfuse development process described in this and the previous section resulted in a number of “workarounds” described in Section 5.3.6 which in turn significantly increased Webfuse usage (Section 5.4).

### 5.3.3. Object orientation and design patterns

The initial design rationale for Webfuse (Jones & Buchanan, 1996) mentions that object-orientation is one of a number of approaches known to maximise adaptability. The initial Webfuse implementation, however, did not make use of object orientation. The key ideas of object-orientation arose during the 1960s, but it was the early 1990s before Fichman and Kemerer (1993, p. 7) argued the object-orientation was the leading candidate to become “tomorrow’s dominant software process technology.” With object-oriented design, system designers
analyse and design in terms of objects or “things” – instead of operations or functions – with an executing system made up of interacting objects that maintains state and provides operations that manipulate that state information (Sommerville, 2001, p. 261). Proponents argue that object-orientation is an approach that helps avoid the labour intensive need to build all code from scratch due to its support for constructing software systems through the assembly of previously developed components (Fichman & Kemerer, 1993). The independent encapsulation of state and operations enables this reuse and reduces design, programming, and validation costs as well as reducing risk (Sommerville, 2001, p. 262). All of these features that seemed to be ones which would significantly help increase the flexibility of Webfuse.

Programming with objects, however, is complex and in the case of large systems some of the ramifications are not yet fully mastered or understood (Szyperski, 1999, p. 132). It was this problem that led to the identification, abstraction and use of design patterns for object-oriented systems. In perhaps the most important early book on design patterns, Gamma et al. (1995, p. 2) argue that design patterns make it easier to reuse successful designs and architectures. This reuse is achieved by expressing proven techniques in ways that are more accessible to developers and by allowing choice between design alternatives. A pattern is ‘a generic approach to solving a particular problem that can be tailored to specific cases. Properly used, they can save time and improve quality’ (Fernandez, 1998, p. 37). Sommerville (2001, p. 324) argues that while patterns are a very effective form of reuse, they do have a high cost of introduction and can only be used effectively by experienced developers.
Moving Webfuse to a more object-oriented design was influenced by the author’s consultancy work during 1999 to develop a Web-interface for a helpdesk system. This work directly contributed to the development of the Wf framework (Section 5.3.4) as a means of developing interactive Web applications. It also included work on a data mapper (Fowler, 2003) to support the transfer of data between relational databases and objects. From here, a number of CQU classes were created to model common objects within the University. For example, the People::Campus class provided a simple abstraction to query and modify information about the University’s various campuses. Eventually the Webfuse page types were moved to an object-oriented design. These classes replaced the use of procedural code in the development of new page types. The length of an average page type was reduced from 1000+ lines of code to less than 250 lines. The move to an object-oriented page type process, however, was never completed due to a focus on other developments.

By 2010, the Webfuse code-base included 900+ classes, 65 dynamic Web applications and a 190+ test harnesses. The test harnesses were mostly developed from 2001 through 2003 when the combination of the Webfuse agile development process, the increasing use of object-orientation, and a resourced Infocom Web team enabled the adoption of test-driven development.

5.3.4. Wf Framework

A significant limitation in the initial development of Webfuse (described in Chapter 4) was the absence of formal support for interactive Web applications. This limited support for Web applications was largely influenced by the initial conception of Webfuse as a Web publishing environment. The external
consultancy to develop a Web-based helpdesk interface mentioned in the previous section contributed to the early development of what became the Wf framework. The Wf framework was based on the Model-View-Controller (MVC) framework, made use of the data mapper pattern described in the previous section, and was used to develop 65 dynamic Web applications.

Originally proposed during the 1980s for the development of graphical user interfaces, the MVC framework allows a single object to be presented in multiple ways with each presentation having a separate style of interaction (Sommerville, 2001). Gamma et al. (1995) describe MVC as a triad of classes used to build user interfaces in Smalltalk-80 and draws on a number of patterns including Strategy, Factory, Observer, and Composite. The MVC architectural pattern has since become widespread through its use in a number of Web application frameworks.

All interactive Web applications built using the Wf framework used a URL matching the following format

\[
http://hostname/object/objectName/method/methodName/?param=value
\]

For example, the URL for the “Staff MyCQU” application’s course history method for the CQU course COIS12073 was accessed using the following URL

https://localhost/wf/object/StaffMyCQU/method/CourseHistory/?COURSE=COIS12073

To parse and handle this URL the Apache Web server was configured to use a Perl module. That module used the WebfuseFactory class to identify and call the appropriate application controller. This identification was done by the objectName (e.g., StaffMyCQU) matching a particular Perl class (e.g., StaffMyCQU.pm). The methodName part of the URL would specify which method of that Perl class to
execute. Any parameters contained within the URL (e.g., COURSE=COIS12073) would be passed as parameters to the method. As the Perl class was created it would perform authentication and access control checks to ensure that the user had permission to perform the requested method. The method executed would normally consist of the following steps: creating a model class (CourseHistory); creating a view class (CourseHistory_View); passing the model to the view; and, using the view to generate the HTML to send back to the browser. Depending on the information contained in the model the view would generate different output. For example, a class list view might generate a HTML page, a CSV file, or an Excel spreadsheet depending on user preference.

Sommerville (2001, p. 315) argues that the inherent complexity of frameworks means it takes time to learn how to use them and this can limit their use. Experience with Webfuse in the early 2000s reinforced this perspective as new developers, familiar with the simpler coding approaches of Web “scripting” took some time to grasp and see the value of this complexity. As shown below (especially in Section 5.3.6 on Workarounds), the consistent metaphor and other advantages provided by this additional, initial complexity provided an important part of the ability of Webfuse to respond quickly and effectively to organisational requirements and changes.

5.3.5. Default course sites and wizards
As described in Chapter 4, the initial assumptions built into Webfuse were that a course web site would simply be an empty page. From this single, empty page it was assumed that each individual teacher would then draw on the variety of page types (hypermedia templates) to design and construct their course web site. This
assumption is similar to that built into all Learning Management Systems (LMS) and matches the purpose of CQU’s initial adoption of an official LMS, described by Sturgess and Nouwens (2004, n.p.) as:

   to enable teaching staff to develop and manage online courses with little professional support.

As shown in Chapter 4, few if any staff used Webfuse course sites in this way. A number of potential explanations were proposed for this limited use. The majority of academic staff did not have qualifications in teaching and limited experience in the use of technology to improve learning and teaching. Few staff had large amounts of time to invest in learning these skills due to other work demands, particularly research. Many of the tasks necessary to create a course web site were also low-level tasks often requiring re-entry of information already provided elsewhere. Some of these tasks (e.g., uploading 12 weeks of lectures or study guide chapters) required repetitive manual work that increased the chance of human error. Lastly, there was little or no integration of institutional practice with Webfuse.

An initial solution to these problems was the manual creation of default course sites by technical and administrative support staff. While this practice solved some of the above problems, these course sites were: of limited quality; failed to encourage further enhancement from academic staff; and, required significant workload from other staff. Consequently, it was seen as necessary to develop an alternative approach to course site creation. One that offered better support for the concept of a course as well as encouraging greater engagement from academic staff.
During 1999 an initial attempt at addressing these problems was commenced as the “Wizard” project. Briefly described in Jones and Lynch (1999) the Wizard project planned to provide an interface based on the Wizards common to the Widows programs of the late 1980s. Such an interface would walk the academic through a series of questions about their course. The provided answers would be combined with the Webfuse page types to create a course site. A particular focus of this plan was an adopter-focused development approach. Due to organisational uncertainty and limited development resources, however, this project did not move beyond the prototype and planning stage.

The next attempt to address this problem was creation of an automated and expanded default course site approach for the second term of 2001. At this time, CQU was implementing the Peoplesoft enterprise system and was undergoing a number of changes. It was hoped that an improved course site would help address some of the concerns arising from these changes thus achieving greater levels of adoption. The expanded Webfuse development team made the default course site approach possible.

The following lists the components of the default course site. Each component is described in more detail in the following sub-sections. The Webfuse default course site approach included:

- an expanded default course site

  The single empty page default course site was replaced with a much expanded standard site consisting of: five separate sections; a range of course related information and services; and, a re-designed interface. Each course would have a course site created using this default.
• course specific page types

Each of the five sections of the default course site were implemented through new Webfuse page types. Each of these page types was provided with the details of the course (course code, period, and year) and used this information to gather data from existing sources from which to provide the necessary services.

• automatic creation

The creation and population of all default course sites was performed by running a script that when given the details of the term would automatically create default course sites for all courses offered that term.

• copying process

Once a default course site was created, staff could add additional resources to the site. Removing the need to add this material for each offering, staff could use a copying process to copy additional resources from one course web site to another.

• support for a real course site

Each default course site had support for an optional “real” course site. This added another area of the default course site in which the staff member could upload a course site they had created personally.

• support for on-going changes

While initially implemented with a single default course site for all Infocom courses, the default course site approach provided a platform for on-going change.
**Expanded default course site**

The assumption is that the course site for all courses would have the same structure and appearance with only the information and services being course specific. Consequently, the first step in creating the default course site was designing the structure and appearance. The initial default site used a simple hierarchical structure represented in Figure 5.1. A course home page formed the top of the hierarchy with five sub-sections and the hierarchical structure could continue under each of these sub-sections.

![Figure 5.1. Structure of default course site.](image)

The five sub-sections were:

1. **updates**
   
   The updates section provided a function that allowed teaching staff to create and distribute course wide updates or announcements. The titles and post dates of the most recent updates were also visible from the home page.

2. **Study schedule**
   
   This section provided a week by week breakdown of the course, its topics, content and assessment.
3. assessment

Provided access to details about course assessment. By default this would summarise for each assessment item: the title, due date, and percentage of the overall assessment.

4. resources

All remaining course resources and services were made available via this section. By default this included a link to the course profile (syllabus) document, details of the course textbook(s) (including a link to the university bookshop) and, if used, a discussion forum or mailing list.

5. staff

Contains details for all teaching staff as well as an area in which staff could communicate and share resources. The details of teaching staff included name, contact details and, where available, a photo.

The initial look and feel for the default course sites is shown in Figure 5.2, which is the home page for one of the course sites from July 2001. The course home page, like each page in the default course site, had three main sections:

1. header

Includes a range of navigation links, branding, and administrative information. Navigation links included breadcrumbs to indicate current location and links to other common institutional services such as the student portal, the faculty home page, and services such as search, help and, feedback. Branding information included common colours, and the name of the institution and faculty. Administrative information included the course name and the time it was being offered.
2. **body**

The main area of a page intended to include information specific to the page type. The CourseHome page (Figure 5.2) included a course synopsis, the most recent course updates, and pointers as well as descriptions of each of the five course sub-sections: updates, study schedule, assessment, resources, and staff.

3. **footer**

A small area for various administrative information such as the Webfuse page update link, details of when and who last updated the page, various disclaimers, and generic contact details.

*Figure 5.2. Home page for a Webfuse default course site (July 2001).*

**Course page types**

Each of the pages identified in the initial design of the default course site (Figure 5.1) were matched with the creation of a new Webfuse page type to implement the necessary services. A particular focus of these new page types was to embody...
course and institutional specific knowledge related to the particular section. Given the course code, period, and year, each page type could draw on institutional data sources to generate the necessary content and services. A summary of the initial content and services provided by these page types follows.

The CourseHome page type was responsible for producing the home page for a course as shown in Figure 5.2. It also provided the teaching staff with three additional services via the page update process (Figure 5.8). These services were:

- **staged release of the course site**

  A default course site could be in three possible stages. The initial stage consisted of just the home and updates page and was used prior to all information being available. When this information became available the second stage, a complete default site, could be created. Lastly, staff had the option of creating a real course site. The real course site concept is described in more detail below.

- **access to information about course enrolments**

  As described in Section 5.3.6 there was no simple method for academic staff to access information about enrolments in a course. An initial solution was to provide a summary of course enrolments in the page update process.

- **the ability to temporarily enrol students**

  Students were allocated to a course site based on enrolment information from the student records system. On occasion, this system did not provide up-to-date information which could prevent students from accessing restricted resources and services. The CourseHome page type provided staff with the
ability to temporarily enrol students in the course and thus provide access to restricted resources.

The *RSSUpdates* page type provided the ability for the teaching staff to create and distribute a list of course-wide updates or announcements. These updates were visible on both the updates page and as headlines on the course home page (Figure 5.2). In addition, the page type also generated an RSS file containing the updates to which the student could subscribe to. Subsequently, the Student MyCQU portal made use of these RSS files to display the updates for all courses a student was enrolled in on the home page.

The *CourseSchedule* page type provided support for managing a simple study schedule. For each week, the academic could specify the study material, tasks, and content the students were expected to use for a given week of the teaching term. The CourseSchedule page automatically provided the dates for each week of term by drawing on institutional data sources. Such schedules were a common part of CQU practice and all course profiles (aka course syllabi) contained such a schedule. It was planned for the CourseSchedule page type to use this existing data source to generate the course schedule. Access to this data, however, was not possible for two reasons. First, course profiles were manually produced as Word documents. Second, access was not granted to the data produced by the new course profile management system.

The *CourseAssessment* page type would produce a table containing information about all approved assessment items for the course. This information was pulled from a database and included the name, due date, and percentage contribution to final grade of each item. Initially, this information was manually transcribed from
the course profiles (in Word documents) into a Webfuse database. Eventually, this information was available from a central database. In addition, academics could choose to add a “sub-page” for each assessment item. This item page was used to provide additional details about the assessment item.

The *CourseResources* page type was designed to provide students with access to all course related resources and services. Some of these resources, such as a link to the course profile and details about any set course texts, were automatically generated. The remaining resources were manually added, deleted, and managed by the teaching staff using the page update process.

The *CourseStaff* page type produced a page that provided a list including personal details of each teaching staff member associated with the course. This list would also include, where available, a photo of the staff member, a link to their home page, and their contact details. The page would also automatically create a “staff only” section underneath the staff page. This “staff only” section was automatically restricted to teaching staff and was used to share information and services restricted to staff.

**Automatic creation**

Prior to the default course sites, Webfuse courses sites within Infocom were created through manual editing of pages by faculty administrative staff. To remove this workload, and prevent it simply being transferred to academic staff, it was envisaged that the default course sites would be automatically created. The implementation for this automatic creation depended on two artefacts: a collection of identified data sources; and the *CourseList* page type to create the course sites.
The identified data sources were a collection of databases and files that provided all of the necessary information required to construct the default course sites. This information included: which staff were teaching which course; the name of the course and where it was being offered; the weeks that made up the term; where the course profile PDFs were located; information about individual assignment items; information about selected textbooks; and, staff web sites and photos. This information was spread across a variety of institutional systems (e.g., Webfuse itself, student records system etc.) and some of the information was not in a machine-readable format. An ever-changing range of workarounds were necessary to convert this information into a format that could be accessed by Webfuse. The inability to access some of this information remained the largest limit on the ability to extend the default course sites.

The CourseList page type was used to create a Web page listing all of the courses being offered in a given term. It was also used for creating the course sites. The CourseList page type could work with the staged release of course sites mentioned in the previous section. The creation of the default course sites was guided by a skeleton site structure that was copied into the appropriate location and then updated with information specific to the course. It was possible for different courses to use different default course sites simply by pointing to a different site skeleton.

**A copying process**

The model adopted was that each offering of a course would have a different course web site. Course sites from previous terms were retained for historical and administrative reasons. Over time, it became evident that many courses were made up of the automatically created default course site and some additional
material added by the teaching staff. This additional material often remained the same from term to term with only minor changes. Rather than expect academics to manually upload this additional material each term, a copy process was instigated. The process allowed academics to specify which parts of the additional material from an old course site they wished to copy to the new course site.

**Support for a real course site**

As shown in Chapter 4, there remained a small number of staff who wished to create their own course web sites using a variety of Web or HTML editors. The desire to create an individual course web site was particularly common amongst staff teaching in the multimedia discipline. This desire raised the difficult question of how to balance the faculty’s needs to ensure a minimum standard of online presence, with the individual academic’s disciplinary and identity needs. The solution adopted by Webfuse was to add the notion of a real course site to the default course site. The CourseHome page type was modified to include a check box, which when selected would create a real course site. The real course site was essentially an empty directory under the home page of the default course site. The academic could then upload whatever they wished into this directory as the real course site. The default course site would then provide an additional link to the real course site in its header. Staff using the real course site facility would often supplement this link with additional pointers. Figure 5.3 shows the home pages for both the default course site and the real course site from a single course in 2002.
Support for on-going change

A significant advantage of the default course site approach was that it provided an abstraction which enabled significant flexibility in responding to on-going change and diversity. Possible responses provided included:

- different default course sites
  Different courses could be configured to have default course sites that differed in terms of interface and structure

- the addition of page types and styles
  The interface (styles) and structure (page types) of default course sites could be modified over time to respond to changing requirements

- the automatic updating of course sites
  Webfuse scripts enabled existing course sites, or individual pages within course sites to be automatically updated without requiring manual editing of the pages via the Webfuse page update process.

These features were used by Webfuse to implement changes to the default course sites in response to both top-down and bottom-up changes. In terms of top-down or management driven changes, the specification of the default course site could
be changed. For example, the inclusion of a course barometer (described in Section 5.3.6) in the initial default course site was part of a management driven attempt to increase formative feedback from students and subsequently improve the quality of learning and teaching (Jones, 2002). For various reasons, the barometer was removed from the faculty default course site in 2004. The addition and removal of the course barometer was done through simple changes to the default site skeleton.

Bottom-up changes to the default course sites also arose from the adopter-focused, emergent development process used by Webfuse. For example, when the CQU bookshop started providing a web site with details of set texts for courses, the CourseResources page was modified to include a link to the appropriate page on the bookshop web site. Such changes also arose from supporting and observing the use of the default course sites. For example, in 2004 a LectureRepository page was added to make it simple for staff to upload and distribute lecture slides.

From the initial development of the default course site approach in 2001, through to the final use of Webfuse for course sites in 2009, the vast majority of course sites used the same default course site skeleton. This skeleton did change considerably in terms of appearance and features over that time, but was used by essentially all default course sites. In 2007, the author undertook the development of two different default course sites, well after leaving the Webfuse development team. The home pages for these two different default course sites are shown in Figure 5.4 and Figure 5.16. The default course site in Figure 5.16 has a different look, but a fairly common structure. The default course site shown in Figure 5.4 was radically different and was referred to as the “Web 2.0” course site.
While the “Web 2.0” course site was implemented as a default site, including the use of Webfuse page types. Webfuse did not implement any of the functionality including discussion, wiki, blog, portfolio, and resource sharing. Instead, freely available and externally hosted Web 2.0 tools and services provided all of the functionality. For example, each student had a portfolio and a weblog provided by the site http://redbubble.com. The content of the default course site was populated by using BAM (discussed in section 5.3.6) to aggregate RSS feeds (generated by the external tools) which were then parsed and displayed by Javascript functions within the course site pages. Typically students and staff did not visit the default course site, as they could access all content by using a personal news-reader to view the RSS feeds.

Figure 5.4. Web 2.0 Course site (2007).
5.3.6. **Workarounds**

The adopter-focused, emergent development process adopted by Webfuse during this period led to the implementation of a large number of contextually specific interventions. The majority of these interventions were not strategic projects identified by management. Instead, they were “workarounds” that arose in response to factors or changes that became evident during the use and support of Webfuse. These interventions range from low-level technical changes, through ad hoc combination and integration of existing workarounds, to the implementation of large and complex applications that were later adopted as official, institutional information systems. The breadth and diversity of these interventions illustrate how Webfuse was able to respond quickly to local problems and opportunities. This section provides an overview of a number of these workarounds.

**Student numbers and student usernames**

CQU, like many other universities, has adopted the practice of assigning students unique student numbers as usernames for accessing institutional information systems. Due to contextual reasons, however, from 2000 through 2009 CQU had two different types of student number. The initial (pre-Peoplesoft) student numbers started with the letter Q or a C, followed by 8 numbers. For some students, the last number might be the letter X. From 2001 onwards, after the implementation of the Peoplesoft student records system, the second type of student number started with the letter S and was followed by 7 numbers. The first set of student numbers had 9 characters, while the second set had 8 characters.

The length of the first student numbers created problems for Windows-based authentication systems adopted around 2000. Such systems had a limit for usernames of 8 characters. This limit meant that initially students had to be told
that they should leave off the last character of their student number when logging in. The introduction of the 8 character long Peoplesoft student numbers in 2001 complicated these instructions further. Students with Peoplesoft student numbers had to be told not to leave off the last character. The Windows-based authentication systems were not flexible enough to deal with this variety and the task was pushed back onto users. The design pattern-based, OO design of the Webfuse authentication system provided significant more flexibility. Over time, the authentication system was modified to automatically handle most combinations of student numbers, including the handling of situations where students left the caps lock key on.

**Evolution of Webfuse user authentication and access control**

The evolution of the Webfuse authentication system to handle different student usernames is only one example of its evolution. Jones, Lynch, and Jamieson (2003) use the evolution of the Webfuse user authentication sub-system to illustrate the design for repair, not replacement, ethos adopted by Webfuse. Table 5.3 is a summary of the changes made to the user authentication system up until 2003. All these changes occurred without any apparent change from the users’ perspective and limited change in the Webfuse programming interface (Jones, et al., 2003).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Webfuse specific accounts</td>
<td>With no access to institutional systems, students had to have special Webfuse accounts.</td>
</tr>
<tr>
<td>Student records passwords</td>
<td>With access granted to the CQU student records system, students could use the same username/password combination to access student records and Webfuse.</td>
</tr>
<tr>
<td>CQU domain accounts</td>
<td>The advent of and access to a central Windows NT domain infrastructure allowed CQU staff to access Webfuse via their</td>
</tr>
</tbody>
</table>
The adoption of PeopleSoft in 2001 meant a change in how student account details were checked. Including working with both 8 and 9 character usernames.

In the initial months, the PeopleSoft database was barely available from 9-5 on weekdays. To enable 24x7 access to Webfuse, student account details were cached on the Webfuse server.


Access to institutional data

One of the lessons learned identified during the initial period of Webfuse use and described in Chapter 4 was the observation that Webfuse was limited in how well it was integrated with other institutional systems, in particular how limited it was in its access to other institutional data. The creation of both the interactive Web applications and the default course sites required greater access to institutional data. Gaining access to this data was achieved through one or a combination of: page or screen scraping (Alba, Bhagwan, & Grandison, 2008); manual data entry from one computer-based source to another; local caching and value-adding; and, merging of different institutional data sources. In a number of cases, there was no existing data source. For example, there was no institutional source for information about who was teaching what course where and in what role. In these cases, Webfuse became the primary source for this information.

Table 5.4 provides a summary of from where and how Webfuse gained access to a range of institutional information sources. Screen scraping was used when the Infocom Web team were not allowed to gain access to the database storing the information, or when there was no database. For example, there was no single data source for on-campus timetables. The main CQU campuses used software, which relied on a proprietary file format, not a database, to store information, but...
did produce Web pages. To produce the timetable generator Wf application, these Web pages were scraped and the data inserted into a Webfuse database.

Even when a database connection was available, it was not always the best data source. For example, during 2001 and 2002 the institutional student records system was generally only available during business hours. In addition, there were often significant delays between when a student enrolled in a course and when that enrolment was represented in the database. To work around these limitations, the Infocom Web team implemented a local cache of the PeopleSoft database that was updated early every morning. This local cache database ensured availability, and also enabled the addition of the “temporary enrolment” feature described above.

Table 5.4. Institutional information, sources and methods.

<table>
<thead>
<tr>
<th>Information</th>
<th>Institutional Source</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course synopsis</td>
<td>University handbook web site</td>
<td>Screen scrape web site</td>
</tr>
<tr>
<td></td>
<td>Handbook database</td>
<td>Database connection</td>
</tr>
<tr>
<td>Student records information</td>
<td>Student records system</td>
<td>Database connection</td>
</tr>
<tr>
<td></td>
<td>PeopleSoft student records system</td>
<td>Database connection After initial unreliability, implemented local cache</td>
</tr>
<tr>
<td>Course assessment details</td>
<td>Course profiles</td>
<td>Manual data entry from within faculties</td>
</tr>
<tr>
<td></td>
<td>Course profile system</td>
<td>Database connection</td>
</tr>
<tr>
<td>Teaching responsibilities</td>
<td>None</td>
<td>Webfuse as primary source</td>
</tr>
<tr>
<td>Staff details</td>
<td>None</td>
<td>Webfuse as primary source</td>
</tr>
<tr>
<td></td>
<td>AIC teaching responsibilities</td>
<td>Merged with Webfuse source</td>
</tr>
<tr>
<td>Course profile</td>
<td>PDFs</td>
<td>Uploaded to Webfuse Web server in specific place</td>
</tr>
<tr>
<td></td>
<td>Course profile system</td>
<td>Links to profiles in profile system</td>
</tr>
</tbody>
</table>
The diversity inherent in CQU’s organisation, especially the distinction between traditional campuses and the Australian International Campuses (AICs) – owned and operated by a commercial partner – often meant there were multiple institutional information sources. For example, the AICs used their own systems for teaching responsibilities and timetabling. The traditional CQU campuses used a different timetabling system, but had no teaching responsibilities database. The Infocom Web team had to merge these different data sources into the one database.

**Staff MyCQU, student records and results upload**

Prior to the implementation of Peoplesoft, CQU provided academic staff with InfoWeb, a simple Web-based application that provided access to the student records system. InfoWeb allowed staff to: search for information on particular students; download course lists; and, upload results at the end of term. For various reasons, the PeopleSoft implementation project did not provide an InfoWeb replacement and when PeopleSoft went live, Infoweb was replaced with use of the PeopleSoft desktop interface (Jones et al., 2004). This interface was: time consuming; confusing and difficult; restricted to use on the CQU network; only usable via a computer running Microsoft Windows; and, was seen by academic staff as a significant step backwards (Jones, 2003b).

By mid-October 2001, near the end of the first term after the PeopleSoft go live, a new process for the uploading of final student results was introduced. Within Infocom, there were significant concerns about this process. In particular, the process introduced significant workload implications and significantly increased

<table>
<thead>
<tr>
<th>Timetable</th>
<th>Various information sources</th>
<th>Screen scaping from some, database connection for others</th>
</tr>
</thead>
</table>
the potential for human-error. These concerns resulted in the development of a Webfuse results uploading system designed to be: significantly simpler to use than the equivalent PeopleSoft process; provide support for faculty specific requirements; and, integrate with the PeopleSoft Higher Education system (Jones et al., 2004). The system was developed in just over a month and was used for the first time in November 2001. By the end of 2009, over 340 different staff uploaded their final results for over 58,000 distinct students in over 3800 course offerings.

By the end of 2001 it became obvious that the PeopleSoft access to student records was causing problems. For example, to generate a list of student details for a course required: a 26-step process; two separate applications that could only be run on a Windows-based computer; knowledge of internal data representations not in common use by academics; and, a time investment of over 20 minutes (Jones, 2003b). In early 2002, a new member of the Infocom Web team was given the task of developing a Webfuse interface to the student records system as a training task. Within a month the interface was available and being used by staff (Jones et al., 2004). Initially known as MyInfocom, the system evolved to act as the staff portal as well as providing access to a range of faculty features and services.

By August 2002, another faculty requested access to MyInfocom for their staff. The integration of MyInfocom with specific Infocom services meant that access to MyInfocom would be confusing for non-Infocom staff. Instead, the design patterns-based, OO design of the Wf framework made it possible to provide MyCQU, a version of MyInfocom with the Infocom specific features removed. By 2005 the distinction between MyInfocom and MyCQU was removed and
MyCQU increasingly became a centrally supported, system key to university operations. As of 2010 MyCQU is still functioning as the staff portal for CQU academic and general staff.

A key reason for the continued support of MyCQU was the use of the Wf framework to develop a number of institutional systems from 2005 onwards. These institutional systems were accessed via MyCQU and included the following systems:

- **Academic Misconduct Database**
  
  Used to store, track, and manage incidents of student misconduct

- **Academic Staff Allocations**
  
  Used to store, track, and manage details of which staff were teaching which courses and at which campuses

- **Assignment Extensions System**
  
  Used to request, manage, and track student requests for extensions to assignments.

**Other Wf applications**

The emergent, adopter-focused process for the identification and development of Wf applications lead to the creation of over 20 different applications. Each of these applications were developed in response to an identified problem or requirement. The following offers a brief description of some of these applications.

The **course barometer** was a Web-based application designed to provide students a simple, anonymous method for providing informal feedback about their feelings
toward a course while it was being taught (Jones, 2002). Initially used on an ad hoc basis based on the preference of the academic, the barometer became a required part of the default course site in 2001. Its use was subsequently actively supported and encouraged by the faculty (Jones, 2003a). From 2005 onwards the barometer once again became an optional part of a Webfuse course site. In 2007/2008, CQU used the barometer as part of an attempt to encourage formative feedback in both Webfuse and Blackboard.

The **timetable generator** allowed students and staff to automatically generate a personal, on-campus, class timetable. The generator combined various institutional information systems so that it knew which campus students or staff were located as well as which courses they were studying or teaching. This integration allowed the generator to automatically produce customised timetables for all staff and students.

The **Email merge** application allowed staff to create and send the same email message to a list of selected students (Jones, 2003b). The content of the message could be modified based on information specific to each student drawn from the student records system. As such, the application provided a balance between the ease of bulk email with the individual focus of individual email.

The **Informal Review of Grade** (IROG) application allowed students to apply for an informal review of their final grade via a Web-based form. The IROG application allowed each student’s IROG to be examined and approved by appropriate staff. The IROG application was developed within 3 weeks to replace an inefficient and error-prone paper-based process which was causing problems
due to the significant geographical distances between CQU’s campuses (Jones, 2003b).

**Blog Aggregation Management** (BAM) was an application that allowed students to create individual, externally hosted Web-logs (blog) and use them as reflective journals. Students registered their external blog with BAM, which then mirrored all of the students’ blog posts on an institutional server and provided a management and marking interface for teaching staff. Created by the author for use in his own teaching in 2006, BAM was subsequently used in 26 course offerings by 2050+ students (Jones & Luck, 2009).

The Online Assignment Submission, Infocom System (**OASIS**) supported the submission, management, and return of student assignments. It replaced the physical submission of assignments that was, due to CQU’s multi-campus nature and its distance education students, somewhat problematic. Arising out of early attempts using email to reduce turnaround times on the assignments for distance education students (Jones & Jamieson, 1997), OASIS went through five different generations of development as described by Jones and Behrens (2003) with the last generation described as evolutionary development (aka emergent development as described above). The evolutionary/emergent development of OASIS was through “an on-going process of discussion with the users allowing the system to grow and meet their needs as they arise” (Jones, Cranston et al., 2005, n.p.).

**Combinations and integration**

A major benefit of the Wf framework and its design pattern-based, object-oriented design was that it enabled rapid development of new applications. A second
benefit of this design was that it also enabled the mix and match of different applications, technologies and views. The following provides three examples of this: grouping students by date of enrolment; supporting multiple discussion forums in Blackboard; and, integration with page types and course sites.

**Grouping by date of enrolment.** Figure 5.5 shows a part of the standard class list page provided by Webfuse. This page shows a range of details concerning students enrolled in a particular course. This page was frequently used by teaching academics to discover more about their students. As it stands, Figure 5.5 contains a number of examples of the Webfuse ability to combine and integrate different services. For example, at the top of Figure 5.5 there is a button “Mail Merge.” The email merge facility described above was designed to be able to take a list of student numbers from any application. Once the email merge facility was completed the “Mail Merge” button was added to the class list page allowing staff to email all students in the course. In addition, if staff were to narrow the class list to a particular campus, the “Mail Merge” button would only work with the appropriate subset of students.

![Course List](image)

*Figure 5.5. MyCQU class list ordered by name.*
By 2006, some academic staff were using this facility to send a “welcome to the course” email to students in the course. The purpose of such an email was to create an initial social connection with the students as well as provide students with some initial guidance on what they should be doing. This “welcome” email approach was somewhat complicated by the likelihood that students could enrol in a course at times ranging from months before the start of term until two weeks (and sometimes more) after the term had started. Sending the email too early would miss some students, sending the email too late and students may already have started feeling lost. Sending multiple copies of the same message to students could be overwhelming.

Figure 5.5 shows the initial and only view of the Class list, one that is sorted by student name. In 2006, the Model-View-Controller architecture of the Wf framework was used to create a view of the class list sorted by date of enrolment (Figure 5.6). Not only did the Wf framework’s pattern-based, object-oriented design mean that this new view was trivial to create, it also enabled the multiple uses of the “Mail Merge” button in Figure 5.6 to work with no modification.

![Course List](image)

*Figure 5.6. MyCQU class list ordered by enrol date.*
Supporting multiple discussion forums within Blackboard. In 2007, a CQU curriculum designer created a design for a course using the Blackboard LMS. The design required the division of the hundreds of students in the course into small groups. Each group would have its own portion of the course site. Within each group site it was required that a number of separate discussion forums be available to serve very different instructional purposes. This instructional design could not be implemented with the Blackboard LMS due to how group discussion forums worked. Rather than drop the design, the adopted solution was to create the individual discussion forums within Webfuse and integrate them into Blackboard. Figure 5.7 shows the Blackboard course site and one of the Webfuse discussion forums used by one of the groups.

Figure 5.7. Webfuse discussion forum integrated into a Blackboard course site.

Integration with page types and course sites. As mentioned above, the use of a design pattern-based, object-oriented design was used in both the Wf framework and the next iteration of the Webfuse page types. Beyond developing a better
framework for developing page types, this practice also enabled integration between page types and Wf applications. For example, Figure 5.8 shows part of the page update form for the CourseHome page type. The table showing the number of students at each campus for this course is provided by code first used for Wf applications. Another approach to integration is provided by the “Get CSV Course List” and “Add Students” links on the page update form in Figure 5.8. Each of these links is to specific parts of different Wf applications.

Figure 5.8. Page update process for CourseHome page type.

5.4. Evaluation

The previous section described a range of the interventions that were undertaken as part of the development and support of Webfuse from 2000 through 2009. In order to more easily compare this evaluation with that provided in Chapter 4, the following is organised using the five original requirements for Webfuse used in
Chapter 4. Table 5.5 provides a summary of these requirements and the results of the evaluation reported in the following sections.
Table 5.5. Summary of Webfuse evaluation (2000–2009).

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Web publishing tool (Section 5.4.1)</td>
<td>Decreasing use of Webfuse as Web publishing tool. Webfuse really only used on Infocom web site. Significant percentage of Infocom site pages (61%) and requests (49%) associated with teaching.</td>
</tr>
<tr>
<td>A comprehensive OLE (Section 5.4.2)</td>
<td>Webfuse seen as “best thing about teaching and learning” in 2003 annual report. Course site feature adoption regularly exceeds adoption of other systems and contexts. Including significant adoption by non-Webfuse courses. In 2001, there are almost 6.5 million hits on Webfuse course sites. Wf applications widely adopted across the institution.</td>
</tr>
<tr>
<td>Eclectic, yet integrated (Section 5.4.3)</td>
<td>Staff MyCQU application became “portal” for majority of CQU staff enabling access to an eclectic range of functionality. BAM and Web 2.0 course sites enable integration of external applications. Significant political barriers to integration with some institutional systems.</td>
</tr>
<tr>
<td>Flexible and support diversity (Section 5.4.4)</td>
<td>Changes in Webfuse product/process significantly increased flexibility leading to increased feelings of involvement from staff and diverse collection of applications and diversity in default course sites.</td>
</tr>
<tr>
<td>Encourage adoption (Section 5.4.5)</td>
<td>Significant increases in both staff and student usage. Usage spread beyond courses using Webfuse to become institutional system.</td>
</tr>
</tbody>
</table>

### 5.4.1. A Web publishing tool

As described in Chapter 4, the original design of Webfuse included a specific aim that it be able to act as a general Web-publishing tool. This ability of Webfuse was then used from 1997 through 1999 to manage and publish a range of large, often multi-author web sites summarised in Table 4.13. By 2000, Webfuse use as a Web publishing tool was restricted to the organisational web site of Infocom (including course web sites) and the author’s personal web site. By 2005 or 2006, management of faculty web sites was done by an institutional system, with Webfuse limited to course web sites. While this change was primarily an organisational decision, it also represented the reduced focus on Webfuse as a...
Web-publishing tool during this period. The limitations of Webfuse as a
Web-publishing tool identified in Chapter 4 were not completely addressed during
this period. Instead the focus for Webfuse was primarily on learning and teaching
applications including Wf applications and default course sites. As of 2004,
however, Webfuse was still managing the quite large Infocom web site. Table 5.6
breaks the Infocom web site as of 2004, into a number of sections and shows the
number of requests and documents for each of those sections.

Table 5.6. Infocom Web site categories, documents, and requests (2004).

<table>
<thead>
<tr>
<th>Category</th>
<th>Requests</th>
<th>Documents</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching</td>
<td>1,062,909</td>
<td>68,659</td>
<td>Course web sites and other pages used in teaching</td>
</tr>
<tr>
<td></td>
<td>(49%)</td>
<td>(60.7%)</td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>262,005</td>
<td>1</td>
<td>The web site home page</td>
</tr>
<tr>
<td></td>
<td>(12.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mailing lists</td>
<td>191,563</td>
<td>11,966</td>
<td>Archives of misc. non-teaching mailing lists</td>
</tr>
<tr>
<td></td>
<td>(8.8%)</td>
<td>(10.6%)</td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>163,449</td>
<td>2218</td>
<td>Home pages for faculty staff</td>
</tr>
<tr>
<td></td>
<td>(7.5%)</td>
<td>(2%)</td>
<td></td>
</tr>
<tr>
<td>Student support</td>
<td>55,090</td>
<td>762</td>
<td>Information to help students studying within the faculty (not directly teaching related)</td>
</tr>
<tr>
<td></td>
<td>(2.5%)</td>
<td>(0.7%)</td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>37,819</td>
<td>570</td>
<td>Faculty research pages</td>
</tr>
<tr>
<td></td>
<td>(1.7%)</td>
<td>(0.5%)</td>
<td></td>
</tr>
<tr>
<td>Publicity</td>
<td>37,816</td>
<td>338</td>
<td>Information about studying</td>
</tr>
<tr>
<td></td>
<td>(1.7%)</td>
<td>(0.3%)</td>
<td></td>
</tr>
<tr>
<td>Tech support</td>
<td>18,774</td>
<td>508</td>
<td>Support for using all technology in faculty</td>
</tr>
<tr>
<td></td>
<td>(0.9%)</td>
<td>(0.4%)</td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td>6421</td>
<td>608</td>
<td>Intranet, meeting minutes and other administrative uses</td>
</tr>
<tr>
<td></td>
<td>(0.3%)</td>
<td>(0.5%)</td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td>1707</td>
<td>59</td>
<td>Various community related projects</td>
</tr>
<tr>
<td></td>
<td>(0.1%)</td>
<td>(0.1%)</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.6 illustrates how much of a focus teaching and learning was for Webfuse
use and support. The teaching section is by far the largest category in terms of
number of documents (almost 61% of all documents) and requests (49% of all
documents). Later sections (e.g., Section 5.4.2) will provide more detail on how
heavily these course sites were used by both staff and students.
5.4.2. A comprehensive OLE

As described in Chapter 4 (Table 4.3 and Section 4.3.2) a primary aim for Webfuse was to provide a single, integrated interface for all learning and teaching activities and resources. Work from 2000 through 2009, especially from 2001 through 2004 with the expanded Infocom Web team, was aimed at expanding on earlier work and addressing known limitations. The increased adopter-based (Section 5.3.1) and emergent (Section 5.3.2) focus for the Webfuse development process as well as the changes to the design of the Webfuse system (Sections 5.3.3 and 5.3.4) were the main mechanisms for achieving this goal. This work led to a greater focus on rapidly integrating the system with the requirements of staff and students, and subsequently providing better support for the concept of a course through the default course sites and a range of Wf applications.

The overall success of this work is illustrated by a quote from the Infocom annual report for 2003 cited by (Danaher et al., 2005, p. 39)

> [t]he best thing about teaching and learning in this faculty in 2003 would be the development of technologically progressive academic information systems that provide better service to our students and staff and make our teaching more effective. Webfuse and MyInfocom development has greatly assisted staff to cope with the complexities of delivering courses across a large multi-site operation.

The following sub-sections provide additional support for the success of the work in implementing an integrated, online learning environment. These three sections examine: the number of course sites created; the spread of feature adoption within those course sites; and, how much the course sites were used by staff and
students. These sub-sections match those used in Section 4.5.2 and enable a comparison between what happened in the two periods. The final sub-section covers usage of the interactive Web applications that were first implemented in 2000.

**Course sites**

From the start, all courses offered by the faculty using Webfuse had course web sites created for them. This practice continued with the default course sites. The major difference being that with the development of the default course site approach, the creation of the course sites was automated. While the creation of default course sites was entirely automated, the gathering of all the necessary data from various institutional sources in order to create the course sites was not. This problem of limited integration is picked up again in section 5.4.3.

Table 5.7 shows the number of course sites created in Webfuse from 1997 through 2009. It also shows the number and percentage of courses that were created outside of Webfuse. From 2001 onwards these were created as real course sites. As a comparison, by the end of 2003 there were 141 course sites being hosted in the official CQU institutional LMS, WebCT. These statistics mean that at the end of 2003, after 3 years of using WebCT, only 15% of all non-Infocom courses had WebCT course sites.

The introduction of the default course site approach did not increase the percentage of Infocom courses with course web sites. It did, however, expand the default level of information and services available through those course sites. In the last term before implementation of the default course site approach, a standard Webfuse course site provided: a course synopsis; a link to the course profile;
details about course coordinator; and if used, a Web-based archive of a mailing list. The default course site design described in Section 5.3.5 added a range of additional information (e.g., assessment item details) and services (e.g., each course had a course barometer). A manually created default site had a minimum of three pages. A default course site had a minimum of 10. In both types of course sites, academics could then choose to add further to the initial course web site. The average number of pages per Webfuse course site increased from 7 in 2000 to 17 in 2001 (the first full year using default course sites).

Table 5.7. Comparison between default course sites and real course sites (2002–2009).

<table>
<thead>
<tr>
<th>Year</th>
<th>All courses</th>
<th>Real course sites</th>
<th>% Real course sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>110</td>
<td>3</td>
<td>2.7%</td>
</tr>
<tr>
<td>1998</td>
<td>142</td>
<td>7</td>
<td>4.9%</td>
</tr>
<tr>
<td>1999</td>
<td>192</td>
<td>8</td>
<td>4.2%</td>
</tr>
<tr>
<td>2000</td>
<td>176</td>
<td>13</td>
<td>7.4%</td>
</tr>
<tr>
<td>2001</td>
<td>244</td>
<td>16</td>
<td>6.6%</td>
</tr>
<tr>
<td>2002</td>
<td>312</td>
<td>27</td>
<td>8.7%</td>
</tr>
<tr>
<td>2003</td>
<td>302</td>
<td>29</td>
<td>9.6%</td>
</tr>
<tr>
<td>2004</td>
<td>328</td>
<td>16</td>
<td>4.9%</td>
</tr>
<tr>
<td>2005</td>
<td>300</td>
<td>15</td>
<td>5.0%</td>
</tr>
<tr>
<td>2006</td>
<td>297</td>
<td>15</td>
<td>5.1%</td>
</tr>
<tr>
<td>2007</td>
<td>251</td>
<td>4</td>
<td>1.6%</td>
</tr>
<tr>
<td>2008</td>
<td>225</td>
<td>2</td>
<td>0.9%</td>
</tr>
<tr>
<td>2009</td>
<td>211</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Note: Archives of course sites for 1 term in 1998 and 2000 are not available.

Features used in course sites

This section seeks to examine more closely the level of specific Webfuse feature adoption within courses. The examination uses the Malikowski et al. (2007) model introduced in Chapter 4. A model that abstracts LMS features into five system independent categories (Figure 4.8). This sub-section first describes the changes in the available Webfuse features – both through new Webfuse page
types and Wf applications – from 2000 onwards in terms of the Malikowski et al. (2007) model. It then outlines how Webfuse feature adoption within course sites changed over the period from 2000 through 2004 and compares that with other systems at other institutions. Finally, it compares and contrasts feature adoption during 2005 through 2009 at CQU between Webfuse and Blackboard. It finds that feature adoption in Webfuse occurred earlier and at higher levels than found both outside and within CQU. It finds significant adoption of Webfuse features in courses not using Webfuse to host the course site.

Table 4.16 lists four of the five Malikowski et al. (2007) LMS feature categories and lists the Webfuse features within those categories divided between the two time periods. The 2000 onward features included features provided by both page types and Wf applications. As described in Chapter 4, the fifth Malikowski et al. (2007) category – Computer-Based Instruction – is not included in the following discussions because Webfuse never provided features that fitted within this category. In addition, Malikowski et al. (2007) found it to be a category of feature rarely present or used in other LMSs.

|--------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Transmitting content           | Various content and index page types  
Lecture and study guide page types  
File upload and search page types | CourseHome  
CourseResources  
CourseSchedule  
CourseStaff  
CourseAssessment  
RSSUpdates  
LectureRepository  
Timetable generator (Jones, 2003b) |
| Creating class interactions    | Email2WWW  
EwgieChatRoom  
WWWBoard and WebBBS | YaBB  
CourseGroup, CourseGroups  
CourseMailingLists  
Email Merge  
Etutes |
| Evaluating students            | AssignmentSubmission | Quiz  
Assignment extension management  
Academic misconduct database  
OASIS (Jones & Behrens, 2003)  
BAM (Jones & Luck, 2009)  
Plagiarism detection  
IROG (Jones, 2003b)  
Peer Review  
Topic Allocation |
| Evaluating course and instructors | Barometer  
UnitFeedback/FormMail | Survey |

*Note:* Archives of course sites for 1 term in 1998 and 2000 are not available. A variety of contextual factors and limitations are necessary to understand the data presented in Table 5.9. These include:

- **missing course sites**

  As mentioned in previous tables both the course web site archives for 1998 and 2000 are each missing course sites for a single term. The percentages shown in Table 5.9 represent the percentage of courses offered in the terms for which archival information is available.
missing mailing lists
For most of the period shown in Table 5.9 a significant proportion of courses made use of electronic mailing lists for course communication. These lists, while supported by the Webfuse team, did not have an automated Web interface until after the introduction of the default course sites. Information about the use of mailing lists before the default course sites is somewhat patchy. With none available before 2000 and only some information for 2000 and the first half of 2001.

optional versus compulsory content transmission
All Webfuse course sites, including both manually produced sites (pre 2nd half of 2001) and the default course sites (post 2nd half of 2001) used content transmission features. Rather than simply show 100%, Table 5.9 shows the percentage of courses where teaching staff made the optional decision to place additional content onto the course site.

the definition of adoption and the course barometer
From 2001 through 2005 the presence of a course barometer was part of the Infoccom default course site. Inclusion of the barometer within the default course site means that 100% of all Webfuse course sites had a course barometer. This is not, however, represented in the figures for “evaluating courses and instructors” in Table 5.9. Instead, Table 5.9 includes the percentage of courses where the course barometer was actually used within the course by students.

greater than 100% adoption
From 2006 onwards, both the class interactions and evaluating students
columns suggest that greater than 100% of Webfuse course sites had adopted features in these categories. An adoption figure of more than 100% is possible due to the ability of courses to use a number of the Webfuse provided features (e.g., email merge and results upload) without using Webfuse for course sites.

Table 5.9. Feature adoption in Webfuse course sites (1999-2004).

<table>
<thead>
<tr>
<th>Usage</th>
<th>Transmitting content</th>
<th>Class interactions</th>
<th>Evaluating students</th>
<th>Evaluating courses and instructors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malikowski %</td>
<td>&gt;50%</td>
<td>20–50%</td>
<td>20–50%</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>Blackboard %</td>
<td>94%</td>
<td>28%</td>
<td>17%</td>
<td>2%</td>
</tr>
<tr>
<td>1997</td>
<td>34.9%</td>
<td>16.5%</td>
<td>0.9%</td>
<td>9.2%</td>
</tr>
<tr>
<td>1998</td>
<td>38.4%</td>
<td>48.6%</td>
<td>1.4%</td>
<td>0.7%</td>
</tr>
<tr>
<td>1999</td>
<td>46.0%</td>
<td>43.7%</td>
<td>2.1%</td>
<td>9.5%</td>
</tr>
<tr>
<td>2000</td>
<td>46.6%</td>
<td>43.7%</td>
<td>24.7%</td>
<td>6.9%</td>
</tr>
<tr>
<td>2001</td>
<td>51.6%</td>
<td>32.4%</td>
<td>47.1%</td>
<td>28.3%</td>
</tr>
<tr>
<td>2002</td>
<td>69.6%</td>
<td>63.8%</td>
<td>57.7%</td>
<td>44.2%</td>
</tr>
<tr>
<td>2003</td>
<td>69.2%</td>
<td>68.5%</td>
<td>93.7%</td>
<td>37.7%</td>
</tr>
<tr>
<td>2004</td>
<td>61.3%</td>
<td>61.9%</td>
<td>91.8%</td>
<td>35.7%</td>
</tr>
<tr>
<td>2005</td>
<td>64.2%</td>
<td>69.2%</td>
<td>93.6%</td>
<td>39.8%</td>
</tr>
<tr>
<td>2006</td>
<td>70.0%</td>
<td>68.7%</td>
<td>105.1%</td>
<td>31.6%</td>
</tr>
<tr>
<td>2007</td>
<td>68.5%</td>
<td>102.0%</td>
<td>168.1%</td>
<td>33.1%</td>
</tr>
<tr>
<td>2008</td>
<td>72.9%</td>
<td>110.7%</td>
<td>192.0%</td>
<td>51.6%</td>
</tr>
<tr>
<td>2009</td>
<td>69.2%</td>
<td>105.7%</td>
<td>211.4%</td>
<td>42.7%</td>
</tr>
</tbody>
</table>

*Note:* Archives of course sites for 1 term in 1998 and 2000 are not available.

The following graphs (Figure 5.9, Figure 5.10, Figure 5.11, and Figure 5.12) provide a visual representation of the Malikowski et al. (2007) categories of feature adoption shown in Table 5.9. Each figure compares feature adoption within Webfuse from 1997 through 2009, Blackboard at CQU from 2005 through 2009, and the general adoption range found by Malikowski et al. (2007). For example, Figure 5.9 provides a representation of the adoption of content transmission features. The Malikowski et al. (2007) range is identified by the dotted lines and suggest that it is common to find between 50% and 100% of course sites using content transmission features. The dashed line in Figure 5.9 shows that from 2005 through 2009 between 80% and 100% of CQU Blackboard
course sites were using content transmission features. The thicker black line that includes data labels represents the percentage of Webfuse course sites where staff took the option to use additional content transmission features above what was already provided by the default course sites.

![Diagram of content transmission adoption rates](image)

**Figure 5.9.** Percentage course sites adopting content transmission: Webfuse (solid), Blackboard (dashed), and Malikowski et al. (2007) (dotted range).

From Figure 5.9 it is possible to see an increase from the optional use of content transmission features when the default course site approach was introduced during the second half of 2001. In 2002, the first full year of operation for the default course site approach, there was an increase of over 20% use of content transmission features over 2000, the last full year without the default course site approach. From 2002 the adoption rate of optional content transmission features within Webfuse course sites stayed above 60%.

Figure 5.10 shows the percentage of course web sites adopting class interaction features such as discussion forums, chat rooms etc. As of 2004, Malikowski et al. (2007) found that it was typical to find between 20% and 50% of course sites adopting these features. From 2005 through 2009, the percentage of Blackboard
courses adoption class interaction features increased from 28% through 61%. The data series with the data labels represents the adoption of class interactions within Webfuse course sites and highlights some of the limitations and contextual issues discussed above about Table 5.9.

Figure 5.10. Percentage course sites adopting class interactions: Webfuse (solid), Blackboard (dashed), and Malikowski et al. (2007) (dotted range).

As mentioned in the previous chapter, the Department of Mathematics and Computing (M&C) – in which the Webfuse work originated – had started using email lists in 1992 as a way of interacting with distance education students. These lists arose from the same place as Webfuse. As outlined above prior to 2001, the archives of these mailing lists were kept separate from the Webfuse course sites and records are somewhat patchy. For example, there are archives of the mailing lists for 1998, hence the peak of 48.6% in 1998. The 1.8% and 9% adoption figures for 1997 and 1999 represent years for which mailing list data is missing. In addition, the greater than 100% adoption rates in 2007–2009 arise from increased use of the email merge facility by courses that did not have Webfuse course sites. These courses accessed the email merge facility through Staff MyCQU.
Figure 5.10 shows that adoption of class interaction features were significantly higher within Webfuse than both the Malikowski averages and in Blackboard. Once adopted, it was unusual for a course mailing list to be dropped, unless replaced by a Web-based discussion forum. It is thought that complete archives of the pre-2001 mailing lists archives would indicate that as early as 1997, almost 50% of Webfuse course sites had adopted some form of class interaction. Most of this adoption arose from M&C courses continuing use of mailing lists. The increased adoption of class interaction features post 2002 arose from the increased prevalence of Web-based discussion, especially amongst non-M&C courses.

Figure 5.11 shows the percentage adoption of features related to student assessment – typically quizzes and online assignment submission. It shows that the typical Malikowski et al. (2007) adoption rate is expected to be between 20% and 50%. It shows that CQU Blackboard adoption from 2005 through 2009 ranged between 17% and 30%. On the other hand, Webfuse adoption after a minimal adoption in 1997 through 1999, increased to levels of over 90% from 2003 through 2005 before exceeding 100% from 2006 onwards.
The almost non-existent adoption of student assessment features within Webfuse from 1997 through 1999 is a reflection of the almost non-existent provision of these features. A primitive online assignment submission system was used in a small number of courses during these years, mostly those taught by the Webfuse designer. From 2000 onwards an online quiz system became available and a new assignment submission system was beginning to be developed. From this stage on adoption grew to over 90% in 2003. The use of Webfuse student assessment features far outstrips both the Malikowski ranges and those of CQU Blackboard courses.

Figure 5.12 shows the adoption of course evaluation features. It shows the expected Malikowski et al. (2007) range to be between 0% and 20%. The adoption of course evaluation features by CQU Blackboard courses ranges from 2% in 2005 through to 5% in 2009. Prior to 2001, the Webfuse adoption rate is less than 10%, but then increases to range between 28% and 52% from 2001 on. This increase is generally due to the increasing availability of the Webfuse course barometer feature (Section 5.3.6).
Figure 5.12. Percentage course sites adopting course evaluation: Webfuse (solid), Blackboard (dashed), and Malikowski et al. (2007) (dotted range).

Two of the peaks in the Webfuse adoption of course evaluation features from Figure 5.12 coincide with concerted efforts to encourage broader use of the course barometer. The 2002 peak at 44.2% coincides with the work of a barometer booster within Infocom during 2001 and early 2002 as described in Jones (2002). The 2008 peak of 51.6% coincides with a whole of CQU push to use the barometer for student evaluation purposes.

**Usage of course sites by staff and students**

This section seeks to examine in more detail the level of Webfuse course site usage by staff and students. Student usage (Table 5.10) is examined in terms of the number of requests for course information (course site hits). Staff usage (Table 5.11) is described in terms of the number of updates to information on the course site. It shows the measures used to represent staff and student usage increased significantly following the introduction of the default course sites. In following years, staff and student usage reduced until it remained at a level higher than before the introduction of the default course sites. Figure 5.13 provides a graphical representation of these trends. Please note, Web server logs from
January through to April 24 2005 have been lost and could not be included in these calculations.

As described in Chapter 4, the open nature of Webfuse course sites meant that visitors did not need to authenticate with a valid user account before accessing the majority of course site information. No requirement for authentication makes it impossible to identify exactly the level of student usage of course sites. Instead, as in Chapter 4, Table 5.10 uses the total number of requests (or hits) on the course sites as a proxy measure of student usage. The total number of hits includes requests from staff and the general public. It is expected that for most courses the majority of these hits would be from students. In Table 5.10 the number of hits on course sites is shown for each year of Webfuse operation along with the number of course sites and the number of student/courses (a single student enrolled in three courses represents three student/courses). As is shown in Table 5.10, the number of sites and student/courses varies considerably over the time period. To enable comparison Table 5.10 includes a column showing the number of course site hits per student/course for each year. This ratio is also shown graphically in Figure 5.13.
Table 5.10. *Hits on Webfuse course sites: 1997-2004.*

<table>
<thead>
<tr>
<th>Year</th>
<th># Sites</th>
<th># Stud/Courses</th>
<th>Course site hits</th>
<th>Hits per stud/course</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>108</td>
<td>7453</td>
<td>780,651</td>
<td>105</td>
</tr>
<tr>
<td>1998</td>
<td>229</td>
<td>14703</td>
<td>905,326</td>
<td>62</td>
</tr>
<tr>
<td>1999</td>
<td>189</td>
<td>16726</td>
<td>1,378,699</td>
<td>82</td>
</tr>
<tr>
<td>2000</td>
<td>205</td>
<td>24446</td>
<td>1,931,971</td>
<td>79</td>
</tr>
<tr>
<td>2001</td>
<td>244</td>
<td>37084</td>
<td>6,491,238</td>
<td>175</td>
</tr>
<tr>
<td>2002</td>
<td>312</td>
<td>42674</td>
<td>5,346,867</td>
<td>125</td>
</tr>
<tr>
<td>2003</td>
<td>302</td>
<td>35792</td>
<td>4,686,393</td>
<td>131</td>
</tr>
<tr>
<td>2004</td>
<td>328</td>
<td>33929</td>
<td>4,133,551</td>
<td>122</td>
</tr>
<tr>
<td>2005</td>
<td>299</td>
<td>37349</td>
<td>2,422,395</td>
<td>65</td>
</tr>
<tr>
<td>2006</td>
<td>297</td>
<td>30488</td>
<td>3,278,221</td>
<td>108</td>
</tr>
<tr>
<td>2007</td>
<td>251</td>
<td>18925</td>
<td>1,891,192</td>
<td>100</td>
</tr>
<tr>
<td>2008</td>
<td>225</td>
<td>14671</td>
<td>1,848,491</td>
<td>126</td>
</tr>
<tr>
<td>2009</td>
<td>211</td>
<td>14809</td>
<td>1,958,401</td>
<td>132</td>
</tr>
</tbody>
</table>

*Note:* Access logs for Jan through 24 April 2005 are unavailable.

Table 5.11 shows the number of updates to course web sites by academics.

Updates made by support staff such as the webmaster, helpdesk staff, or other administrative staff have been removed from this figure. A further exclusion from the data in Table 5.11 are the updates made by the author and designer of Webfuse to his course sites during the period from 1997 through 1999. Not surprisingly, the design of Webfuse was inherently interested in using Webfuse for teaching and subsequently his use of Webfuse was very high during this period. For example, in 1997, 1998, and 1999, the designer’s updates to his Webfuse course sites made up 39%, 27%, and 11% of the total Webfuse course site updates by teaching academics.

A further limitation, reflected in Table 5.11, is that is not possible to identify the percentage of academic staff making updates. This problem is due to the absence of any institutional system at CQU for accurately recording the total number of teaching staff for a set of courses. As a proxy for this figure, Table 5.11 shows the number of authors who updated their course sites. To enable some comparison of
updates per year, Table 5.11 also shows the average number of updates per course site for each year. This average is also shown graphically in Figure 5.13.

Table 5.11. Modifications to course web sites by academic staff (1997-2009).

<table>
<thead>
<tr>
<th>Year</th>
<th># Sites</th>
<th>Updates</th>
<th>Unique authors</th>
<th>Updates per site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>108</td>
<td>3415</td>
<td>19</td>
<td>32</td>
</tr>
<tr>
<td>1998</td>
<td>229</td>
<td>2835</td>
<td>34</td>
<td>12</td>
</tr>
<tr>
<td>1999</td>
<td>189</td>
<td>5383</td>
<td>36</td>
<td>28</td>
</tr>
<tr>
<td>2000</td>
<td>205</td>
<td>7002</td>
<td>50</td>
<td>34</td>
</tr>
<tr>
<td>2001</td>
<td>244</td>
<td>30858</td>
<td>70</td>
<td>126</td>
</tr>
<tr>
<td>2002</td>
<td>312</td>
<td>29318</td>
<td>100</td>
<td>94</td>
</tr>
<tr>
<td>2003</td>
<td>302</td>
<td>27248</td>
<td>101</td>
<td>90</td>
</tr>
<tr>
<td>2004</td>
<td>328</td>
<td>21405</td>
<td>79</td>
<td>65</td>
</tr>
<tr>
<td>2005*</td>
<td>299</td>
<td>14430</td>
<td>80</td>
<td>48</td>
</tr>
<tr>
<td>2006</td>
<td>297</td>
<td>23847</td>
<td>87</td>
<td>80</td>
</tr>
<tr>
<td>2007</td>
<td>251</td>
<td>20347</td>
<td>71</td>
<td>81</td>
</tr>
<tr>
<td>2008</td>
<td>225</td>
<td>18420</td>
<td>66</td>
<td>82</td>
</tr>
<tr>
<td>2009</td>
<td>211</td>
<td>16555</td>
<td>53</td>
<td>78</td>
</tr>
</tbody>
</table>

*Note: Access logs for Jan through 24 April 2005 are unavailable.*

Figure 5.13 provides a graphical representation of the trends for student (hits per student/course) and staff (updates per site) usage over the life-time of Webfuse. This representation shows a significant increase in both the staff and student usage in 2001, the year the default course sites were introduced. It also shows that after this year both staff and student usage reduced until settling at a level above that found prior to 2001. It also shows that changes in both staff and student usage followed a fairly similar pattern. In a context as complex as CQU (as described in Section 5.2) it is difficult to identify all factors that would influence these trends, or confidently attribute changes to particular factors. The size of the 2001 increase in usage, however, appears likely to be a result of the introduction of the default course sites and factor such as, but not limited to: the concerted effort to promote the new approach; the difference or novelty of the new approach; increasing
expectations and familiarity with the Web and e-learning; and, the attractiveness of the new approach.

Figure 5.13. Average usage – updates and hits – for Webfuse course sites 1997-2009. Note: Access logs for Jan through 24 April 2005 are unavailable.

**Usage of dynamic Web applications by staff and students**

As described in Section 5.3.4, a major addition to Webfuse from 2000 onwards was dynamic Web applications developed using the Wf framework. This section briefly illustrates (Table 5.12) and explains the usage of these dynamic Web applications by both staff and students from 2000 onwards. It shows how these applications enabled Webfuse to become a heavily used component of everyday learning and teaching within the entire institution, not just with staff using Webfuse course sites. The large number of requests, significant percentage of staff/students using Wf applications, the use of Wf applications by staff not using the Webfuse course sites, and the breadth of services provided by Wf applications suggests that the Wf applications have been very successful in improving the comprehensive OLE provided by Webfuse. In particular, the Wf applications have been instrumental in fulfilling one of the major lessons identified at the end of
Chapter 4 – “to be better integrated with the requirements and practice of academic staff and students.”

Table 5.12 provides a summary of Wf application usage for both staff and students from 2000 through 2009. It shows the number of unique students and staff using Wf applications and the number of requests made of Wf applications. By 2009, 59% of all students enrolled at CQU had used a Wf application. While difficult to give a similar percentage for staff – given the absence of any system tracking total number of teaching staff at CQU – a significant majority of CQU staff were also using Wf applications by 2009. There are, however, two other figures against which the 1169 staff using Wf applications in 2009 can be compared. These two figures are:

1. 1023 staff at CQU

The CQU AUQA Performance Portfolio (CQU, 2010) describes CQU has having 1023 staff broken up into 365 full-time equivalent (FTE) academic staff and 658 non-academic staff. What this figure does not capture is the range of staff employed by CQU partners and as casual teaching and support staff

2. 249 staff teaching courses with Webfuse course sites

It is possible to use a Webfuse database to determine a reasonably accurate number of staff associated with courses using Webfuse course sites. Table 5.14 uses this information to compare the number of users of Wf applications against the number of staff involved with courses using Webfuse course sites. In 2009, there was 249 staff associated with courses
with Webfuse course sites. Consequently, the figure of 1169 staff using Wf applications represents 469.5% of “Webfuse course site” staff.


<table>
<thead>
<tr>
<th>Year</th>
<th>Students</th>
<th>Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Users</td>
<td>Requests</td>
</tr>
<tr>
<td>2000</td>
<td>538</td>
<td>1888</td>
</tr>
<tr>
<td>2001</td>
<td>3361</td>
<td>27,936</td>
</tr>
<tr>
<td>2002</td>
<td>4210</td>
<td>39,805</td>
</tr>
<tr>
<td>2003</td>
<td>6115</td>
<td>206,884</td>
</tr>
<tr>
<td>2004</td>
<td>8664</td>
<td>491,136</td>
</tr>
<tr>
<td>2005</td>
<td>9937</td>
<td>461,999</td>
</tr>
<tr>
<td>2006</td>
<td>11,994</td>
<td>1,033,619</td>
</tr>
<tr>
<td>2007</td>
<td>10,810</td>
<td>820,847</td>
</tr>
<tr>
<td>2008</td>
<td>12,085</td>
<td>777,522</td>
</tr>
<tr>
<td>2009</td>
<td>12,342</td>
<td>900,870</td>
</tr>
</tbody>
</table>

Note: Access logs for Jan through 24 April 2005 are unavailable.

In 2000, the first and only Wf application was called TakeQuiz. As the name suggests, students used TakeQuiz to complete online quizzes. From 2000 through 2002, TakeQuiz was the dominant Wf application used by students accounting for 100% of student requests in 2000 and over 99% in 2001 and 2002. In 2000, staff use of TakeQuiz was limited to only two staff testing TakeQuiz to be familiar with the student experience.
The year 2001 saw the development of the initial Wf applications for staff. These included: the results upload application; a facility to generate a class list containing details of enrolled students; an initial online assignment management system; quiz management applications; and, an access control application for the web site. As described in Section 5.3.6 the results upload and class list functionality were implemented in response to difficulties arising from the introduction of a new student records system. In 2001, the top four Wf applications by staff requests were: results upload (53.4%); online assignment management (15.4%); class list (9%); and, access control (6.9%).

During 2002 the focus on developing Wf applications to better support academic staff continued with the development of Staff MyInfocom, a staff “portal” that initially provided staff with simple access to student records. The significant increase in staff usage of Wf applications in 2002 arises from the introduction of Staff MyInfocom. The top four Wf applications used by staff accounted for
almost 83% of staff usage. These were: Staff MyInfocom (41.3%); Online assignment management (33.5%); Quiz management (4.5%); and, results upload (3.5%).

The usefulness of Staff MyInfocom was such that by 2003, the staff from outside Infocom were asking for access. In response, a non-Infocom staff “portal” – Staff MyCQU – was developed. Staff MyCQU was essentially Staff MyInfocom minus some of the Infocom specific services. The top six Wf applications in 2003 by number of staff requests were: Staff MyInfocom (40%); Staff MyCQU (28.9%); Assignment management (15.9%); results upload (4.3%); informal review of grade (3%); and, quiz management (2.9%). A student “portal” – Student MyInfocom – was also developed in 2003, primarily to help students submit and track their online assignment submissions. The top three Wf applications in 2003 by number of student requests were: Student MyInfocom (55.5%); Take quiz (43%); and, the timetable generator (1.1%).

In 2004, the usage of Staff MyCQU exceeds that of Staff MyInfocom. In 2006, due to an organisational restructure, Staff MyInfocom becomes Staff MyCQU as the services provided become recognised as an institutional service. From 2006 onwards, Staff MyCQU was the most used Wf application by staff accounting for, on average, 75.5% of staff requests each year. Additional administrative Wf applications were added in 2005 – a system for tracking student academic misconduct incidents – and in 2007 – a system to manage student requests for assignment extensions. By 2009, the number of staff requests on Wf applications breaks the million mark.
5.4.3. **Eclectic, yet integrated**

As described in Table 4.3, the eclectic, yet integrated design guideline for Webfuse aimed to ensure that all services required for learning and teaching would be provided by an eclectic collection of tools and resources, brought together in an integrated whole. In the period 1997 through 1999, this eclectic, yet integrated guideline was achieved through the Webfuse page types. It was through the page types that course sites could be created and managed through a single interface, but still draw on services and functionality from an array of different sources. In evaluating the performance of Webfuse against this principle during 1997 through 1999, Section 4.4.3 identifies three shortcomings:

1. The implementation of page types was not all that adaptable and flexible;
2. There was no support for interactive Web applications; and
3. There was limited integration with other institutional systems.

The less than adaptable implementation of page types is picked up in Section 5.4.4 when evaluating the ability of Webfuse to be flexible and support diversity. Support for interactive Web applications was implemented during 2000 through 2004 (Section 5.3.4). The previous section provided a summary of how much these applications were used during this period. This summary showed that the interactive Web applications became a key component of the Webfuse approach to being ‘eclectic, yet integrated’. For many academic staff across the whole institution, not just those within Infocom, Staff MyCQU became the initial launching point for learning and teaching. It became the integrating point for all staff, not just those using the Webfuse course sites.
As outlined in the Workarounds section (Section 5.3.6) various different strategies were employed to integrate Webfuse with institutional data sources and systems. As a consequence, a significant amount of integration of Webfuse with institutional systems was achieved (Table 5.4). Webfuse’s position as a faculty system (prior to 2007) rather than a “whole of university” system, however, provided significant barriers to achieving this integration. In some cases, it was possible to work around these barriers. This often resulted in additional development time as well as the introduction of duplication and potential human error into the process.

Jones, Behrens, Jamieson, and Tansley (2004) describe two incidents during 2000 through 2009 that illustrate some of the on-going integration difficulties with institutional systems. The first occurred during 2002. The proven benefits of Staff MyCQU were such that the central IT division and the Webfuse development team were encouraged to identify how MyCQU’s features could be made available to the institution. The central IT division’s position was that the only way this could happen would be for them to take over responsibility and re-implement all of the MyCQU services within the institution ERP. The Webfuse development team’s argument was that this duplication was wasteful and that the nature of the ERP system meant it unlikely that the re-implemented services would remain easy to use. Before this disagreement could be resolved, other requirements meant the central IT resources were not available for the re-implementation during 2002. The question of re-implementation was never again actively considered. In 2007, the Webfuse development team became part of the central IT division with Webfuse officially becoming an institutional system. At
the time of writing this thesis in 2010, CQU is embarking on a major project to replace and expand the services provided by the Webfuse Wf applications.

The second incident was the shutting down of Staff MyCQU due to known limitations in the integration with institutional data sources. In August, 2003 the Vice-Chancellor of CQU received a complaint from a senior staff member about the inaccuracy of information within Staff MyCQU. As a result the Deputy Vice-Chancellor (Resources) ordered the immediate shut down of all student information services provided by Staff MyCQU. Subsequent discussions identified the absence of exemption information – lists of courses a student did not need to complete due to recognition of prior learning – as the cause of the inaccuracy. This information was not provided in the view of the institutional database provided to Webfuse. Numerous requests to be provided with the information had been rejected. Subsequently, the addition of a warning message describing the absence of exemption information enabled the re-opening of Staff MyCQU.

The development of the Blog Aggregation Management (BAM) Wf application (p. 289) and the Web 2.0 course site (p. 279) are examples of how Webfuse was able to support a different form of eclectic integration. These innovations were examples of Webfuse extending itself to work with the next generation of Web applications, the so-called Web 2.0 (O’Reilly, 2007). In doing so, both applications were able to integrate an eclectic collection of externally hosted applications into a single Webfuse interface. Prior to these applications, Webfuse was limited to integration of applications running on institutional computers. In both cases, students were able to use their choice of application running on any public computer. At the same time, the integration enabled by Webfuse helped the
university to fulfil an institutional purpose. For BAM, the purpose was the management of the process of marking individual student blogs. For the Web 2.0 course site, the purpose was the provision of a central institutionally owned and branded site for the course.

5.4.4. Flexible and support diversity
As described in Section 4.3.4, this original design guideline for Webfuse was based on the recognition that diversity and continual change were inherent in Web-based learning. This section seeks to describe how well the changes to the Webfuse process and product models from 2000 onwards improved the ability for Webfuse to be flexible and support diversity.

Flexibility of Wf applications
The workarounds described in Section 5.3.6 provide the best evidence of Webfuse’s improved flexibility, in particular, the development of Wf applications such as the Informal Review of Grade (IROG) and Results Upload applications. The development of both these applications was not planned. Instead, the need for these applications arose from the on-going, close interaction of the Webfuse development team and faculty staff. The applications themselves were initially developed in very short time frames to solve immediate institutional problems and then further evolved over time. This on-going flexible evolution of Wf applications in response to user need is also evident in the on-going evolution of Staff MyCQU.

The quality of this work is evident from the level of system usage shown in the previous section. It is also shown through this quote by a Webfuse user from Behrens (2009, p. 126)
I remember talking to [a Webfuse developer] and saying how I was having these problems with uploading our final results into [the Enterprise Resource Planning (ERP) system] for the faculty. He basically said, “No problem, we can get our system to handle that”… and ‘Hey presto!’ there was this new piece of functionality added to the system … You felt really involved … You didn’t feel as though you had to jump through hoops to get something done.

Recognition of Webfuse’s flexibility and its benefits is also evident in this quote, also from Behrens (2009, p. 126). The quote comes from one of the managers responsible for the CQU ERP

We just can’t react in the same way that the Webfuse system can, we are dealing with a really large and complex ERP system. We also have to keep any changes to a minimum because of the fact that it is an ERP. I can see why users get so frustrated with the central system and our support of it. Sometimes, with all the processes we deal with it can take weeks, months, years and sometimes never to get a response back to the user.

**Diversity of Wf applications**
The flexibility of Webfuse enabled the development of a diverse collection of Wf applications. For example, Figure 5.14 shows how usage of Wf applications varied from quite large to quite small. The significant disparities in the amount of usage between the Wf applications, is indicative of the diversity of the applications and how they are used. The Results Upload application mentioned in Section 5.3.6 handled only 4956 requests during 2004, or just 0.7% of all Wf
application requests. The results upload application is only required at certain
times by a small sub-set of users. Its limited use, however, did provide a
significant saving in time on the part of academic staff. In comparison, the Staff
MyCQU portal is used by large numbers of staff throughout the year. Figure 5.15
illustrates this diversity of peak usage between three different Wf applications: the
student portal, take quiz, and results upload applications. All three applications
have two main peaks, representing CQU’s two main teaching terms in terms of
student enrolments. The peaks, however, appear at different times of each
teaching term.

![Graph of peak usage between three different Wf applications](image)

*Figure 5.15. Comparison of annual usage peaks for student portal, take quiz, and upload Wf applications in 2004. Note: Usage data from December not available.*

The Blog Aggregation Management (BAM) Wf application (p. 289) represents a
different and significant type of diversity supported by Webfuse. Before BAM, all
software services used by Webfuse were hosted on institutional computers. BAM
assumed students would use externally hosted blog engines of their own choice
and register them with BAM. BAM would use the RSS files generated by the
blogs to mirror and track student blog posts. BAM represented a significant
divergence from the common approach of assuming that learning and teaching
services had to be supplied by the institution. In reviewing BAM, Coghlan et al.
(2007, p. 8) suggest that

> One of the most compelling aspects of the project was the simple way
it married Web 2.0 applications with institutional systems. This

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approach has the potential to give institutional teaching and learning systems greater efficacy and agility by making use of the many free or inexpensive—but useful—tools like blogs proliferating on the Internet and to liberate institutional computing staff and resources for other efforts.

Not only is BAM an example of diversity, it is also an example of another approach being taken to increase the flexibility of Webfuse.

**Flexibility and diversity of the default course sites**

As argued above (pages 277 and 278) the abstractions underpinning the default course sites enabled some significant flexibility in how the default course sites could be created and manipulated. It was this flexibility that contributed to some diversity amongst Webfuse course sites. This section seeks to illustrate this flexibility and diversity through four examples: appearance and structure; creation and enrolment; and, the Web 2.0 course site.

**Appearance and structure.** Since a Webfuse default course site could be based on any skeleton, the appearance and structure of a default site could vary considerably. Examples of different default course sites can be seen in Figure 5.2, Figure 5.4, and Figure 5.16. Figure 5.2 shows what the very first default course site home page looked like in 2001. Figure 5.4 shows the home page for the 2007 Web 2.0 course site. Figure 5.16 is the home page for a commercial course offered by CQU at the end of 2007.
Figure 5.16. EPG02 Default course site 2007.

Creation and enrolment. The way in which a default course site could be created and students enrolled in the course site was also flexible. For the majority of courses this was an automatic process, however, external demands required flexibility. For example, the commercial course site shown in Figure 5.16 was a commercial course. Students in this course were not enrolled in CQU’s student records system like other students. How students were “enrolled” in this course and the site created had to be handled differently.

Another example of this is provided by special topic courses. This is a course that has a single course code in which students enrol; however, each student in a special topic course could be studying a different topic with a different supervisor. Often these different supervisors would require a course site for their topic.
Students need to be enrolled in the single special topic course code and access standard information for that course. At the same time, however, they needed to be able to access a course web site that was specific to their topic and supervisor. The Webfuse solution to this problem was to have a single default course site for the standard special topic course. Information and services for all special topic students was placed within this default course site. Within this default course site a default course site would be created for each unique topic. Each topic would have a special course code – created only in Webfuse by adding a letter to the end of the course code (e.g., COIT11133a and COIT11133b). The Webfuse “temporary enrolment” feature would be used to enrol students in that special course code. Each topic’s supervisor and students could then interact and use the topic specific course web site.

There was additional diversity for academics in terms of the authoring approach they could adopt. Three different approaches were common:

1. do nothing
   The default course site would automatically create the minimum standard as expected by the organisation. Academics did not need to modify the default course site beyond participating in discussions.

2. make changes with Webfuse
   To move beyond the default, academics could modify and add to the default course site by using the Webfuse page types.

3. create a real course site (p. 277)
   Lastly, academics could choose to use their own Web publishing tools to create a real course site that was separate from the default course site.
**Web 2.0 course site.** The last example of the flexibility and support for diversity offered by the default course site approach is the Web 2.0 course site mentioned in Section 5.3.5. The Web 2.0 course site embraces and extends the BAM idea that increasingly universities do not need to provide all of the e-learning tools to be used by staff and students. Instead staff and students can use any one of an increasing range of simple and high quality online tools. Created using the same technology as other Webfuse default course sites, the Web 2.0 course site displays content created by staff and students using external applications such as Wordpress.com, RedBubble.com. Instead of visiting the course web site, students and staff can receive notifications of new course activity and contents through a news-reader application of their choice. The news-reader draws on the same feeds used by the course site to display the content. The Web 2.0 content site provided an institutionally branded home for the course, but staff and students never need to use it.

**5.4.5. Encourage adoption**

In Chapter 4, the limited adoption of Webfuse services by staff was identified as somewhat unbalanced with a limited number of staff being responsible for the majority of system use. This section seeks to evaluate how well the changes made to Webfuse from 2000 helped improve this problem. First, it summarises and brings together quantitative information to illustrate significant increases in adoption. Second, it summarises more qualitative findings from a number of research studies (Behrens, 2009; Behrens et al., 2005; Behrens & Scedera, 2004; Jones, Cranston et al., 2005) to illustrate user perceptions. Based on this information it appears that there was some success in encouraging adoption,
especially when compared to adoption levels of similar systems both within CQU and elsewhere.

**Quantitative evaluation of Webfuse services: staff and students**

It is important to note within a quantitative evaluation of the usage of services offered by Webfuse that there are two distinct sets of Webfuse services. The first, and original, set of Webfuse services are directly associated with the provision of a Webfuse course web site. Usage of the Webfuse course web sites was generally limited to courses being offered by Infocom. The second set of Webfuse services were generally implemented as Wf applications (Section 5.3.4) and were available independently of a Webfuse course site, that is, courses offered by CQU could use these services but use another system for their course web site.

The potential separation of the adoption of Wf application services from the requirement to have a Webfuse course site can create some unusual results (i.e., usage in excess of 100%) in the following discussion. For example, Table 5.13 shows that usage of Wf applications by students grew from just 6.2% of students enrolled in courses with Webfuse courses sites in 2000, to a figure of 183% in 2009. As shown in Table 5.13 this arises because there were on 6744 students enrolled in courses with Webfuse course sites (labelled as “Webfuse students”). While at the same time, there were 12,342 students using Wf applications (Wf student users). There are two reasons behind the retention of the “Webfuse students” as indicating 100%. First, a figure of greater than 100% adoption for some Wf applications makes obvious that this functionality was so popular as to be adopted by non-Webfuse courses. Second, the percentage of course sites is the common measure used by the Malikowski et al. (2007) framework that is being used to enable cross e-learning system comparisons.
Table 5.13 (student usage) and Table 5.14 (staff usage) are attempts to provide a numeric summary of the growth of Webfuse usage from 2000 onwards. To do this, the tables take the number of students and staff using Wf applications from Table 5.12 and attempt to calculate what percentage of the number of students and staff involved with Webfuse course sites this usage represents. The number of Wf users, for either students or staff, is taken from system logs which record every request made by users. The total number of Webfuse students in Table 5.13 is based on data from the CQU student records system and is accurate. Obtaining a similarly accurate total for the number of staff associated with courses with Webfuse course sites is somewhat more uncertain. The number of Webfuse staff figure used in Table 5.14 is taken from the Webfuse teaching responsibilities database that was introduced in 2000. In 2001, the database started to include all teaching staff, including those at the AICs. Over time it began to be used for other courses, but was never entirely complete. This database was also used for a number of purposes. As a result, the figure shown in Table 5.14 includes a number of non-teaching staff. The limitations of these numbers suggests that the actual number of teaching staff using Webfuse course sites might actually be lower than shown and consequently the percentage of staff using Webfuse applications without using a Webfuse course site would be higher.
Table 5.13. % of students in Webfuse courses using Wf applications (2000-2009).

<table>
<thead>
<tr>
<th>Year</th>
<th>Wf Student Users</th>
<th>Webfuse students</th>
<th>% Webfuse students</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>538</td>
<td>8665</td>
<td>6.2</td>
</tr>
<tr>
<td>2001</td>
<td>3361</td>
<td>11276</td>
<td>29.8</td>
</tr>
<tr>
<td>2002</td>
<td>4210</td>
<td>11785</td>
<td>35.7</td>
</tr>
<tr>
<td>2003</td>
<td>6115</td>
<td>10920</td>
<td>56</td>
</tr>
<tr>
<td>2004</td>
<td>8664</td>
<td>11664</td>
<td>74.3</td>
</tr>
<tr>
<td>2005</td>
<td>9937</td>
<td>13427</td>
<td>74</td>
</tr>
<tr>
<td>2006</td>
<td>11,994</td>
<td>12669</td>
<td>94.7</td>
</tr>
<tr>
<td>2007</td>
<td>10,810</td>
<td>9932</td>
<td>108.8</td>
</tr>
<tr>
<td>2008</td>
<td>12,085</td>
<td>7850</td>
<td>154</td>
</tr>
<tr>
<td>2009</td>
<td>12,342</td>
<td>6744</td>
<td>183</td>
</tr>
</tbody>
</table>

Note: Access logs from Jan 2005 through Apr 24 2005 not available.

Within these limitations, it can be seen from Table 5.14 that staff usage of Wf applications quickly spread beyond a restriction to just staff using Webfuse course sites. The significant increase in usage from 2007 represents the adoption of Webfuse as an official institutional system. Webfuse was adopted as an institutional system and adoption continues to grow quite significantly. The spread of student usage, as shown in Table 5.13, was somewhat slower exceeding 100% for the first time in 2007. The figures from these two tables suggest that, at least with Wf applications, the problem of adoption of Webfuse services had been successfully overcome.
Table 5.14. % of staff using Wf applications (2000-2009).

<table>
<thead>
<tr>
<th>Year</th>
<th>Wf Staff Users</th>
<th># Webfuse Staff</th>
<th>% Staff using Wf</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>2</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>2001</td>
<td>96</td>
<td>299</td>
<td>32.1</td>
</tr>
<tr>
<td>2002</td>
<td>298</td>
<td>399</td>
<td>74.7</td>
</tr>
<tr>
<td>2003</td>
<td>575</td>
<td>401</td>
<td>143.4</td>
</tr>
<tr>
<td>2004</td>
<td>633</td>
<td>361</td>
<td>175.3</td>
</tr>
<tr>
<td>2005*</td>
<td>782</td>
<td>428</td>
<td>182.7</td>
</tr>
<tr>
<td>2006</td>
<td>1159</td>
<td>469</td>
<td>247.1</td>
</tr>
<tr>
<td>2007</td>
<td>1289</td>
<td>341</td>
<td>378.0</td>
</tr>
<tr>
<td>2008</td>
<td>1234</td>
<td>257</td>
<td>480.2</td>
</tr>
<tr>
<td>2009</td>
<td>1169</td>
<td>249</td>
<td>469.5</td>
</tr>
</tbody>
</table>

Note: Access logs from Jan 2005 through Apr 24 2005 not available.

Providing a similar quantitative analysis for Webfuse course sites is, for a number of reasons, both more difficult and less useful. First, the majority of Webfuse course site resources could be used without logging in. As a result it is impossible to identify what percentage of students or staff were accessing information on course web sites. For staff, prior to the introduction of the teaching responsibilities database mentioned above and used in Table 5.14 it is not possible to identify clearly how many staff in total are involved with Webfuse courses. Lastly, there is a significant difference between use of Wf applications and editing a course site. In 2002, there were 114 Webfuse courses that had more than five staff as part of the course teaching team. While most, if not all, of these staff would be likely to make use of associated Wf applications, few would be editing the course site. Editing a course site was usually limited to the course coordinator or perhaps a specially employed course developer. This practice offers one explanation of why the percentage of staff editing Webfuse sites shown in Table 5.15 only ever exceeds 26% for the year 2000. As of 2000, not all teaching staff were included in the Webfuse teaching responsibilities database.
The most effective quantitative evaluation of adoption associated with Webfuse course sites is provided in Section 5.4.2 in the discussion of feature adoption (page 299). Based on that discussion, it can be argued that in terms of the feature categorisation scheme proposed by Malikowski et al. (2007), feature adoption in Webfuse course sites was:

- **Greater and less work in terms of content transmission features**
  
  All Webfuse default course sites automatically relied on a useful base level of content transmission features. A significant percentage of course sites relied on additional features. A percentage that is higher than that found at CQU with other LMS and at other institutions. In addition, this higher level of adoption of content transmission features within Webfuse course sites required less work on the part of academic staff due to automation.

- **Significantly higher for classroom interaction features**
  
  From 2002 onwards, Webfuse course sites were more likely to use classroom interactions than rates identified in the literature by Malikowski et al. (2007). From 2005 onwards, Webfuse course sites used classroom interaction features at around twice the adoption rate than Blackboard course sites at CQU.

- **Significantly higher for student assessment**
  
  From 2002 onwards, Webfuse sites were using student assessment features at levels greater than found by Malikowski et al. (2007). From 2003 onwards, adoption was at almost 100%. From 2006 adoption was greater than 100% due to the separation of Wf applications from Webfuse course sites discussed previously. The majority of the student assessment services offered by Webfuse from 2001 onwards were implemented as Wf application. By 2009,
the rate reached 211.4%. During this period, adoption of student assessment
features in Blackboard at CQU was at about 30% of Blackboard courses

- **Significantly higher for course evaluation**

  Adoption of course evaluation features by Webfuse course sites exceeded the
  “Malikowski” norm from 2001 onwards. From 2005 through 2009, the rate
  ranged between 31.6% and 51.6%. Adoption of similar features in Blackboard
course sites never exceeded 5% of Blackboard course sites.

From a quantitative perspective, adoption of Webfuse Wf applications and course
sites show significantly high adoption when compared to similar systems. The
following section provides a more qualitative perspective.

Table 5.15. *Percentage staff editing Webfuse course sites (2000-2009).*

<table>
<thead>
<tr>
<th>Year</th>
<th>Staff editing Webfuse site</th>
<th>Total Webfuse staff</th>
<th>% staff editing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>50</td>
<td>100</td>
<td>50%</td>
</tr>
<tr>
<td>2001</td>
<td>70</td>
<td>299</td>
<td>23.4%</td>
</tr>
<tr>
<td>2002</td>
<td>100</td>
<td>399</td>
<td>25.1%</td>
</tr>
<tr>
<td>2003</td>
<td>101</td>
<td>401</td>
<td>25.2%</td>
</tr>
<tr>
<td>2004</td>
<td>79</td>
<td>361</td>
<td>21.9%</td>
</tr>
<tr>
<td>2005</td>
<td>80</td>
<td>428</td>
<td>18.7%</td>
</tr>
<tr>
<td>2006</td>
<td>87</td>
<td>469</td>
<td>18.6%</td>
</tr>
<tr>
<td>2007</td>
<td>71</td>
<td>341</td>
<td>20.8%</td>
</tr>
<tr>
<td>2008</td>
<td>66</td>
<td>257</td>
<td>25.7%</td>
</tr>
<tr>
<td>2009</td>
<td>53</td>
<td>249</td>
<td>21.3%</td>
</tr>
</tbody>
</table>

**Qualitative and independent adoption**

Two separate research projects have examined adoption of Webfuse and its
features. The first (Behrens et al., 2005; Jones, Cranston et al., 2005) combined
the Technology Acceptance Model (TAM), case study research, and some
open-ended questions to examine what factors had contributed to the success of
the Online Assignment Submission Infocom System (OASIS) Wf application.
The findings of this study used here draw on the qualitative analysis of the open-ended questions. The second (Behrens, 2009; Behrens & Sedera, 2004) was an ethnographic investigation of shadow systems at CQU. This section briefly summarises what these projects have to say about the adoption of Webfuse features.

The first study (Behrens et al., 2005; Jones, Cranston et al., 2005) drew on responses from an online survey from OASIS users – 94 responses (34.9%) – and people who had not used OASIS – 18 responses (15.3%). The survey included a range of questions arising from the TAM and some open-ended questions. The analysis performed as part of the study suggested that non-users perceive OASIS to be useful and easy to use and, if the chance arose, would not hesitate in using it. With one non-user providing the following comment

   my positive experience with other Infocom systems gives me confidence that OASIS would be no different. The systems team have a very good track record that inspires confidence

On the other hand, OASIS users were more pragmatic about the trade-offs about the system but still believed the system to be both useful and easy to use (Behrens et al., 2005). Findings from this study suggested that the agile development methods employed by the Webfuse team to develop OASIS positively influenced the perceptions of usefulness and ease of use held by academic staff. It was through the agile development process that academic staff developed the perception that overall the systems produced by the Webfuse team would be useful and easy to use, and when they were not, the system would quickly evolve to be so.
An ethnographic study (Behrens, 2009) of shadow systems included interviews with 17 CQU staff members about Webfuse including both users and non-users of Webfuse. The study found similar positive perceptions of Webfuse amongst its users, in particular because the “system was built, implemented, and applied with a specific interest in people’s lived experiences” (Behrens, 2009). This perception was achieved by involving staff in a development process that was appropriate and timely. Section 5.4.4 uses two quotes taken from Behrens (2009, p. 126) to show the level of responsiveness Webfuse was seen to have by both Webfuse users and a manager of the CQU central IT division.

It seems possible to draw from the results of these studies a reasonable conclusion that much of the success of Webfuse, in particular in terms of increased adoption, arises from a combination of an agile development methodology, a flexible system, and a focus on understanding and responding to the lived experience of the users.

5.5. Lessons learned

This section, as with Section 4.7, seeks to document the outcomes of a process of reflection on the intervention. Cole et al. (2005) describe this process as reflecting on the outcomes of the intervention in an attempt to generate understanding. Understanding about how (or if) the intervention contributed to the change sought, and why that contribution was considered a success or failure. As outlined in the previous section, it appears that the intervention described here was, overall, a success.
Relative unimportance of the technical product

From the perspective of data structures, algorithms, and bleeding edge technology Webfuse was not at all innovative. Use of scripting languages, relational databases, and open source applications to construct web sites was fairly common and widespread. Nor would much of its implementation be considered theoretically correct by researchers focusing on relational databases, software engineering or computer science. For example, the schema used by Webfuse databases could not be described as being appropriately normalised. In addition, a common complaint about Webfuse has been that it was using technology that would not scale and that was not “enterprise-ready” (even though it could and did scale and support the enterprise). The questions of technical novelty, technical purity, or fulfilling arbitrary scalability guidelines had little or no effect on the success of Webfuse. The success of Webfuse arose from becoming, and being able to stay, an integral, and useful part of the everyday life of students and staff. A sound technical foundation was important to enabling this but was only valuable to the extent it enabled integration into the everyday practice of the institution.

Webfuse was not a product

This emphasis on the characteristics of the technical product was also evident in the continual queries from colleagues asking when Webfuse would be sold or made available to other institutions. The adoption of Webfuse as a product by other institutions was seen as a way for proving its success. This perspective seems to arise from the assumption that Webfuse, like all software, was a product that could be reused regardless of the organisational context. One of the key perspectives underpinning the second phase of Webfuse development, however,
was the recognition that the product and its features were not as important as how well its features matched the needs of the local context as well as how well it continued to evolve in response to those needs. The most important part of Webfuse was the process, not the product. It was through this process of contextual adaptation that Webfuse became part of the way things were done at CQU. It became part of the culture. This tight connection with the institution meant that while the principles behind Webfuse and some of the applications might be useful at other institution, it would be difficult to directly translate Webfuse to another institution. An understanding of this distinction improved the implementation of Webfuse. An inability to explain the importance of this distinction to various stakeholders contributed to the eventual demise of Webfuse. The use of ateleological processes to drive the evolution and development of Webfuse was particularly difficult to explain and is examined in more detail in a following sub-section.

**The importance of the pedagogue**

Coates et al. (2005, p. 26) suggests that a recurrent message from educational technology research is that “it is not the provision of features but their uptake and use that really determines their educational value.” This message matches well with the experience of Webfuse. During the initial phase of Webfuse development described in Chapter 4, the provision of features in terms of various page types was not sufficient to generate use by academic staff and consequently any impact in terms of educational value. If the teaching staff responsible for a course did not use the provided features, or did not integrate them effectively into a course, there was no educational value. It appears that pedagogues are of central importance in terms of any educational value arising from e-learning. The evolution of Webfuse
into an everyday part of teaching practice for academics was achieved by actively engaging with the perceptions and conceptions of academics as a guide to the evolution of Webfuse and its applications.

**Change takes time, familiarity, need, support, and adaptation**

There were few teaching staff who decided to adopt new educational practices or technologies immediately. Instead, adoption decisions appear to occur over varying periods of time as a result of individual experience. Even after adoption, effective use of novel approaches often lagged by a number of years. In part, this lag was because novel practices often generated a need for changes in organisational practices and support. Without such changes the novel practice could not become widely adopted or effectively used. For example, the use of the course barometer feature was highest and most appropriate in 2002 and 2008 (Figure 5.12) when use was encouraged and supported by organisational resources and practices. In the absence of these resources and practices barometer usage fell away. Another factor is that as novel technologies or approaches become more widely used, that use highlights the need for additional features. Greater experience leads to adaptation.

**Helping people increases trust and knowledge**

From 2000 onwards the Webfuse development staff also fulfilled the roles of system trainers and frontline helpdesk staff. Each of these roles is inherently challenging and attempting to balance the competing demands of each role adds further to the complexity. There were, however, also a number of significant benefits that arose from this multi-skilling. These benefits included:
• Helpdesk staff with increased knowledge of the systems

The helpdesk staff handling user problems had deep understandings of how the systems worked, what they could do, and how they could be manipulated. This deep level of knowledge enabled quicker and more flexible responses to problems faced by staff and students.

• Increased ability for rapid changes

In some cases, those flexible responses involved quick modification of the Webfuse code to correct a problem or add a new feature. Such minor problems did not have to rise through a helpdesk escalation and governance process before being remedied. A requirement for minor problems to proceed through more heavyweight governance processes often starves such required changes of attention.

• Developers with increased knowledge of the needs and capabilities of the users

The offering of helpdesk support and training sessions provided a deeper understanding of the capabilities and needs of both staff and student users that could drive the on-going design and development of Webfuse. This understanding was significantly more in-depth and nuanced than could ever be achieved through most traditional requirements gathering processes.

Each of these benefits combined to contribute to an emerging system that was perceived by most users as responding to their needs and making them feel a part of the direction of the system. This level of involvement and trust was a significant enabler of what success can be attributed to the intervention.
You can't keep all the people happy

The experience with Webfuse from 2000 through 2009 has highlighted just how difficult answering the question – “Was Webfuse a success?” – actually is and how dependent it is upon the experiences and aims of the individual answering the question. In terms of success, it is possible to point to the statistics showing much higher levels of usage by staff and students and later adoption of Webfuse as an institutional system. It is also possible to point to qualitative comments from staff around trust and confidence and to formal management reports describing Webfuse as “[t]he best thing about teaching and learning in this faculty in 2003.”

At the same time, it’s possible to point to consistent arguments from central IT staff that Webfuse was a shadow system that duplicated existing systems and was subsequently inefficient and wasteful (Jones et al., 2004). There were also comments from one senior member of staff in 2004 suggesting that Webfuse had made no significant difference to learning and teaching at CQU.

Ateleological processes do not fit in a teleological environment

Webfuse experienced its greatest levels of support and improvement during the period from 2000 through 2004. During these years the Faculty of Informatics and Communication (Infocom) – which supported Webfuse – was undergoing significant growth in student numbers, complexity of teaching, and available resources. At the same time, Infocom had a Dean who had publicly expressed support (Marshall, 2001) for and was comfortable with a more ateleological approach to organisational and systems development.

From 2004 onwards there were a number of changes within CQU, including: (1) changes in faculty and institutional leadership; (2) changes in student enrolment profile raising concerns about faculty and institutional funding; and, (3) an
organisational restructure resulting in increased centralisation of services. These changes led the institution toward a much more teleological approach to systems development and support. Under these conditions the ateleological Webfuse process was seen as a waste of resources and, to some extent, nonsensical.

5.6. **An ISDT for emergent university e-learning systems**

This section seeks to draw on the insights gained through the intervention described in this chapter to formulate an ISDT. Given the significant differences in both the product and process associated with Webfuse described in this chapter the ISDT presented here is very different than the ISDT presented in Chapter 4. The ISDT described here uses the components of an ISDT proposed by Gregor and Jones (2007) and is titled “An ISDT for emergent university e-learning systems”. A summary of the ISDT is given in Table 5.16 and a more complete description follows the table.
### Table 5.16. Summary of the ISDT for emergent university e-learning systems.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core components</strong></td>
<td></td>
</tr>
<tr>
<td>Purpose and scope</td>
<td>1. Provide ICT functionality to support learning and teaching within a university environment (e-learning).</td>
</tr>
<tr>
<td></td>
<td>2. Seek to provide context specific functionality that is more likely to be adopted and integrated into everyday practice for staff and students.</td>
</tr>
<tr>
<td></td>
<td>3. Encourage and enable learning about how e-learning is used. Support and subsequently evolve the system based on that learning.</td>
</tr>
<tr>
<td>Constructs</td>
<td>A range of constructs summarised in Table 5.17.</td>
</tr>
<tr>
<td>Principle of form and function</td>
<td>13 principles in 3 groups including:</td>
</tr>
<tr>
<td></td>
<td>1. Comprehensive, integrated and independent services</td>
</tr>
<tr>
<td></td>
<td>2. Adaptive and inclusive system architecture</td>
</tr>
<tr>
<td></td>
<td>3. Scaffolding, context-sensitive conglomerations.</td>
</tr>
<tr>
<td>Artefact mutability</td>
<td>As an ISDT for emergent e-learning systems the ability to learn and evolve in response to system use is a key part of the purpose of this ISDT.</td>
</tr>
<tr>
<td></td>
<td>It is actively supported by the principles of form and function, as well as the principles of implementation.</td>
</tr>
<tr>
<td>Testable propositions</td>
<td>The system:</td>
</tr>
<tr>
<td></td>
<td>1. provides the functionality and services necessary to support university e-learning</td>
</tr>
<tr>
<td></td>
<td>2. provides a set of functionality that is specific to the institutional context</td>
</tr>
<tr>
<td></td>
<td>3. over time shows greater levels of adoption by staff and students</td>
</tr>
<tr>
<td></td>
<td>4. enables and encourages the university, its e-learning information systems, and its staff and students to observe and respond to new learning about the design, support and use of university e-learning</td>
</tr>
<tr>
<td></td>
<td>5. provides a level of differentiation and competitive advantage to the host institution.</td>
</tr>
<tr>
<td>Justificatory knowledge</td>
<td>A range of theories and knowledge from software engineering, information systems and the broader social sciences summarised in Table 5.18 and Table 5.19.</td>
</tr>
<tr>
<td><strong>Additional components</strong></td>
<td></td>
</tr>
<tr>
<td>Principles of implementation</td>
<td>11 principles split into 3 groups, including:</td>
</tr>
<tr>
<td></td>
<td>1. Multi-skilled, integrated development and support team.</td>
</tr>
<tr>
<td></td>
<td>2. An adopter-focused, emergent development process.</td>
</tr>
<tr>
<td></td>
<td>3. A supportive organisational context</td>
</tr>
<tr>
<td>Expository instantiation</td>
<td>The Webfuse system from 2000 through 2009.</td>
</tr>
<tr>
<td></td>
<td>Aspects of the BIM module for the Moodle LMS (Jones, 2010)</td>
</tr>
</tbody>
</table>
It is widely accepted that an ISDT – or the related concept of technological rule – is not meant to describe a specific instantiation, but instead to provide a general prescription for a class of problems (van Aken, 2004; Walls et al., 1992). The ISDT presented here is intended to offer a prescription for e-learning information systems for universities. In addition to this general class of problems, the ISDT presented here also includes among its principles of implementation (Section 5.6.4) and artefact mutability (Section 5.6.6) components suggestions that recommend significant context specific variability in the final instantiation. The breadth of this variability is captured by the use of the word “emergent” in the title of the ISDT. Emergent is meant here in the sense adopted by Truex et al. (1999, p. 117) where

“emergent” refers to the state of being in continual process, never arriving but always in transition.

The concept of emergence with a focus on contextual responsiveness suggests that specific instantiations of this ISDT are likely to be somewhat different, perhaps even significantly so. Subsequently the specification of final, or even initial, detailed feature sets is not seen as appropriate for this ISDT. Instead, the initial feature set and the on-going emergence of any instantiation arises from engagement with the specifics of the context.

**5.6.1. Purpose and scope**

The purpose and scope of an ISDT is meant to define: what the system is for; what are the goals that specify the type of system to which the ISDT applies; and, the boundaries of the system (Gregor & Jones, 2007, p. 325). The purpose of this ISDT is to guide the development of systems that can satisfy three main aims:
1. Provide ICT functionality to support learning and teaching within a university environment (e-learning)

2. Seek to provide context specific functionality that is more likely to be adopted and integrated into everyday practice for staff and students

3. Encourage and enable learning about how e-learning is used. Support and subsequently evolve the system based on that learning.

The ISDT assumes that the design of information systems to support e-learning within universities is not pre-determined. Instead, it sees the provision and support of these systems as a learning process through which further insights are generated about how the system can be improved and expanded. It recognises that systems designed to learn and respond to use within a specific context are more likely to be integrated into the daily practice of staff and students. Subsequently these systems will provide significant individual and organisational benefits.

5.6.2. Constructs
The entities of interest to this ISDT, its constructs, are summarised in Table 5.17. Only those constructs that are novel (e.g., conglomerations) or that provide a specific definition of a more general term (e.g., e-learning) are included here. A range of other constructs are used within the ISDT, however, it is assumed that these have common, broadly accepted definitions with which many are familiar.
Table 5.17. Construct definitions for the ISDT.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-learning</td>
<td>The use of information and communications technology to support and enhance learning and teaching in higher education institutions (OECD, 2005c)</td>
</tr>
<tr>
<td>Service</td>
<td>An e-learning related function or application such as a discussion forum, chat room, online quiz etc.</td>
</tr>
<tr>
<td>Package</td>
<td>Mechanism through which all services are integrated into and managed within the system.</td>
</tr>
<tr>
<td>Conglomerations</td>
<td>Groupings of services that provide scaffolding and context-specific support for the performance of high-level e-learning tasks. (e.g., creating a course site with a specific design; using a discussion forum to host a debate; using blogs to encourage reflection)</td>
</tr>
</tbody>
</table>

5.6.3. **Principles of form and function**

Gregor and Jones (2007, p. 325) describe the aim of the principles of form and function as defining the structure, organisation, and functioning of the design product or design method. The ISDT described in Chapter 4 was specifically aimed at using the World-Wide Web as the specific platform. A point made obvious by the title of the ISDT, “An ISDT for Web-based learning systems”. This ISDT does not make any similar specific assumptions about the implementation technology. The most appropriate implementation technology will be specific to the particular context and time associated with the specific instantiation of the ISDT. For example, at the end of 2010 it might be most appropriate to focus on mobile and tablet applications for an e-learning system.

There are at least two specific reasons for avoiding the specification of a particular implementation technology. First, is the problem of technological obsolescence or perishability, which is a common problem associated with design research (Ball, 2001; Hevner et al., 2004). The second and somewhat related reason is to emphasise the practice within this ISDT of design for repair, rather
than replacement. Traditional information systems practices result in stable information systems with long life times to recoup costs, and which eventually start to drag the organisation down (Truex et al., 1999). Eventually these systems are replaced, often in large-scale, risky projects sparked by changes in technology. An emergent approach aims to engage in design by repair where a system is continually updated, including transitions to new technologies.

The principles of form and function for this ISDT are presented here as divided into three groupings. Each of these groupings and the related principles are described in the following sub-sections and illustrated through examples from Webfuse. The three groupings of principles of form and function are:

- **comprehensive, integrated and independent services**
  E-learning services are packaged in a way to enable independent implementation and operation with the ability for services to be integrated where needed. The collection of services within the system aims to be as comprehensive as possible within the requirements and constraints of the local context.

- **adaptive and inclusive architecture**
  The software architecture that enables communication and control between the system services is designed to be highly adaptive and inclusive. Adaptive means the ability to rapidly evolve in response to changes in the context or requirements. Inclusive suggests an ability to enable the integration of many different technologies into the architecture.

- **scaffolding, context-sensitive conglomerations**
  The combination and customisation of individual e-learning services into
larger groupings of services that provide additional context-sensitive assistance that encourage and enable on-going improvement in learning and teaching.

The underlying aim of these principles of form and function is to provide a system that is easy to modify and focused on providing context-specific services that actively seek to encourage and enable both e-learning use and its on-going improvement. The ISDT’s principles of implementation (Section 5.6.4) are designed to leverage the principles of form and function in order to enable the design of an emergent university e-learning information system.

**Comprehensive, integrated, and independent services**

The emergent nature of this ISDT means that, rather than prescribe a specific set of services that an instantiation should provide, the focus here is on providing mechanisms to quickly add and modify new services in response to local need. It is assumed that the principles of implementation of the ISDT (Section 5.6.4) would be used to ensure that any instantiation was using this adaptability to continually aim to provide a comprehensive collection of e-learning services that are specific to the context.

An emergent university e-learning system should:

1. *Provide a method or methods for packaging and using necessary e-learning services from a variety of sources and of a variety of types*

   For example, Webfuse provided two methods for user-level packaging services: page types and Wf applications. At a lower level, Webfuse used design patterns and object-oriented design to package services used by the page types and Wf applications. The types of services packaged through these
means included: information stored in databases; various operations on that data; external services such as enterprise authentication services; open source COTS; and, remote applications such as blogging tools.

2. Provide numerous ways to enable different packages to interact and integrate

Interaction and integration between Webfuse “packages” was achieved at three main levels: interface, page types, and classes. At the interface level, Wf applications used simple, consistent naming conventions to enable integration of disparate Wf applications. The page type mechanism enabled the integration of disparate applications into a single Web site. Object-oriented classes, influenced by design patterns, provided the lowest level of interaction and integration.

3. Provide a packaging mechanism that allows for a level of independence and duplication

Within Webfuse, modifications to page types could be made with little or no effect on other page types. It was also possible to have multiple page types of the same type. For example, there were three different Web-based discussion forums with slightly different functionality preferred by different users. Similarly, the use of the Model-View-Controller design pattern in Wf applications enabled the same data to be represented in many different forms. For example, class lists could be viewed by campus, by name (Figure 5.5), with or without student photos, by date of enrolment (Figure 5.6), or as a CSV file.

4. Provide a collection of services that provide as comprehensive a collection of e-learning functionality as possible within contextual constraints
The initial collection of services for Webfuse in 2000 included the existing page types and a range of support services (Section 4.4.3). These provided an initial collection of services that were sufficient for academics to begin using e-learning. An important lesson post-2000 was the importance of enabling the rapid emergence of new functionality within the system in response to contextual requirements and changes. The assumption is that there is no context-independent measure of comprehensive e-learning functionality. Not only does the notion of comprehensive functionality change as the context changes, but use of existing functionality also drives on-going emergence. The principles of implementation of this ISDT (Section 5.6.4) provide guidance about the nature of the process used to enable and encourage this emergence.

5. **Focus on packaging existing software or services for integration into the system, rather than developing custom-built versions of existing functionality**

With Webfuse this was mostly done through the use of the page types as software wrappers around existing open source software as described in Chapter 4. Both the BAM Wf application (5.3.6) and the Web 2.0 course site approach (Figure 5.4) offered a different approach by integrating stand-alone, external applications into Webfuse via standardised XML file formats.

6. **Present this collection of services in a way that for staff and students resembles a single system**

With Webfuse, whether users were managing incidents of academic misconduct, finding the phone number of a student, responding to a student query on a discussion forum, or uploading a Word document they believed they were using a single system. Providing this impression was the initial aim behind the use of course specific page types in default course sites. It was
most successfully achieved, however, through the emergence of Staff MyCQU as a staff “portal.” Staff MyCQU became the home page for many CQU staff.

7. **Minimise disruption to the user experience of the system**

From 1997 through 2009, the authentication mechanism used by Webfuse changed at least four times. Users of Webfuse saw no visible change.

Similarly, Webfuse page types were re-designed from purely procedural code to being heavily object-oriented. The only changes in the user interface for page types were when new services were added. For example, the introduction of a new discussion forum did not mean the replacement of the old.

**Adaptive and inclusive system architecture**

Sommerville (2001, p. 216) defines software architecture as both the structure and the framework for communication and control between the collection of sub-systems within a software system. The principles for integrated and independent services described in the previous section outline much of the architecture recommended here for an emergent university e-learning system. The focus in this set of principles is to make explicit a difference between what is recommended for the architecture of an emergent system and the characteristics of traditional information systems architecture. In particular, the difference between the focus of traditional information systems architecture on achieving consistency and efficiency, and the greater importance an emergent system must place on being adaptive and inclusive. For example, most common component architectures (e.g., JavaBeans) define a specific set of application programming interfaces (APIs) and can only integrate components that use those APIs. This limitation can close off possibilities for diversity and future emergent development. This ISDT views the ability to be adaptive and inclusive as essential
for e-learning. The focus on inclusiveness does not necessarily rule out the use of component architectures within an emergent university e-learning system. It does, however, make it likely that such an architecture could and would most likely be supplemented by and integrated with other architectural mechanisms.

The system architecture for an emergent university e-learning system should:

8. **Support the integration and control of the broadest possible types of services**

   The software wrappers at the core of the Webfuse page types meant it was possible to integrate just about any external service into Webfuse. For example, Webfuse page types wrapped around applications such as: a chat room that was a Java application; a page counter implemented in the C programming language; a lecture page type that combined numerous different applications; and, three different discussion forums implemented in Perl. In addition to the page types, Webfuse also relied heavily on the architecture provided by the Apache Web server for access control, authentication, and other services. The BAM Wf application (Section 5.3.6) used RSS and Atom feeds as a method for integrating disparate blog applications. Each of these different approaches embodied very different architectural models. While this approach increased the inclusiveness of the system it did also increase the complexity and cost of implementation and maintenance.

9. **Support the adaptation of the architecture to enable response to changes in requirements and context**

   Sommerville (2001, p. 605) suggests that major architectural changes are not a normal part of software maintenance. Webfuse was a system that started in the very early days of the World-Wide Web and operated for another 13 years. As
a result of this and other changes Webfuse had to undergo at least one major architectural change. For example, in early 2000 performance problems arose due to increased demand for dynamic Web applications (student quizzes). As a result of these performance issues a significant change in the Webfuse architecture was necessary. This change was aided through Webfuse’s reliance on the Apache Web server and its continual evolution that provided the scaffolding for this architectural change. A part of this was the change to a design- pattern-informed, object-oriented architecture.

**Scaffolding, context-sensitive conglomerations**

The design of e-learning in universities requires the combination of skills from a variety of different professions (e.g., instructional design, Web design etc.), and yet is most often performed by academics with limited knowledge of any of these professions. This limited knowledge creates significant workload for the academics and contributes to the limited quality of much e-learning. Adding experts in these fields to help course design is expensive and somewhat counter to the traditional practice of learning and teaching within universities. This suggests that e-learning in universities has a need for approaches that allow the effective capture and re-use of expertise in a form that can be re-used by non-experts without repeated direct interaction with experts. Such an approach could aim to reduce perceived workload and increase the quality of e-learning.

An emergent university e-learning information system should:

10. *Provide the ability to easily develop, including end user development, larger conglomerations of packaged services*

A conglomeration is not simply an e-learning service such as a discussion
forum. Instead it provides additional scaffolding around such services, possibly combining multiple services, to achieve a higher-level task. The scaffolding should generally embody and provide easy access to forms of expert knowledge that help encourage and enable effective use of the service. On the other hand, while many conglomerations would be expert designed and developed, offering support for end-user development would increase system flexibility and serve to embody and enable the re-use of contextual knowledge. The Webfuse default course site approach (Section 5.3.5) is one example of a conglomeration. A default course site combines a number of separate page types (services), specific graphical and instructional designs, and existing institutional content into a course web site with a minimum of human input. Another form of conglomeration that developed with Webfuse was Staff MyCQU. This “portal” grew to become a conglomeration of integrated Wf applications designed to package a range of services academics required for learning and teaching.

11. Design conglomerations to provide a range of scaffolding to aid users, increase adoption and increase quality

There is likely to be some distance between the knowledge of the user and that required to effectively use e-learning services. Scaffolding provided by the conglomerations should seek to bridge this distance, encourage good practice, and help the user develop additional skills. For example, over time an “outstanding tasks” element was added to Staff MyCQU to remind staff of unfinished work in a range of Wf applications. The BAM Wf application was designed to support the workload involved in tracking and marking individual student reflective journals (Jones & Luck, 2009). A more recent example
focused more on instructional design is the instructional design wizard included in the new version of the Desire2Learn LMS (Teskey, 2010). This wizard guides academics through course creation via course objectives.

12. *Embed opportunities for collaboration and interaction into conglomerations*

An essential aim of scaffolding conglomerations is enabling and encouraging academics to learn more about how to effectively use e-learning. While the importance of community and social interaction to learning is widely recognised, most professional development opportunities occur in isolation (Bransford et al., 2000). Conglomerations should aim to provide opportunities for academics to observe, question and discuss use of the technology. Examples from Webfuse are limited to the ability to observe. For example, all Webfuse course sites were, by default, open for all to see. The CourseHistory Wf application allowed staff to see the grade breakdown for all offerings of any course. A better example would have been if the CourseHistory application encouraged and enabled discussions about grade breakdowns.

13. *Encourage and support conglomerations that are context-sensitive*

Effective integration with the specific institutional context enables conglomerations to leverage existing resources and reduce cognitive dissonance. For example, the Webfuse default course site conglomeration was integrated with a range of CQU specific systems, processes and resources. The Webfuse online assignment submission system evolved a number of CQU specific features that significantly increased perceptions of usefulness and ease-of-use (Behrens et al., 2005).
5.6.4. Principles of implementation

As defined by Gregor and Jones (2007, p. 328) the principles of implementation specify “the means by which the design is brought into being.” As described in this chapter a significant amount of work associated with Webfuse after 1999 has been aimed at developing more appropriate principles of implementation for university e-learning. The result is a rejection of more traditional, plan-driven approaches to information systems implementation, and, instead a set of implementation principles that are founded heavily on the ideas of adopter-focused and emergent approaches to information systems development.

The following principles of implementation for the “ISDT for emergent university e-learning systems” are grouped and described in the following three subsections: Multi-skilled, integrated development, and support team; An adopter-focused, emergent development process; and, A supportive organisational context.

Multi-skilled, integrated development, and support team

An emergent university e-learning information system should have a team of people that:

1. Is responsible for performing the necessary training, development, helpdesk, and other support tasks required by system use within the institution. It should also contain an appropriate combination of technical, training, media design, institutional, and learning and teaching skills and knowledge

Separation of these tasks into different organisational units creates barriers that limit flexibility and emergence. Combining people with these skills and responsibilities into a single unit and encouraging close collaboration increases knowledge sharing as well as the ability to identify opportunities for emergence. The Webfuse development team provided most of these services,
though not always at appropriate levels. In spite of this numerous benefits arose, as partially described in the lessons learned section (Section 5.5) on page 337.

2. *Integrated into the everyday practice of learning and teaching within the institution and cultivates relationships with system users, especially students and teaching staff*

Being regularly involved with teaching staff in their daily practice enables the building of trust through shared problem-solving and greater insight into the problems and experience of system users. A necessary foundation on which to implement an adopter-focused and emergent development approach. For example, the Infocom Web team provided services, including helpdesk, that were used throughout the learning process and, as a result, they interacted everyday with academic staff and students. In addition, most members of the Web team were recently either students of the university, or had been involved in teaching courses in various roles.

3. *Are empowered to make small-scale changes to the system in response to problems, observations, and lessons learned during system support and training tasks without needing formal governance approval*

The ability to make visible changes to systems in response to user problems or requests provides a sense of user-involvement. This visible responsiveness leads to feelings of trust in the system and its developers. Traditional governance processes may slow down and even prevent small-scale changes from ever happening, which in turns encourages negative perceptions amongst users. The Infocom Web team were free to make minor changes to Webfuse as soon as possible given other workload constraints. Often, the developers
would make these changes in order to prevent repeated helpdesk queries about
the issues. Behrens (2009, p. 127) quotes a manager in CQU’s IT division
describing the types of changes made to Webfuse as “not even on the priority
radar” due to traditional IT management techniques and quotes a Webfuse
user as saying “You felt really involved.”

4. *Actively examines and reflects on system use and non-use – with a particular*
*emphasis on identifying, examining and re-framing the work of early*
*innovators – to identify areas for system improvement and extension*

While the Webfuse default course site approach provided an initial structure
for course sites, this structure could be significantly modified through use of
the page types or real course sites (Section 5.3.5). Observing what changes
were being made, typically by innovative users, was a useful way of
identifying improvements that may be useful for future inclusion. The work of
early innovators, however, should not be directly translated for use by less
innovative users. As identified by Geoghegan (1994), there are significant
differences between these groups that generally require some re-framing of the
innovations. For example, many of the features included in the initial default
course site approach were based on observations of the course sites of
innovative staff. The re-framing of these innovations for inclusion in the
default course site focused on automation or the provision of additional
scaffolding to guide use.

5. *Plays a significant part of the governance process*

This enables the governance process to harness the detailed insight gathered
by the development team about user experience with the system to inform
decisions about system evolution. For example, governance of Webfuse was,
for a short period of time, implemented using a representative committee of faculty staff that met each month. At those meetings, the Infocom Web team would present a summary of what it had done in the previous month and, based on directions given by senior management (top-down) and insights gained from observation of system use (bottom-up), present a draft plan for the next month. Members of the governance group would comment and suggest changes to the plan which would then be actioned by the development team.

**An adopter-focused, emergent development process**

Software development performed as part of an emergent university e-learning information system should:

6. *Adopt the goals, perspectives and techniques associated with alternate information systems development perspectives and methodologies such as emergent development (Truex et al., 1999), ateleological design (Introna, 1996), or agile development methodologies (Highsmith & Cockburn, 2001)*

As described in Sections 5.3.2, from 2000 onwards Webfuse development was increasingly informed by an emergent development approach using practices associated with eXtreme programming (Beck, 1999).

7. *Use in-depth knowledge of the human, social and interpersonal aspects of the institutional context to inform the design and dissemination of new system features with the intent of encouraging greater levels of adoption by users*

As outlined in Section 5.3.1, Webfuse development was informed by an adopter-focused approach. An essential component of this is the recognition that diversity is a key characteristic of e-learning within universities. A part of
this is recognising that a single consistent approach is not appropriate for all
users and is in part captured by the re-framing of innovations described in the
fourth principle of implementation.

8. *Maximise the ability of the system to be tailored for and by the users of the
   system*

End-user development is perhaps the ultimate adopter-based development
process as end-users develop applications in response to their own needs and
perspectives. Even with systems that enable end-user development; however,
there remains a need for effective and appropriate interaction between
end-users, system owners and system developers (Eriksson & Dittrich, 2007).
Tailorability was not a principle that Webfuse embodied; however, it was at
various times an aim.

9. *Seek to establish a balance between the internal emergent process and
   external plan-driven processes*

The title and the majority of the principles of this ISDT suggest that e-learning
should adopt an emergent process. This ISDT seems to be heavily in what
Clegg (2002, p. 17) describes as the “learning school” of thought around
process (Section 2.4.1 has a discussion of the two predominant views on
process). As shown in Section 2.4.2, however, the majority of processes
within universities continue to adopt, or at least espouse, a heavy emphasis on
plan-driven processes. While these perspectives represent divergent ways of
understanding process, there are risky extremes inherent in both approaches
that need to be avoided (Jones, Luck et al., 2005). An instantiation should seek
to achieve an appropriate synthesis between the two approaches that enables
adaptability and inclusiveness within an appropriately efficient and sufficiently resourced framework that is moving towards institutional goals.

**A supportive organisational context**

The organisational context in which an emergent university e-learning information system is used should:

10. *Have senior management and an organisational culture that understands, accepts, and actively enables and encourages an emergent approach to e-learning*

As briefly described in Section 5.5 the emergent development of Webfuse was most effective when the faculty Dean recognised, supported, and understood the benefits of emergent development. A leader or organisational culture that places significant value on consistency, efficiency and more plan-based processes will not value the characteristics of emergent development. As a result, the use of more ateleological processes will be difficult and consequently the ability to respond to contextual requirements will be limited.

11. *Use an approach to governance that encourages decentralised control while maintaining an appropriate, but minimal, level of top-down control*

A description of the governance process used by Webfuse is provided in the 5th principle of implementation.

**5.6.5. Justificatory knowledge**

The purpose of the justificatory knowledge component is to provide an explanation of why the ISDT is structured as it is and why it should be expected to work appropriately. Much of the justificatory knowledge that underpins this ISDT has been described previously within the literature review (Chapter 2), the
first Webfuse action research cycle (Chapter 4), and earlier in this chapter. To avoid repetition this section provides a summary and brief discussion of this knowledge with a focus on additional justificatory knowledge underpinning the ISDT for emergent university e-learning systems. This summary is linked specifically to the ISDT’s principles for form and function, and principles of implementation.

**Justificatory knowledge for principles of form and function**

Table 5.18 provides a summary of the justificatory knowledge for the principles of form and function for this ISDT and is followed by a brief description. The ISDT’s principles of form and function are grouped into three categories. These three categories are used to separate the justificatory knowledge presented here.

Table 5.18. *Summary of justificatory knowledge for principles of form and function.*

<table>
<thead>
<tr>
<th>Principle</th>
<th>Justificatory knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive, integrated, and independent services</td>
<td>Section 2.3.2 – Software wrappers (Bass et al., 1998; Sneed, 2000)</td>
</tr>
<tr>
<td>Adaptive and inclusive system architecture</td>
<td>Systems of Systems (Perrochon &amp; Mann, 1999, p. 48) Section 2.3.2 – Best of breed (Light et al., 2001; Lowe &amp; Locke, 2008), Service Oriented Architectures (Chen et al., 2003; Weller et al., 2005, pp. 253-254), End-user development (Eriksson &amp; Dittrich, 2007) Section 4.4.4 – Micro-kernel architecture (Liedtke, 1995)</td>
</tr>
<tr>
<td>Scaffolding, context-sensitive conglomerations</td>
<td>Constructive templates (Nanard et al., 1998), End-user development (Eriksson &amp; Dittrich, 2007), Distributed cognition (Boland, Ramkrishnan, &amp; Te’eni, 1994; Hollan, Hutchins, &amp; Kirsh, 2000)</td>
</tr>
</tbody>
</table>

As summarised in Chapter 4, a software wrapper is a type of encapsulation that enables software components to be encased in an alternative abstraction. This alternative abstraction enables clients, often in a new context, to access the wrapped components services (Bass et al., 1998; Sneed, 2000). As such software
wrappers are one example of an approach that provides integrated and independent software services.

Some of the relative advantages and limitations of more tightly integrated systems are described in the enterprise software literature. In this literature, comparisons between tightly integrated systems and best-of-breed approaches have argued that integration involves centralisation of processes and consequently there is a tendency to reduce autonomy, increase rigidity, and reduce competitiveness (Light et al., 2001; Lowe & Locke, 2008). The best-of-breed approach, focusing on a more inclusive integration of appropriate packages, increases system flexibility while at the same time requires greater time, skills and resources to integrate diverse applications (Light et al., 2001). Perrochon and Mann (1999) argue that traditional approaches to system architecture, even those with a focus on adaptivity, are appropriate for greenfield developments due to their reliance on the assumption of design (specify the architecture) and then implement. This is an approach that limits subsequent adaptability to the constraints of the initially specified architecture.

The concept of constructive templates (Catlin et al., 1991; Nanard et al., 1998) was developed in response to the difficulty faced by content providers in developing hypermedia structures that followed the known principles of interface and hypermedia design. Constructive templates helped content experts to create well designed hypermedia (Catlin et al., 1991). The “conglomeration” principles build on the constructive template idea through insights from distributed cognition and related ideas. Amongst other important aspects, Hollan et al. (2000) describe how distributed cognition expands what is considered cognitive beyond an individual to encompass interactions between people, their environment and the
tools therein. Boland et al. (1994, p. 459) define a distributed cognition system as one that “supports interpretation and dialogue among a set of inquirers by providing richer forms of self-reflection and communication.” Scaffolding, context-sensitive conglomerations aim to improve or increase the quality and quantity of cognition within an e-learning system and support self-reflection and communication.

**Justificatory knowledge for principles of implementation**

The principles of implementation for this ISDT are divided into three categories. These categories are used in Table 5.19 and below to summarise the justificatory knowledge underpinning those principles.

Table 5.19. *Summary of justificatory knowledge for principles of implementation.*

<table>
<thead>
<tr>
<th>Principle</th>
<th>Justificatory knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-skilled, integrated development, and support team</td>
<td>Job rotation, multi-skilling etc. (Faegri, Dyba, &amp; Dingsoyr, 2010), Organisational learning (Seely Brown &amp; Duguid, 1991), Situated learning, Situated action, Communities of practice (Seely Brown &amp; Duguid, 1991), Knowledge-based theory of organisational capability (Grant, 1996)</td>
</tr>
<tr>
<td>An adopter-focused, emergent development process</td>
<td>Section 2.4 examines the topic of processes, including a comparison of traditional plan-driven processes (e.g., the SDLC) and learning-focused processes such as emergent development. Additional discussion occurs in Section 5.3.2 Section 5.3.1 introduces the conception of adopter-focused development.</td>
</tr>
<tr>
<td>A supportive organisational context</td>
<td>Organisational fit (Hong &amp; Kim, 2002), Strategic alignment (Henderson &amp; Venkatraman, 1993), Bricolage (Chae &amp; Lanzara, 2006), Mindful innovation (Swanson &amp; Ramiller, 2004, p. 576)</td>
</tr>
</tbody>
</table>

Seely Brown and Duguid (1991) argue that the tendency for education, training and technology design to focus on abstract representations that are detached from
practice actually distort the intricacies of practice. Consequently this hinders how well practice can be understood, engendered, or enhanced. The idea of the development team integrated and embedded in the everyday practice of e-learning seeks to improve the learning of both academics and students about how to harness e-learning, and also improve the learning of the development team (and the organisation) about how e-learning is being used. The ISDT seeks to establish a process for supporting and developing e-learning which is situated in shared practice with a joint, collective purpose.

Faegri, Dyba et al. (2010) argue that turbulent environments increase the importance of employee skills and competencies. They argue that having employees cycle through different jobs – such as developers being on helpdesk – can improve knowledge redundancy, and organisational knowledge creation. Faegri, et al. (2010) also cite Keil-Slawik (1992) as arguing that full understanding of software requires experience developing the software.

Traditional hierarchical structures associated with the division of labour around e-learning within universities typically result in: helpdesk and developers organised into separate units within an IT division; learning and teaching support staff located in another division focused on learning and teaching; and, faculty academics located within disparate academic units. Consequently, there are numerous, often significant, organisational boundaries between the participants within e-learning. Such boundaries are seen by Grant (1996) as inhibiting the ability to integrate knowledge from members of an organisation, an ability that is fundamental to the organisation’s ability to create and sustain competitive advantage.
There is significant literature (Bamford & Forrester, 2003; R Baskerville et al., 1992; March, 1991; Mintzberg, 1994) in a variety of disciplines that identifies plan-driven processes as the dominant approach in most organisations. This and related literature also examines the limitations of plan-driven approaches, especially in contexts with rapid change or significant diversity (Section 2.4). Consequently there is significant literature identifying both the theoretical basis and guidance (Introna, 1996; Truex et al., 1999) as well as practical implementation methods (Beck, 2000; Schwaber & Beedle, 2002) for more emergent or adopter-based development processes.

Literature examining success factors for information systems development (e.g., Ewusi-Mensah, 1997; Scott & Vessey, 2002) has long considered it vital for senior management to be supportive of and committed to systems development. Brown et al. (2007) identify commitment – defined as the resources dedicated to IT, organisational dedication to change procedures, and top management support – as one of two most cited problems in the IS projects they examined and identified it as the factor most cited within the literature. Organisational fit (Hong & Kim, 2002) and strategic alignment (Henderson & Venkatraman, 1993) between various aspects of an organisation and its information technology systems and processes have long been argued as critical success factors. A similar importance on having an organisational context that is committed and appropriate to information systems development is also found in approaches that are less traditional or teleological (e.g., bricolage and mindful innovation) and have more in common with the emergent, adopter-focused approach advocate in this ISDT. Collective or organisational bricolage requires the combined effort of several individuals and groups (Chae & Lanzara, 2006). An organisation which is mindful
in innovating with IT, uses reasoning grounded in its own organisational facts and specifics when thinking about the innovation, the organisation recognises that context matters (Swanson & Ramiller, 2004). Within mindful innovation, management have a responsibility to foster conditions that prompt collective mindfulness (Swanson & Ramiller, 2004, p. 576).

5.6.6. **Artefact mutability**

Gregor and Jones (2007, p. 326) define artefact mutability as part of the special nature of information systems artefacts. They suggest that the lack of theories about how such systems emerge and evolve over time is a key unresolved issue of information systems research. The intent of this component of an ISDT is to explicate how much it is anticipated that the state of the artefact will change over time.

In seeking to improve design research, Hovorka and Germonprez (2009) suggest that design theory should seek to describe “the secondary design and interaction by participants” as they use the system. In particular, they argue that ISDTs should account for the secondary design that arises through tinkering and bricolage and which subsequently “creates an evolutionary trajectory for contextually situated information processes.” The focus on emergence taken within this ISDT and embodied in a number of its principles is an attempt to directly support and guide this mutability. This ISDT sees the ability of a system to be highly mutable as essential to responding to the on-going needs of e-learning within universities. The view of emergence adopted here is one where the system is always in transition, always changing and very mutable.
5.6.7. **Testable propositions**

Drawing on the principles and justificatory knowledge expressed in this ISDT it is possible to identify a range of testable propositions that should hold for instantiations built following this ISDT. It is suggested that an information system built using this ISDT will:

1. Be able to provide the functionality and services necessary to support university e-learning.

2. Over time provide a set of functionality that is specific to the institutional context.

3. Over time show increasing levels and quality of adoption by staff and students.

4. Better enable and encourage the university, its e-learning information systems, and its staff and students to observe and respond to new learning about and insight into the design, support and use of university e-learning.

5. Through the combination of the above, provide a level of differentiation and competitive advantage to the host institution.

5.6.8. **Expository instantiation**

An expository instantiation assists in representing the ISDT by acting as both an expository device and a platform for testing (Gregor & Jones, 2007, p. 322). In describing this ISDT in the previous sections, the main expository instantiation has been Webfuse. It was the work on Webfuse from about 2000 onwards that specifically informed the formulation of the “ISDT for emergent university e-learning information systems.” These principles and the justificatory knowledge
on which they were based (Section 5.6.5) draws heavily on the insights generated through the research and development of Webfuse. In particular, the importance of adopter-based and emergent development were first proposed in a range of Webfuse publications starting in 1999 (Jones, 2000, 2003b, 2004; Jones, Luck et al., 2005; Jones & Lynch, 1999; Jones, Lynch et al., 2003; Jones & Muldoon, 2007) and eventually implemented within Webfuse from 2001 through 2004.

In addition, it has been possible to identify examples of scaffolding, conglomerations in Section 5.6.3 – and especially the 11th principle of form and function of this ISDT – in other e-learning systems. Completely independent of this work is the instructional design wizard feature of the Desire2Learn LMS (Teskey, 2010). The 11th principle also used the BAM Wf application (Jones & Luck, 2009) as an expository instantiation. In 2010, the concept of BAM was ported to the Moodle LMS as BIM and is currently being used at a number of educational institutions, not just universities.

While Webfuse has informed the formulation of this ISDT and provided examples of some of the ISDT’s principles, the design of Webfuse has not been informed by a complete version of this ISDT. The ISDT has, however, arisen from subsequent reflection upon the development of Webfuse. Consequently, there are some limits to the ability for Webfuse to act as a platform for testing the ISDT’s hypothesis. Table 5.20 provides a summary of if and how Webfuse can provide evidence supporting the ISDT’s hypothesis.
Table 5.20. Summary of evidence for Webfuse fulfilling ISDT design propositions.

<table>
<thead>
<tr>
<th>Proposition</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provide the functionality for e-learning</td>
<td>As described in Section 5.4.2 Webfuse successfully provided the functionality required of an integrated online learning environment through a combination of the default course sites and Wf applications.</td>
</tr>
<tr>
<td>2. Functionality specific to host institution</td>
<td>Webfuse has provided the host institution with a range of functionality significantly before its availability in other systems (e.g., plagiarism checking integrated with online assignment submission), that is significantly different from similar functionality (e.g., integration between student records and e-learning, availability of different discussion forums), or not available elsewhere (e.g., BAM, course barometer)</td>
</tr>
<tr>
<td>3. Increasing and higher levels of adoption</td>
<td>As shown in Section 5.4.5 adoption of Webfuse e-learning features grew significantly over time and shows significantly higher levels of adoption than found in broader e-learning and literature and with an alternate e-learning system within the same institution.</td>
</tr>
<tr>
<td>4. Enable and respond to learning</td>
<td>A number of the most successful Webfuse applications – including the default course sites and online assignment submission (Jones &amp; Behrens, 2003) – were the result of long term processes of evolution in response to the experience of using the applications. See also Section 5.3.6 and in particular page 289.</td>
</tr>
<tr>
<td>5. Differentiation and competitive advantage</td>
<td>As outlined above Webfuse provided a range of functionality specific to the host institution, on example of differentiation. Perspectives backed by external comment (e.g., Coghlan et al., 2007). As described throughout the evaluation of this intervention (Section 5.4) Webfuse provided significant advantage to the host faculty, especially in dealing with the increasing complexity of teaching within its specific context.</td>
</tr>
</tbody>
</table>

### 5.7. Conclusions

This chapter has described a second period of action research aimed at evolving the Webfuse system at Central Queensland University (CQU) from 2000 through 2009. The chapter started with a description of the changes in the CQU context
(Section 5.2), the subsequent changes in Webfuse (Section 5.3), an evaluation of those changes (Section 5.4), and the identification of some lessons learned (Section 5.5). Finally, the chapter describes (Section 5.6) the “ISDT for emergent university e-learning systems” that is the major contribution of this work. This work argues that this ISDT is significantly different, and from some perspectives better, than most existing methods for implementing e-learning information systems within universities. The next, and final, chapter describes and reflects upon this and other contributions of the thesis, identifies its limitations, implications, and makes suggestions for future research.
Chapter 6 - Reflections, contributions and conclusions

6.1. Introduction

The specific aim of this thesis, as described in Section 1.3, was to make a contribution to knowledge around the following research question:

How do you design, implement and support an information system that effectively and efficiently supports e-learning within an institution of higher education?

The OECD (2005c) defines e-learning as the use of information and communications technology to support and enhance learning and teaching. Using technology in this way is becoming increasingly prevalent and important to higher education. Numerous authors, however, have identified the need for further research into a variety of issues, including: the adoption and implementation of e-learning tools (West et al., 2006); the structures and processes required to encourage e-learning adoption at the organisational level (Alavi & Leidner, 2001); how perspectives from information systems research and organisation theory help us better understand the implementation of e-learning (Keller, 2005); and, the development of theories, principles, and methodologies of change related to the sustainability of e-learning within universities (Salmon, 2005). The research in this thesis has made contributions to knowledge that helps address these needs. It does so by drawing insights from the design, support and evolution of the Webfuse information system at Central Queensland University from 1996 through 2009.
The aim of this chapter is to summarise these contributions and demonstrate that they constitute an original contribution to the body of knowledge. The chapter starts by providing an overview (Section 6.2) of the three main findings of this thesis. The chapter then explores (Section 6.3) the contributions these findings make to both research and practice. Next, a discussion of the research limitations (Section 6.4) and a description of ideas for further research (Section 6.5) follows. The chapter ends with some concluding remarks (Section 6.6).

6.2. Overview of findings

The findings made by the research described in this thesis arise from three separate activities. First, the analysis of current university e-learning practice has contributed the Ps Framework and an analysis that highlights some limitations of current practice. Efforts at using existing ISDT representations have led to the identification of limitations and to the development of an improved representation. Finally, the formulation of an ISDT has led to the development of a new ISDT for university e-learning. Details of each of these three findings are summarised in Table 6.1 and described in more detail in the following.
Table 6.1. *Overview of findings.*

<table>
<thead>
<tr>
<th>Method</th>
<th>Analysis of current practice (Section 6.2.1)</th>
<th>Improved ISDT representation (Section 6.2.2)</th>
<th>Formulating e-learning ISDT (Section 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Literature analysis and review</td>
<td>Analytic approach</td>
<td>Iterative action research</td>
</tr>
<tr>
<td>Findings</td>
<td>The Ps Framework</td>
<td>Identification of weaknesses in previous representations of ISDTs.</td>
<td>An ISDT for emergent university e-learning systems</td>
</tr>
<tr>
<td></td>
<td>Identification of a mismatch between characteristics of widespread implementation practice and the requirements of e-learning in universities</td>
<td>Presentation of an improved representation of an ISDT that has been used by other researchers.</td>
<td>An ISDT that better matches the requirements of e-learning within universities and leads to several benefits</td>
</tr>
</tbody>
</table>

### 6.2.1. Analysis of current practice

The analysis of current university e-learning practice was an essential first step in this research. After numerous, initial, partially successful attempts (Jones, 2000, 2004; Jones & Buchanan, 1996) to analyse and describe the characteristics of existing practice it was the development of the Ps Framework in 2007 and its subsequent use in publications and presentations (Jones, 2008, 2009; Jones et al., 2008) that enabled the more complete analysis of existing current practice provided in Chapter 2 of this thesis. This work has generated two main findings: the Ps Framework and the identification of a potential mismatch between the nature of university e-learning and the process and product models currently used to implement it.
The Ps Framework was introduced in Section 2.2 and is used throughout Chapter 2 to analyse and describe current practices and requirements around the implementation of information systems for university e-learning. The framework consists of seven components that focus analysis and aim to describe the most important aspects of e-learning within universities. The seven components of the Ps Framework are: purpose, place, people, pedagogy, past experience, product and process. The graphical representation of the Ps Framework (Figure 6.1) illustrates the situationally contingent nature of the components and dynamic and complex inter-relationships between each of the components.

![Figure 6.1. The Ps Framework.](image)

Using the Ps Framework Chapter 2 provides an analysis of the existing dominant practice of university e-learning. This dominant form is labelled *industrial* e-learning and is characterised by its use of a specific type of product, the Learning Management System (LMS) a type of integrated and monolithic information system. The implementation and support of industrial e-learning is typically done using processes with a heavily teleological or plan-driven emphasis. Using the remaining components of the Ps Framework – purpose, place, people, pedagogy and past experience – Chapter 2 identifies that the defining characteristics of e-learning within universities are: diversity, uncertainty
and rapid change. Further, Chapter 2 argues that the characteristics of the product (integrated, monolithic software package) and process (teleological/plan-driven) models used in industrial e-learning are ill-suited to supporting the identified characteristics of university e-learning. It is argued that such a weak fit between the characteristics of e-learning and the methods used to support it will increase risk.

6.2.2. Representation of an ISDT

Walls, Widmeyer, and El Sawy (1992) developed the first representation of an ISDT which specified the required components. It is this representation that had been used by numerous authors (e.g., Markus et al., 2002). It was also used in the initial attempts at formulating an ISDT for e-learning from this work (Jones & Gregor, 2004, 2006; Jones, Gregor et al., 2003). It was during this initial formulation of an ISDT for university e-learning that led to the identification of limitations in the Walls et al.’s (1992) ISDT representation. In particular, it was identified that the Walls et al.’s (1992) ISDT representation (Gregor & Jones, 2007): had included only some of the ideas from Dubin (1978) and Simon (1996); had not incorporated insights from related design work; did not require ISDTs to fully reflect the mutability of IS artefacts; and, had not recognised the communicative role instantiations could play for ISDTs. Based on these identified limitations an improved representation of an ISDT was formulated in Gregor and Jones (2004; 2007). This improved representation of an ISDT is summarised in Section 3.3.2. Table 6.2 (a copy of Table 3.5) provides a summary of the eight components of this improved specification of an ISDT.
Table 6.2. *Eight components of an Information Systems Design Theory (ISDT).*

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core components</strong></td>
<td></td>
</tr>
<tr>
<td>Purpose and scope (the <em>causa finalis</em>)</td>
<td>“What the system is for,” the set of meta-requirements or goals that specifies the type of artefact to which the theory applies and in conjunction also defines the scope, or boundaries, of the theory.</td>
</tr>
<tr>
<td>Constructs (the <em>causa materialis</em>)</td>
<td>Representations of the entities of interest in the theory.</td>
</tr>
<tr>
<td>Principle of form and function (the <em>causa formalis</em>)</td>
<td>The abstract “blueprint” or architecture that describes an IS artefact, either product or method/intervention.</td>
</tr>
<tr>
<td>Artefact mutability</td>
<td>The changes in state of the artefact anticipated in the theory, that is, what degree of artefact change is encompassed by the theory.</td>
</tr>
<tr>
<td>Testable propositions</td>
<td>Truth statements about the design theory.</td>
</tr>
<tr>
<td>Justificatory knowledge</td>
<td>The underlying knowledge of theory from the natural or social or design sciences that gives a basis for explanation for the design (kernel theories)</td>
</tr>
<tr>
<td><strong>Additional components</strong></td>
<td></td>
</tr>
<tr>
<td>Principles of implementation (the <em>causa efficiens</em>)</td>
<td>A description of processes for implementing the theory (either product or method) in specific contexts.</td>
</tr>
<tr>
<td>Expository instantiation</td>
<td>A physical implementation of the artefact that can assist in representing the theory both as an expository device and for purposes of testing</td>
</tr>
</tbody>
</table>


### 6.2.3. An ISDT for e-learning

The final finding of this research and its primary outcome is an ISDT for university e-learning. An *ISDT for emergent university e-learning systems* is described in its entirety in Chapter 5 and is summarised in Table 6.3. This ISDT seeks to provide theoretical guidance about how to develop and support information systems for university e-learning that are capable of responding to the dominant characteristics (diversity, uncertainty and rapid change) of university
e-learning identified in Chapter 2. This was achieved through a combination of product (principles of form and function) and process (principles of implementation) that focus on developing a deep and evolving understanding of the context and use of e-learning. Additionally, it is through being able to use that understanding to make rapid changes to the system, which ultimately encourages and enables adoption. It suggests that any instantiation built following the ISDT will support e-learning in a way that: is specific to the institutional context; results in greater quality, quantity and variety of adoption; and, improves the differentiation and competitive advantage of the host institution.

Table 6.3. *An ISDT for emergent university e-learning systems.*

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core components</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Purpose and scope (Section 5.6.1) | 1. Provide ICT functionality to support learning and teaching within a university environment (e-learning).  
2. Seek to provide context specific functionality that is more likely to be adopted and integrated into everyday practice for staff and students.  
3. Encourage and enable learning about how e-learning is used. Support and subsequently evolve the system based on that learning. |
| Constructs (Section 5.6.2)   | A range of constructs summarised in Table 5.17.                                                                                             |
| Principle of form and function (Section 5.6.3) | 13 principles in 3 groups including:  
1. comprehensive, integrated and independent services  
4. adaptive and inclusive system architecture  
5. scaffolding, context-sensitive conglomerations. |
<p>| Artefact mutability (Section 5.6.6) | As an ISDT for emergent e-learning systems the ability to learn and evolve in response to system use is a key part of the purpose of this ISDT. It is actively supported by the principles of form and function, as well as the principles of implementation. |</p>
<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
</table>
| Testable propositions (Section 5.6.7) | The system:  
1. provides the functionality and services necessary to support university e-learning.  
2. provides a set of functionality that is specific to the institutional context.  
3. over time shows greater levels of adoption by staff and students.  
4. enables and encourages the university, its e-learning information systems, and its staff and students to observe and respond to new learning about the design, support and use of university e-learning.  
5. provides a level of differentiation and competitive advantage to the host institution. |
| Justificatory knowledge (Section 5.6.5) | A range of theories and knowledge from software engineering, information systems and the broader social sciences summarised in Table 5.18 and Table 5.19. |
| Additional components             | 11 principles split into 3 groups, including:  
1. multi-skilled, integrated development and support team  
2. an adopter-focused, emergent development process  
3. a supportive organisational context |
| Expository instantiation (Section 5.6.8) | The Webfuse system from 2000 through 2009. Aspects of the BIM module for the Moodle LMS (Jones, 2010) |

6.3. **Contributions to practice and research**

The findings of this research described in the previous section make a number of contributions for three groups of stakeholders: e-learning practitioners; information systems and design science researchers; and, teachers and practitioners of information systems. A summary of these contributions is provided in Table 6.4 and described in more detail in the following.
Table 6.4. Contributions arising from this research for specific groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Contributions and implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-learning practitioners (Section 6.3.1)</td>
<td>1. Identification of a mismatch between the requirements of university e-learning and the characteristics of current practice.</td>
</tr>
<tr>
<td></td>
<td>2. Provision of an ISDT for university e-learning that addresses this mismatch.</td>
</tr>
<tr>
<td></td>
<td>3. Provision of a mechanism to analyse and describe the e-learning landscape within an institution.</td>
</tr>
<tr>
<td>IS and design science researchers (Section 6.3.2)</td>
<td>1. Provision of an improved ISDT representation.</td>
</tr>
<tr>
<td></td>
<td>2. Demonstration of value of design research using real-world systems.</td>
</tr>
<tr>
<td>IS practitioners and teachers (Section 6.3.3)</td>
<td>1. Increasing awareness of alternatives to techno-rational or teleological views of organisations, people, information, and technology.</td>
</tr>
</tbody>
</table>

6.3.1. E-learning practitioners

It is e-learning practitioners in the form of developers, managers and users that may benefit the most from this research. With both the analysis of current university e-learning practice and the ISDT for emergent university e-learning systems generating insight that can help inform and improve university e-learning.

The three contributions for e-learning practitioners described here are: (1) the requirements/practice mismatch; (2) An ISDT for emergent university e-learning systems; and, (3) the Ps Framework.

The requirements/practice mismatch

The analysis of current university e-learning practice summarised in Section 6.2.1 and described more completely in Chapter 2 has identified a significant mismatch between the requirements or characteristics of university e-learning (diversity, uncertainty and on-going change) and capabilities provided by the process (mostly teleological) and product (single integrated system, an LMS) models. Recognition of this mismatch will enable e-learning practitioners to examine their current practice to determine if this mismatch is significant within their context and
whether or not it needs to be responded to. Context appropriate responses to the level of mismatch observed within a particular context should help improve the quality of e-learning practice and its outcomes. At the very least, an increased awareness of just how diverse, uncertain and open to change university e-learning as well as the limitations inherent in current approaches to university e-learning should encourage active consideration of alternatives.

**An ISDT for university e-learning**

Examination of existing practice reveals the need to better respond to the diversity, uncertainty and on-going change characteristic of university e-learning. The *ISDT for emergent university e-learning systems* offers one form of theoretical guidance to help e-learning practitioners do so more effectively. This ISDT also presents e-learning practitioners with empirical evidence and theoretical guidance that demonstrate an alternative to the current dominant practice. Such guidance could be used in a variety of ways. Practitioners could adopt the ISDT completely and use it to radically change their own practice. Alternatively, and an approach more in keeping with the emergent and agile development methods underpinning the ISDT, practitioners could draw on aspects of the ISDT to adopt smaller changes currently suitable for the local context. They could then observe the effect of those changes, and continue the process in a contextually sensitive manner. At the very least, the ISDT and its justificatory knowledge may simply make practitioners more aware of alternate perspectives to those they have taken for granted.

**The Ps Framework**

As it stands, the Ps Framework is a nascent theory for analysis and description and consequently its contribution and implications are somewhat limited. In terms
of assessing the value of the type of theory the Ps Framework best fits (Type 1 theory), Gregor (2006) identifies three possible measures: is the framework useful in aiding analysis; are the elements of the framework meaningful, natural and well-defined; and, is the categorisation complete and exhaustive. As a nascent Type 1 theory, the Ps Framework has not undergone rigorous testing of these measures, especially the last two. The Ps Framework, however, has proven useful in finally providing a clearer analysis of existing e-learning practice, a task that plagued the author for many years. The Ps framework has also been used to frame futures of university e-learning and Personal Learning Environments that has resulted in publications (Jones, 2008; Jones et al., 2008). The Ps Framework does at least provide e-learning practitioners with a useful way to organise and analyse questions about e-learning.

### 6.3.2. IS and design researchers

As identified in Chapter 3, design science research remains an area of some disagreement and on-going discussion. At the start of the work described here, questions about the legitimacy of design science research and uncertainty about its nature and processes was especially prevalent. Engaging in the work described in this thesis has required engaging with this uncertainty and led to two contributions from this work for IS and design researchers. The first is the improved representation of an ISDT. Second, is the demonstration of benefits that can arise from real-world design research.

**An improved representation of an ISDT**

This thesis (Section 3.3.2) has taken the position that design research should aim to make a contribution to theory. In attempting to make this contribution, there was a need to develop an improved representation of an Information Systems
Design Theory (ISDT). Gregor and Jones (2007, p. 312) also argue that this contribution is significant because

the unambiguous establishment of design knowledge as theory gives a sounder base for arguments for the rigor and legitimacy of IS as an applied discipline and for its continuing progress.

Better understanding of the nature of design theories provides other benefits, including (Gregor & Jones, 2007): more systematic specification of design knowledge; support more cumulative building of knowledge, rather than faddish reinvention; and, support novice researchers. The quality of this work is evident from its increasing use by other researchers with an ISI citation count of 40 as of early 2010. In addition, the Gregor and Jones (2007) paper was the 2007 paper of the year for the *Journal of the Association for Information Systems* and as one of five outstanding publications in the discipline of Information Systems for 2007.

**Benefits of real-world design research**

Hevner et al. (2004) observe that the artefacts produced by design-science research are rarely full-grown information systems used in practice. The limited use of “real” information systems may be because of the high cost of developing and supporting real-world instantiations combined with the difficulty of finding an organisation to agree to trial the instantiation (Jones & Gregor, 2006). The reliance on a real-world information system for the basis of this work has generated significant, often unexpected, benefits which suggest that crucial benefits might arise from an increase in the quantity of information systems design research that is based on real-world problems over long periods of time.
The lack of testing design research with real-world information systems can create problems. Mattessich (1995) describes a growing gap between practitioners and researchers that is bound to grow as an increasing number of academics are involved in the modelling of simplified and unrealistic situations or testing of non-instrumental empirical hypotheses. Glass (1996) identifies the problem arising from a failure to evaluate ideas within a practical setting before advocating them. The end-result of this practice is what Kasanen, Lukka, and Siitonen (1993) describe as an instantiation being considered adequate in technical or theoretical terms, but not necessarily working in practice. Design research that is directly involved with a real organisational setting can reveal perceptions, issues and problems that are not readily visible when limited to a prototype or theoretical instantiation.

The use of a large, long-term instantiation as the basis for this work has (Jones & Gregor, 2006): provided improved understanding of the problem area; taken the research in unexpected directions; and, generated significant amounts of evidence to inform and support the design theory. The fully-grown instantiation has also made it possible to engage in a complementary research cycle between design-science and behavioral-science research. Within this project, this cycle has generated behavioural-science research in both information systems (Behrens et al., 2005; Behrens & Sedera, 2004; Jones et al., 2004) and distance education (Jones, Luck et al., 2005; McConachie et al., 2005). This cycle has also led to research that offers potential new insight into long-standing issues, for example, there is a common view that shadow systems are an undesirable phenomenon (Oliver & Romm, 2002) that undermine ERP system implementation (Strong & Volkoff, 2004). Through an ethnographic investigation of Webfuse, Behrens
(2009) provides evidence to suggest that shadow systems may, in some instances, be mechanisms to ensure organisational survival in an increasingly uncertain and competitive environment; and, identifies five lessons for the successful organisational use of shadow systems.

The call for the use of more real-world information systems as the basis for design research is not new. Hevner et al. (2004) called for an increased alignment of design-science research with real-world production experience. This can, however, be taken further. One example is the call by Brooks (1996) for computer scientists to see themselves as toolsmiths collaborating with other disciplines to solve real world problems. As described by Brooks (1996), such an approach: targets relevant, rather than toy-scale, problems; requires understanding of the whole problem rather than just the easy parts; and, by tackling the hard parts of the problem leads to the development of new knowledge in the discipline of the toolsmith. Perhaps it is time for the information systems research community, especially design researchers, to see themselves as toolsmiths engaged in actively helping other researchers solve significant problems.

The “Brooks toolsmith” approach has a strong resonance with the “helping-role” which Baskerville and Wood-Harper (1996, p. 235) suggest is taken on by IS researchers when using action research. This resonance could be seen as a reason to increase the amount of IS design research that uses action research as the research method. This suggestion of greater connection between design research and action research arises at a time when there is on-going discussion (as described in Section 3.3.3 of this thesis) within the literature about such a
relationship. The experience in this thesis suggests that action research is a useful method for design research.

These arguments for the value of real-world design research are not meant to suggest that all information systems design research, or even all information systems research, should follow such an approach. It does, however, suggest that there are benefits for design research that adopt a more “Brooks toolsmith” approach. These benefits seem to identify an area worthy of further discussion and experimentation by information systems and design science researchers.

6.3.3. IS practitioners and teachers

Perhaps the most significant difference between the first action research phase of this work (described in Chapter 4) and the second phase (described in Chapter 5) is the adoption of a less techno-rational approach to information systems development. In fact, it is this adoption of alternatives to a techno-rational approach that is arguably the key distinguishing factor between the proposed ISDT and the current, common practice of e-learning implementation. The length of time it took to recognise the need for less techno-rational approaches as well as the difficulties adopting such approaches within an organisation reported in Section 5.5. suggest that there is a need for IS practitioners, and perhaps their teachers, to be more aware of these alternative approaches.

For example, Truex, Baskerville, and Klein (1999) argue that the training and practice of information systems development is dominated by teleological processes. McKay and Marshall (2007a, p. 132) express consternation that the majority of introductory textbooks covering information systems “perpetuate rational and mechanistic views of and assumptions about organisations, people,
information and technology.” This mechanistic emphasis is not because little is known or published about the need, nature, benefits and costs of less techno-rational approaches. As shown in Chapter 2, especially Section 2.4.1 on processes and Section 2.6.3, there is significant literature examining these issues. The implication is that IS practitioners need to be aware of the less techno-rational approaches to organisations and information systems development. The on-going limited awareness of the place these approaches have amongst practitioners has implications for what is being taught in books and at universities.

6.4. Limitations

As with any research, this work may be open to a number of limitations that should be considered when examining its findings. Baskerville and Wood-Harper (1996) identified four possible limitations of action research, each of which may be applicable to this work. These limitations are: (1) lack of impartiality of the researcher; (2) lack of discipline; (3) mistaken for consulting; and (4) context-dependency leading to difficulty of generalising findings.

6.4.1. Lack of researcher impartiality

Within this work the author’s participation was not limited solely to the research acts of diagnosis and evaluation. Instead, at various times during the life of the Webfuse information system, the author often played a central role in the design, development, support, and use of Webfuse. In particular, at various times from 2000 through 2005, the author was required to take on advocacy roles within the organisation to argue for the benefits of the Webfuse approach over that of alternatives. Success with such tasks is not necessarily congruent with the maintenance of researcher impartiality. From another perspective, the need to
engage in these tasks did contribute to the evolution of the ISDT and in particular the focus on adopter-based development methodologies.

What researcher impartiality was maintained during this work is demonstrated in the history of peer-reviewed publications arising from research involved in this work. This publication history covers both the action research-based development of Webfuse as well as the complementary behavioural science research. All of these behavioural research projects involved other researchers, with at least two (Behrens, 2009; Danaher et al., 2005) not directly involving the author of this thesis. The evaluation sections of chapters 4 and 5 draw on the evidence provided by this research and use of the Webfuse system to provide evidence for the success and limitations of the research.

6.4.2. Lack of discipline or rigor

Baskerville and Wood-Harper (1996, p. 241) describe this problem under the title liberal action research, a situation where “the researchers become so involved in the immediate practical effects of the research they neglect the scientific discipline.” The fact that the formulation of ISDTs for e-learning in this work commenced in 2002, six years after the initial development of Webfuse, suggests that this may be a possibility here. Similar conclusions could be drawn from the absence of some log data as used in the evaluation section of Chapter 5.

Baskerville and Wood-Harper (1996, p. 241) describe rigorous action research as involving: a clear cycle of activity; a premise; a pronounced theory under test; and, empirical data collection. As described in Chapter 4 (Section 4.2.3), one of the reasons for developing Webfuse was to enable research in e-learning systems. As shown in Chapters 4 and 5 development of Webfuse was documented in a
range of publications. The history of these publications shows that the evolution of Webfuse, even before attempts to formulate ISDTs, showed a clear cycle of activity in which propositions were built into the software, tested, and then improved.

6.4.3. Consulting
Both action research and design research have been criticised as being, or at least having the potential to be, too much like consulting or simple systems development. The work described here does through the development of a real-world information system involve aspects of systems development. For example, during 1996 and from 2000 through 2004, the author was employed by Central Queensland University to design, develop and support the Webfuse information system. Unlike a consultant or IS professional; however, this work has also involved an additional layer of research as shown by the previously mentioned history of peer-reviewed publications. Perhaps the most important distinction between consulting and this work is the formulation of An ISDT for emergent university e-learning systems. This formulation of the ISDT, as an attempt to contribute to knowledge, is not a typical output of consulting.

6.4.4. Context-dependency
As pointed out by Baskerville and Wood-Harper (1996), action research can be overly context-dependent. This context dependence arises because it can be difficult to determine whether the cause of any effect is due to the environment, researcher, or the methodology. This limitation may apply to this work due to it arising from work within a single organisational setting. There are limitations to generalisation from such a single case. Through the formulation of an ISDT this
work is an example of what Firestone (1993) describes as analytic generalisation. For Firestone (1993), the aim of analytic generalisation is not to prove a theory, but instead to provide evidence to support the theory. The evidence drawn from the implementation and use of the Webfuse system as well as the theoretical support provided by the justificatory knowledge component of the final ISDT seek to provide the ability for the ISDT to generalise beyond the context of the original work.

6.5. **Further research**

There are numerous opportunities for further research due to the nature of the research method, the research output, and the topic of study studied in this work. The following describes a number of these opportunities under four categories.

6.5.1. **Expand upon the Ps Framework**

As described above the Ps Framework is, at best, a nascent framework of Gregor’s (2006) Type 1 theory. While it is argued here that it has provided some value in analysis and description there remains significant work before it can be claimed as a complete Type 1 Theory. Such research has the potential of producing a useful framework for analysing different perspectives and approaches to the implementation of e-learning.

An important first step would be research that aims to improve how well the Ps Framework meets the Gregor’s (2006) three measures of Type 1 theories, which are: is the framework useful in aiding analysis; are the elements of the framework meaningful, natural and well-defined; and, is the categorisation complete and exhaustive. Such research could include use of the Ps Framework to analyse and describe different e-learning approaches, especially where other researchers
perform such work. Research that sought to position and evaluate the Ps Framework against related frameworks (e.g., aspects of Alter’s (2002) work system method) could also be useful in evaluating the contribution, if any, of the Ps Framework as well as its value as a Type 1 theory.

Such work would provide a complete Ps Framework that would then enable research that seeks to undertake a critical analysis and evaluation of the current and evolving practice of e-learning. For example, does the espoused view of e-learning implementation of senior management match the lived experience of teachers and students? The Ps Framework could also be used to compare and contrast e-learning implementation between sectors. For example, does e-learning implementation within universities differ from implementations in non-profit or commercial organisations? Does it differ between cultures or countries? Should it? Further research with the Ps Framework could also examine what, if any, benefits arise from using the Ps Framework as a tool to gather the perspectives of different actors associated with e-learning implementation. For example, is the view of the pedagogy, product, people or process of e-learning held by management, academics, students, and IT staff consistent?

6.5.2. **Formulation of alternate ISDTs**

The ISDT formulated in this work is but one possible ISDT for university e-learning. At least one other, mostly implicit, ISDT currently underpins the current dominant approach to university e-learning. At the same time, there are increasing examples of alternate approaches to both general and university-based e-learning. Such examples include: personal learning environments or networks (Jones, 2008); e-learning 2.0 (Downes, 2005); other examples of post-industrial
university e-learning (Mott, 2010); informal learning (Cross, 2006); and, massively online open courses (Cormier & Siemens, 2010). Each of these alternate approaches to e-learning is based on very different assumptions from traditional university e-learning.

Explicit ISDTs for alternate approaches to e-learning would, by making the underlying principles explicit, enable analysis and critical evaluation of these approaches to e-learning. For example, is it consistent for e-learning folk to espouse pedagogies heavily reliant on constructivist philosophies as enabling the best learning outcomes, but at the same time adopt an ISDT for university e-learning with principles firmly planted in behaviourist/objectivist philosophies?

Being explicit about the design theories informing e-learning implementation would provide a firmer foundation for comparison, evaluation and research into what works and what does not.

If followed, the development of these alternate ISDTs for e-learning may result in an “ISDT catalogue.” Such a catalogue might offer benefits similar to those provided by other collections of design knowledge such as engineering design handbooks or pattern languages. The idea of an “ISDT catalogue” raises a range of potentially interesting research questions. Could such a catalogue be developed? How? What benefits might arise from it? Does it offer anything different from other collections of design knowledge? Could such a catalogue be one contribution to developing what Simon (1996, p. 113) described as “a body of intellectually tough, analytic, partly formalisable, partly empirical teachable doctrine about the design process.”
Further testing of the theory

This thesis aimed to formulate an ISDT for university e-learning and provide sufficient evidence to establish the plausibility of the ISDT. As described above, the intent was to achieve a level of what Firestone (1993) describes as analytic generalisation. The intent in this research was not to “prove” the ISDT. Such proof can likely never be generated; however, further testing of the ISDT through replication in other contexts and the use of alternative research methods would offer additional insight into the value and applicability of the ISDT.

As described in Chapter 5, the ISDT formulated here is argued to lead to e-learning systems that are: more flexible; encourage greater levels of adoption, innovation and differentiation; and, enable adaptation to the specific context. No claims have been made about other attributes of an e-learning system that may be thought desirable. For example, low initial and on-going cost, lack of dependence on specialised technical staff, integration with other systems, specific support of learning design and other pedagogical practices, and so on. Further research that explores how well this ISDT does or does not support those desirable attributes, and how they might be fulfilled could prove useful.

In addition, further testing of the ISDT could focus on testing specific design principles from the ISDT. Such testing could have two main aims: first, simply testing the claims put forward by these principles; and second, additional testing could improve and expand upon the specification of these principles. For example, a particularly interesting avenue for future research is further testing and investigation of the principles of form and function under the heading of “Scaffolding, context-sensitive conglomerations”. What different forms of
scaffolding can be provided to improve student learning or the quality of
teaching? Are there observable improvements? Which of the potential kernel
theories of activity theory, distributed cognition, and others provide useful
guidance in the design of such conglomerations? How can such conglomerations
be integrated into existing LMS such as Moodle, Sakai or Blackboard? There
would appear to be the possibility of a program of complementary design and
behavioural research in areas such as this.

6.5.4. Responding to further changes and emergence
Two of the fundamental assumptions of the ISDT presented here offer significant
possibilities of further research. The ISDT is based on an analysis of university
e-learning that assumes diversity, uncertainty and on-going change are key
characteristics. The very nature of e-learning and university e-learning will
generate areas worthy of further research that may well lead to improvements to
or replacement of the ISDT. On top of this the ISDT assumes that practice is
emergent and context dependent. The complex interplay of contextual factors will
generate additional changes that open up the possibilities for further research and
development.

6.6. Concluding remarks
This research has made a contribution to knowledge around the original research
question

How do you design, implement and support an information system that
effectively and efficiently supports e-learning within an institution of
higher education?
This contribution includes an analysis and description of current dominant university e-learning practice. The analysis reveals that the nature of university e-learning involves significant levels of diversity, uncertainty and on-going change. The analysis also suggests that the current dominant practices for university e-learning implementation – with their reliance on teleological processes and single, integrated systems – are ill suited to dealing with diversity, uncertainty, and on-going change. This analysis of existing practice has led to the development of the Ps Framework, which is presented as a nascent but still useful tool for analysing and describing e-learning practice.

In response to this apparent mismatch this work aimed to formulate an ISDT for university e-learning. At first, limitations with existing ISDT representations led to the development of an improved ISDT representation that has been used here and elsewhere. Using this improved ISDT representation, this thesis has described the formulation of An ISDT for emergent university e-learning systems. This ISDT provides theoretical guidance for an alternate approach to the design and support of university e-learning information systems. Use of the ISDT can lead to university e-learning information systems that: are able to support e-learning; emerge to match the requirements of the specific institutional context; can respond to on-going developments in e-learning; encourage greater quantity and quality of adoption by staff and students; and, provide a level of differentiation and competitive advantage.
References


Role-based access control, Fairfax, Virginia.


Ewell, P. (2009). *Assessment, accountability and improvement: Revisiting the*


Geirsdottir, G. (2009). *We are caught up in our own world: Conceptions of curriculum within three different disciplines at the University of Iceland*. Iceland University of Education.


Goles, T., & Hirschheim, R. (2000). The paradigm is dead, the paradigm is dead...long live the paradigm: The legacy of Burrell and Morgan. *Omega, 28*, 249–268.

57(3), 299–314.


Educational Technology Publications.


QUT, Brisbane.


Kasanen, E., Lukka, K., & Siitonen, A. (1993). The constructive approach in


Kember, D., & Dekkers, J. (1987). The role of study centres for academic support in distance education. Distance Education, 8(1), 4–17.


232.


Knight, C., Knight, B. A., & Teghe, D. (Artist). (2006). Releasing the pedagogical power of information and communication technology for learners: A case study


Higher Education, 50(4), 537–571.


426
Studies, 29(2), 103–114.


