CECIL: THE FIRST WEB-BASED LMS

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Abstract

The benefits of learning managements systems have been documented for more than thirty years. Coupled with the astounding potential of the internet they provided a compelling opportunity for "olde" mainframe and LAN developers to "have another go". This paper describes how a small group of enthusiasts within The University of Auckland Business School built a computer supported learning system (CSL aka Cecil) that became, perhaps, the first of a new genre of web-based learning managements systems. Cecil has been independently compared with the market leaders, found superior, and is The University of Auckland's sole LMS platform. Its features, functions and current performance will be described, followed by our "vision" for the future.

Keywords

Computer supported learning, learning management systems, internet based, flexible learning, successful use of the Web and learning technologies,

Introduction

The first description and major, academic analysis of computer managed instruction (CMI) was provided by Frank Baker (1978). At that stage the hardware choices were mainframe or minicomputer systems with local area networks (LANs) only becoming common by the mid to later 1980s. Computer-based training (CBT) or computer-assisted learning (CAL) did not began to take hold until academics received funding sufficient for desktop authoring systems and student computer laboratories were reasonably well populated. Heretofore the choices for CBT/CAL had been expensive systems such as the IBM 1500 or CDC PLATO. Few (none) of these systems existed in Australasia. On the other hand, some excellent work was done using conventional time-shared systems with languages such as FORTRAN, BASIC and COBOL. In the main, all of these technology platforms have disappeared along with their learning materials. (CDC was estimated to have spent US$600M during the 70's and early 80's.) The reasons for their disappearance has as much to do with the technology as the need for sustained motivation and reward amongst their academic supporters. (Stanford, 1997b)

The characteristics of computer-managed learning (CML) have been succinctly described by Robinson & Stanford (1997)

> CML is the generic term applied to the use of computers in managing the teaching and learning process, especially where testing is an integral part. The fundamental requirements for the use of CML are careful course design, elaboration of learning objectives and construction of tests. These are consonant with good educational practice. Their placement in a CML environment entails specification of the course objectives; division of the course into modules or relatively self-contained components; allocation of learning objectives to each module; preparation of a study guide for each module; and writing items for or otherwise developing a testbank.

It takes very little imagination to see the connection between the CMLs of yesteryear and the learning management systems (LMSs) of today. Dr. Jon Stanford of the Economics Department, The University of Queensland was one of the pioneers of CML in Australasia. His extensive publications document not only the benefits of CML but also the frustration and failure to get them "institutionalised". The twenty

year history of CMLs in Australia and Canada was presented at ASCILITE in 1995 (Sheridan & Stanford, 1995). Coincidentally, the first prototypes of Cecil were also presented at that ASCILITE conference (Sheridan, 1995). The rest, as they say, "is history".

In early 1995 the conditions were favourable to create a robust and extensible system that would assist in the management of courses, materials, and assessment. The principle author had been appointed as the head of the Management Teaching Technology unit of the University of Auckland Business School, David White, his co-conspirator, had built a Gradebook of considerable sophistication, and David was looking for a project to challenge his database management classes. The prototypes developed by these classes were so compelling that the MSIS HOD and the university's director of computing became product champions for the first version of Cecil launched in 1996. There were no appropriate servers on the market for something like Cecil, with the result that a load-balanced, environment of multiple, single-threaded servers was created by Richard Vowles, a very talented tutor in the MSIS department. It is for this reason that we believe Cecil became the first web-based LMS in February 1996.

Since then one might estimate hundreds of similar products have been created with the market share now going to Blackboard and WebCT. In 2001, The University of Auckland questioned the continued development of Cecil given the consolidation of the market and commissioned an independent, technical panel to evaluate Cecil in light of the competition. These products were considered and rejected as unsuitable due to their limited underlying data structures when compared to the Cecil system:

Number of objects (tables, views, stored procedures, functions etc.): 836 Objects
Number of tables: 388 tables
Number of columns (attributes): 3872
Number of rows: 154,560,246 (+3.3% per month growth)
Data: 63521.56 MB (+ 2.9% per month growth)
Average Number of transactions per second: 80-100
Number of sessions per day: 15-20,000
Number of paper enrolments: 94,000
Number of courses, 980
Number of academic users: 932
Percentage of total enrolment using Cecil: 74%

Cecil has developed over a period of seven years. It is a system that enables delivery of teaching, assessment and class administration to occur in one environment. Cecil contains the entire enrolment of the University allowing any course to use the system. The web site is one of the busiest in New Zealand. The operation is professionally managed by the University's technology support centre.

The Cecil Architecture

Cecil has been designed and built using a fully documented data model that mirrors administrative systems currently in use at the University and extends it to the requirements of the academic staff. At present it interfaces with nine different university systems. It is comprehensive, thorough and designed for growth.

Cecil has a number of features that enable its full use in the academic and professional environment. It is Internet enabled supporting world-wide access for Internet users using the popular browsers on a variety of common platforms. It has industrial strength database and server software installed on universally accepted hardware to provide a reliable, responsive, and flexible environment for work. Every transaction on the system is tracked and recorded in a highly responsive manner. The design specification calls for a response latency of less than one second. The security subsystem is extensible and therefore able to embrace all industry standards as they evolve. Secured sockets, encryption and bio-sensing devices can be implemented.

We support an 'open architecture approach to web-based products', because we believe that course content creation is best left to the marketplace. Academics should be able to use any state-of-the-art solution for the creation and tagging of learning objects.

Cecil has 6 load-balanced IBM front-ends, and two IBM 4 CPU SQL Servers on a 1GB network. It has 90GB on an IBM Shark SAN with backups on a SUN storage array as well. The University's Computing Centre maintains operators on site 24 h a day. Cecil has a remarkable record of reliability.

Cecil has a separate interface for students and for instructors**.** The student interface provides a single point of access to all enrolled courses, and within each course the Gradebook (marks-to-date), course materials, schedules, on-line assessments with immediate feedback, and communications systems (announcements, discussion groups and chat).

The instructor's interface provides access to relevant student's data, their assessments, their photos, and communication systems, as well as the tools to build references, test items, diagnostic feedback, course content, and various course activities. Authors are able to incorporate large item banks from textbook publishers and batch load these questions with a minimum of manual effort. The interface also allows the instructors to import data from optical mark readers (OMR).

Cecil is updated from the University's enrolment and registry system on a daily basis with the result that instructors do not need to create and maintain class rolls.

Cecil Explorer: Instructor's Interface

This section discusses the functional areas of Cecil from the perspectives of the instructor and administrator. A staff member interacts with Cecil using a program called Cecil Explorer (CE). Access to CE is normally provided through a Citrix client on the desktop. The Citrix server is also web-accessible and some academics choose to use this solution from home or when overseas.

Cecil is primarily an instructional management and assessment system. The challenge for any university that has an abundance of creative people from a wide range of disciplines (who are extremely eclectic in their teaching philosophies and practices) is to find one educational software solution to satisfy everyone. (Tong & Angelides, 2000)

Cecil was designed to support all of the University's disciplines. It allows instructors to store and organise all of their teaching and research materials in one location and then assign these resources to individual courses. In this sense it becomes a personal body of knowledge (BoK) that can be shared with colleagues and with students. The architecture of Cecil is designed to replicate the BoK from the academic's desktop to the University system and then on to the student's laptop. (Figure 1)

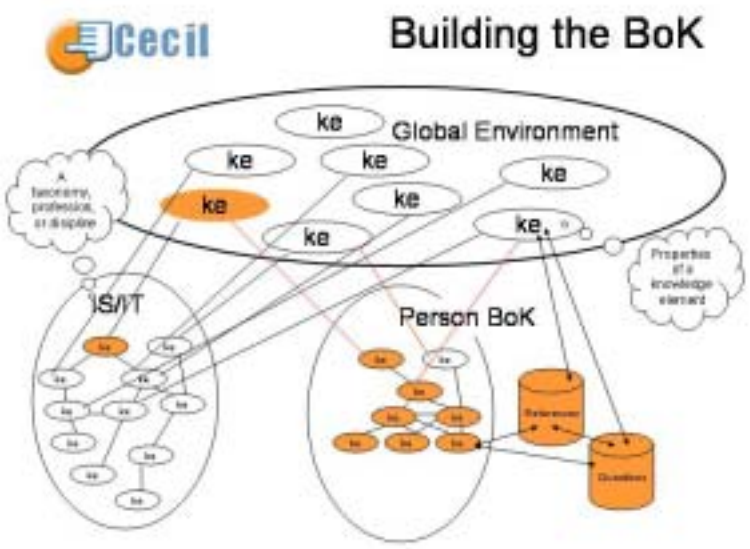

Figure 1 Body of Knowledge (BoK)

As an assessment system Cecil supports instruction by storing large banks of questions and then selecting, from these banks, questions that meet the instructor's instructional objectives. The questions form an assessment that is presented to the student via a web browser either under supervised or non-supervised conditions. Assessments are immediately scored and the feedback is provided using a protocol established by the instructor. Cecil supports multiple-choice questions, questions with options of variable weights, criterion (rubric) marking, sub-scale based feedback, embedded random variables, short answer (phrases), batch loaded OMR scanned tests, and surveys.

Management of courses through Cecil is extremely flexible; academics access the system to post announcements, upload materials and use Gradebook features from the web. Professors visiting Europe can instantly inform all their students of the latest developments and tutors regularly mark assignments at home and post the marks via their Internet connection.

Topics and Bodies of Knowledge

Cecil provides other services such as an impressive method of organising multimedia or text based learning materials. The 'topic' system enables the instructor to file all relevant information regardless of its source and to drag and drop these topics into various class folders. As the 'topic' system grows it will become a personal body of knowledge and a useful system for teaching and research alike.

In the Cecil data model all learning is related to what might be called a career, discipline or a body of knowledge (BoK). Many professions such as medicine, accounting, mathematics and information systems have well articulated taxonomies. The body of knowledge (BoK) for information systems has been developed over a number of years and based upon numerous studies by individuals and professional organizations. In the past, IS'95and IS'97, have been proposed as a model curriculum by the AIS, ACM and DPMA (Longnecker *et al*., 1995; Davis *et al*., 1997). This curriculum details hundreds of knowledge elements and classifies them in a variety of ways that includes the use of Bloom's Taxonomy of Educational Objectives (Bloom, 1956). Combinations of the knowledge elements form learning units that in turn form the basis of courses of study in IS. Using Cecil the MSIS Department has modeled the body of knowledge for Information Systems to make a formal link between professional requirements, courses of study, individual courses and the assessments (Figure. 2).

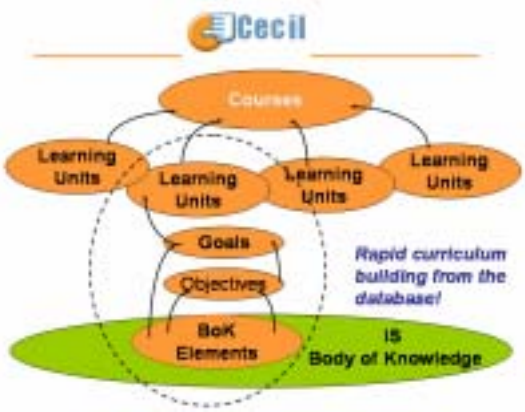

Figure 2 Body of Knowledge (BoK)

Cecil has recently been enhanced to allow librarians to create and embellish the BoKs with materials from the university's digital library collection. Now instructors and librarians can leverage the institutions digital assets in creative, applied ways.

Building a link between assessments and knowledge elements has many benefits; one is the student's ability to plot their progress in their studies over weeks, months, or years. The system keeps students' achievement data and so can report on what parts of the body of knowledge the students have learned, what remains to be learned for a qualification, and what changes have occurred in the body of knowledge that were not available when they were taking their training. This latter feature is especially useful for planning postgraduate sessions. Life long students will be able to monitor the evolution of their discipline

through the evolution of the university's various bodies of knowledge.

Assessment and Feedback Options

Cecil provides secure access to self-assessment options such as multiple-choice questions (including true/false as well as multiple-right questions), questions that use embedded random numbers. Multimedia objects can be inserted into questions that include streaming audio, video, graphics files, and even QuickTime movies. Java applets are also becoming popular and these can also be inserted into the custom questions.

When assessments are generated within Cecil they become permanent records in the database. Any assessment presented to a student is capable of regeneration at any time in the future. In other words, test items are locked once delivered.. No aspect of the assessment can be changed at any time in the future. A tutor can regenerate a test to review it with a student and can indicate the student's response and the correct answer at the same time. Cecil's design respects the due diligence required of traditional assessment methods. Since every student's response to a question is stored, we can also model the activities of a student or group of students during an assessment – including their vacillation over the "right" answer

Self-assessment activities are one of the most popular features of the system. Students use Cecil at all hours to check their understanding of the learning materials. The fact that no academic credit might be obtained for doing a self-assessment seems irrelevant so long as the learning content is clearly mapped to the course objectives and examinations. In the first semester of 2002 Cecil presented more than 4M questions to students.

Many forms of feedback are provided that include: feedback on the each of the possible student's responses, feedback immediately after a response, feedback at the end of the quiz, and/or feedback by email. The feedback message can be either extremely terse or detailed. Naturally feedback messages can include multimedia objects as well as links (URLs) to other useful sites.

Gradebook

Gradebook, a highly flexible method of tracking student progress and has been designed to integrate with the University's Academic Registry. Gradebook is loaded automatically with the latest enrolment data from the Registry. Where a course has many tutorial streams (sections) then course streams may be loaded into Gradebook. Instructor's can assign tutors to mark assignments by stream and give them access to selected parts of Gradebook for fixed periods of time. Gradebook activities can be linked to grading criteria (a type of rubric assessment) with the result that essays and other assignments can be marked anywhere, anytime (over the internet) and the student's grades updated, feedback sent by email and the students enabled to see their marks via the web as well. Gradebook has many unique features for course management techniques (plussage, aegrotat standing), and also advanced grading techniques.

Cecil's Student Interface

Student users access Cecil through a web interface and at the home page have the option of viewing a 'diary' with a view of 'today'. The most popular features are checking for announcements and down loading new learning materials. Last year an option was provided to send SMS to students' cellular telephones. In two months more than 400,000 messages were sent. Unfortunately the telephone company was not willing to continue the free trial and so the service was discontinued.

The home page menu bar displays options for selecting information on enrolled courses, the resource booking system, the discussion system, or the personal preferences unit. Other options include checking announcements by course, activities associated with a course, progress results for a course, a description of the course and the ability to download materials. All of these will be discussed in the following paragraphs.

Student users have a number of parameters about themselves and the defaults of the system that they may change. They may change their e-mail address from the default University address to another outside of the University such as their address at work or home. Students may also substitute another photo for the

one that is automatically loaded from the University's identification card database. The student can also enter a 'preferred' name. Often students from Asia use this option to insert their 'Westernised' name.

As noted above, the home page for Cecil defaults to today's date (0800–2000) and lists all of the tasks due for all of the student's courses. The user can choose to display weekly and monthly views to get a more comprehensive look at what lies ahead.

The entries in the calendar view have icons that identify if the event is a booking. If the student 'clicks' on any of these events s/he is taken directly to its detailed description or activity. Students select a specific course from a list of current courses via a pull-down menu. Each course has associated with it announcements, activities, results, discussions, and downloads. As noted in Figure. 3, two summary tables are provided. One indicates what is 'new' such as the number of unread announcements, and number of learning materials available but not yet downloaded by the student. The second 'progress' table lists the course activities and their status. Since each course can use Cecil in slightly different ways the list of activities can vary. In general, the list includes all of the assessed and non-assessed 'events' within the course and against each a summary of those completed and in total.

Figure 3. Cecil Web - a calendar view

Like many large institutions, The University of Auckland has very large enrolments in its first and second year courses. In order to provide seminars, laboratory experiences, projects and tutorials to small groups of students, they are 'streamed' by the University's registry system. Inevitably the students with work and home commitments find themselves placed in impossible situations and need to be moved.

Fortunately Cecil provides these students with self-streaming options so that they can shift themselves around to more convenient timeslots if some are available. When all else fails the students see the course coordinator! This streaming feature has saved students much hardship and course coordinators several days work each semester.

Lectures are associated with a specific date and may have assessed or non-assessed status. In other words, there could be an attendance credit associated with a lecture. If the student selects a specific lecture then the date, time, location and duration of the lecture are provided. The learning materials associated with the lecture may be made available, at the discretion of the lecturer, before or after the lecture. These learning materials can be in a wide range of file formats (55 in fact) that include: Microsoft Office products, Visio, ERWin, Adobe Acrobat, QuickTime, Real Audio, Real Video, and Lotus ScreenCam. The Business School produces a CD ROM each semester with updates to the Internet browsers as well as all of the plug-ins to the browsers that students may require and learning materials too large to conveniently download.

The collaborative work area termed 'Discussion' provides threaded discussions as well as synchronous chat rooms. The interface has been configured so that it provides a visually seamless transition to and from the Cecil home spaces. Cecil built the Discussion application after attempting to use three major commercial products – none of which would support hundreds of students simultaneously. Collaboration environments are growing in sophistication and demand is high.

Evidence of Success

There is evidence that students at the University are motivated to participate in learning activities for several reasons: where an activity is assessed for credit, where an individual feels that participation is useful (practise for an exam), and (we suppose) out of idle curiosity.

Evidence from several observations and studies in the University have noted improvements in learning outcomes, perceived usefulness of on-line learning tools and use of tools. There are several reports of the use of on-line learning tools for no credit, purely as a learning exercise to test understanding.

In 1997 after 1 semester of operation student responses were sought on the ease of use and perceived usefulness of the site. The results in Table 1 show a positive response to the system. The results have been drawn from two identical questionnaires given a total response rate of 42%, the response rate for the first round being 24%. (Paynter & Ong, 1997).

Paynter & Frazer (1999), document the comparison of Cecil with two other computer learning sites of a similar nature using a WAMMI questionnaire. A WAMMI is a Web usability questionnaire (Web site Analysis and MeasureMent Inventory).

This is a tool that can be used to allow your users help you improve the effectiveness of your web site. Their survey found that on a scale of 1–5 where 1 is the best and 5 is the worst the current Cecil system scored 1.8, where as the best of the other systems scoring 2.3.

Evidence from another faculty has shown that 68% of students attending the course said that Cecil pre-test had increased their level of understanding of the lecture. 85% of this student group found the on-line tests a useful diagnostic while 92% responded that the on-line materials were useful.

Response content.	Response rate 24%	Response rate 42%
Access from home always	7 %	13%
Access from home sometimes	17%	65%
First access to Cecil found to be very easy to OK	97%	90%.
Students would use Cecil as a study aid for no credit.	90%	85%
Students would use Cecil to look at their marks in other papers	97%	89%
Students would like to take Cecil tests for their other papers	67%	(71%).

Table 1. Summary of results from Cecil survey.

The School of Biological Science also analysed the grades for a course against the previous history of the course and found that there was a significant increase in the scores of individual students on the course. Thus is evidence to support the premise that students both perceive the system to be useful and gain advantage with their studies.

Enterprise-wide Decision Making

From a management information systems (MIS) perspective the term 'enterprise' means a consideration of all of the organisational's units, functions, processes and data elements (Laudon & Laudon, 1999). A number of systems, similar to Cecil are on public offer to academics and their departments. Very few of these systems have been adopted on a school-wide basis and then exploited for their enterprise wide benefits. The installation of a stable user friendly system may facilitate more than the collation of marks and the provision of feedback to students, it enables the closer collaboration of staff at any scale within

the organisation (Figure 4).

Historically the need to provide a working solution to problems has lead individuals to purchase and administer their own systems. Often the implementation and administration of these systems have been subject to several pitfalls. While the individual implementation may be sound there are increasing security risks associated with the proliferation of these systems. These risks may over time compromise the organisation's information systems security and the privacy of the client's data. Simple and essential functions such as backups and thorough administration may be unavailable luxuries for the individual's system. The short-term reliance of these systems also on one or two staff to provide maintenance will become a longer-term liability as the consequence of staff departure become apparent.

Figure 4. Prototype data mining tool using Crystal reports.

These issues can be addressed, in many universities compromise and compound systems have been forged. The inability to share and transfer data and teaching resources between administrative units and departments is, however, a major loss. This must be measured both in terms of the costs incurred in data translation and duplication and the frustration and inefficiency of the system. A recipe for chaos and data corruption is apparent (Mensching & Adams, 1991).

Given these hazards an enterprise solution has been developed. Cecil allows the instructor or administrative units to mine the statistical data stored within its database. Such data mining may be used to gauge the performance of a cohort of students, or look at the effect of changes in teaching and learning both in present and for trend analysis (Dhar & Stein, 1997; Turban & Aronson 2001).

From small beginnings Cecil has begun to produce management reports and comparisons reports for student grades and also for resource usage. Staff members may produce status reports to prompt their teaching activity, managers may compare departmental grades across the faculty, and postgraduate coordinators may select from the data base all those students who have satisfied a number of criteria for invitation to higher degrees.. Such reporting techniques are extremely useful in terms of planning strategy and also in terms of labour savings.

The Future

As with all locally developed and resourced products, funding and critical skills are in short supply. Systems like Cecil need to attract the wider academic community if they are to flourish. Cecil is now serving the School of Biological Sciences by providing learning materials to more that 24 of the best secondary schools in the country. The SBS has shown a remarkable increase in applications and accepted enrolment from these schools in the past year. The gender balance has changed significantly too! A nation-wide roll out will continue in an effort to attract the best and brightest.

We realise that knowledge management principles must be evident in LMSs. Cecil currently manages approximately 20,000 documents with versioning implemented. Meta-tagging and enhanced search engines are priority issues for LMSs. Cecil has the database attributes ready when a specification is finally selected.

An LMS must be designed to cope with procrastinators and the inevitable boom at the end of semesters. We have experienced a four fold increase in activities from one day to the next. As our on-line activities extend well into the "wee hours" we have come to realise our students need support after their part-time employment and household and family responsibilities recess. 24/7 is a fact of life when an increasing proportion of our students must work to survive.

Portals do not appear to be popular with students. Students are extremely parsimonious and efficient. Access to systems must be simple, information easy to access and the results predictably rapid. We must listen carefully to students. Many students do not desire complexity and use computers under sufferance. It is a tool, not an end in itself. We must often remind ourselves to listen carefully and observe.

Recently Cecil has become a "meeting place" for departments, lecturers, honours students, and students with common ethnic and cultural interests. Repository and communications / discussions areas seem to be creating new demands for service.

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