The evolution of an LMS: Cecil fifteen years on

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"Cecil, the First Web-Based LMS" (ASCILITE, 2002) described how The University of Auckland's home grown LMS originated. Now - fifteen years on we describe the challenge of maintaining such a system given of the evolution of computer hardware and software and the increasing sophistication of its users. Over time we have made the transition to the latest processors and database architectures and at present we are running a pilot to replace a significant a amount of our own code with Microsoft Office *SharePoint Services* (MOSS) - while seeking to retain the original functions and features including a bodies of knowledge (taxonomy), gradebook, assessment engine and communications modules. One important outcome of the pilot is to relieve our team of developers, who have '*grown up'* with Cecil, from legacy code maintenance. The SharePoint pilot has proved that moving to a higher level of abstraction will position the University to deliver core functionality 'out of the box' freeing resources for integrating new computer supported learning features. Innovators in the teaching and learning 'space' may find the history of Cecil useful as they prepare for fearless change.

Introduction

Cecil began in 1995 and has been designed, implemented and maintained over the past fifteen years by a combination of two lead academics and more than 60 students who began as part-time programmer / developers shadowing their full-time peers. As their mentors moved on, trainees from the student population came on-board. Over the period many changes occurred in software and computer architectures. In most cases change was inevitable as hardware and software engineering evolved rapidly thanks to Moore's Law. Some new features were based upon requests from academics with their respective departments paying to have the option included for the following year. In the beginning there were no appropriate servers on the market for something like Cecil, with the result that a load-balanced, environment of multiple, single threaded web servers running on a single box was created by Richard Vowles, a very talented tutor in the MSIS department. Based on this homespun technology we believe that Cecil became the first web-based LMS in February 1996 - our first semester. (Sheridan , 1995) (Gardner & Sheridan, 2000) (Gardner, Sheridan & White, 2001 & 2002) (Sheridan, et al, 2002)

Cecil's authoring tools were initially accessed via Citrix terminal services to provide a richer user interface for academics than was possible, at that time, in a web browser. From the students' perspective Cecil used the popular browsers on a variety of common platforms. Based on Microsoft SQL Server installed on commodity hardware Cecil provided a reliable, responsive, and flexible environment, both for development and production. We began with desktop computers as servers and after a couple of semesters and with rapidly increasing loads migrated to a Sequent ™ four processor system thanks to one of our champions, the Director of Information Systems. The use SQL Server was a matter of considerable industry speculation because Cecil was the busiest educational site in the country running on what some believed was a system inferior to Informix, Oracle, Sybase, etc. Keeping up with the browser wars and noting many students seldom updated their browsers was a challenge for the team. Now both academics and students use browsers to access Cecil's resources.

One of the Cecil "founders", an educational psychologist, requested that every transaction on the system be tracked and recorded. The other Cecil "founder ", an engineer and a systems and database architect, agreed. (Sheridan, 1998) The design specification also called for a response latency of less than one second. The security subsystems were extensible and therefore able to embrace all industry standards as they evolved.

We supported an 'open architecture approach to web-based products', because we believe that course content creation tools were 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. It is only in recent years that taxonomies/ontologies have become part of many academics' vocabulary yet we designed Cecil from the start to integrate a taxonomy and to relate all assignments and assessments and other learning resources to the taxonomy – in effect to embed the taxonomy and the graduate profile at the same time in the interests of life-long learning. (Figure 1) (Sheridan, 1997) (Sheridan & White, 1997) (Ronchetti & Sant, 2007)

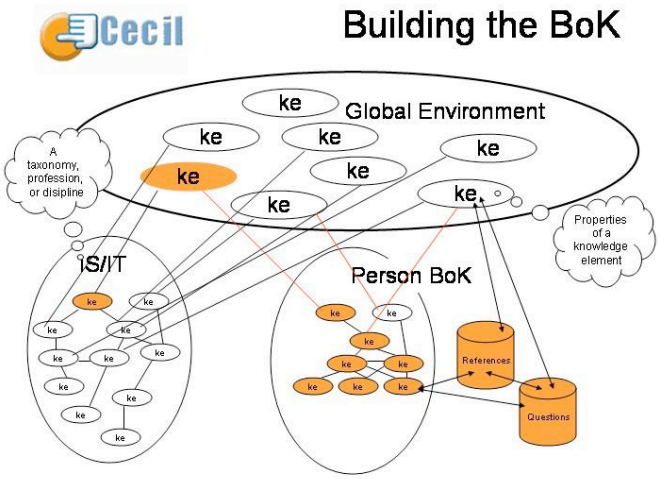

Figure 1: Bodies of knowledge

In spite of our best intentions the hundreds and then thousands of users did not understand the design and continued to manage and use Cecil on a semester-by-semester basis. We are still hopeful that teachers and learners will come to understand the integrative power of taxonomy. None the less the following sections will provide an overview of the features and functions of Cecil and how it evolved given the irresistible evolution of the technologies.

Gradebook functionality

Grade book, the cornerstone application within Cecil was designed before Cecil as a stand-alone MS Access application. It records assessments and non assessments (such as milestones, attendance) of a student or group of students within a class. It was possible to set up a template of assessment types such as labs, mid-semester test, project and final exam and to assign weights to each of the events. These could be 'rolled over' from year to year with the result that departments were found to gradually standardise their class delivery & assessments.

The university historically allowed departments / classes to apply grades to accumulated marks in unique ways with the result that the Gradebook was designed to allow the lecturer to slide the demarcation points for grades such as D, C, B, A to account for certain break-points in the distribution. As a result there were calculated 'raw' marks, and 'adjustments' were allowed to render the final grade.

Marks can be uploaded to the Gradebook from Excel or CSV files. Data may be obtained from OCR scanners or the result of merging data provided by a team of markers. To provide widespread use, the Gradebook was modified to allocate (randomly, numerically, or alphabetically) a certain number of students per marker with the result that markers may enter data into the Gradebook one at a time using a web-interface within the range of students they were assigned, or the course coordinator can merge the markers data into one large spreadsheet for uploading. An audit trail of all transactions within Cecil was part of the initial design. When marks are entered each is tagged with the user's ID and time stamp. A change in marks requires the entry of a comment to justify the change. These changes are summarised and sent to the teaching team to ensure any changes are noted by those in ultimate authority.

Other features included 'plussage', 'aegrotat', 'DNS' and 'x best out of y'. These later features significantly reduced the workload of the lecturers who had large classes with the result that there were a number of compelling reasons to use Gradebook even if other aspects of Cecil were unattractive. The return on investment (ROI) for some of these features was outstanding. In fact ROI has been one of the

central motivations in creating 'round trip' solutions. (Phillips et al, 2004) (Moonen, 2005) (Kirkpatrick & Kirkpatrick, 2006)

Approximately five years ago the Registrar requested that all final grades be submitted via Cecil and at that point few reasons remained not to use the system. Once the final grades are submitted the Gradebook is locked. Any subsequent changes require the lecturer to complete a hard copy form and include an acceptable rationale for the change.

The original multiuser Gradebook was written in Delphi and underwent a number of transitions as more features were added. Approximately ten years ago PeopleSoft purchased a version for use in their academic system. Subsequently a web-based version was introduced. An improved Gradebook is now under development which will integrate assessment creation, links to taxonomies, and assessment results whether OCR, peer assessment, team-based or output from rubric / criterion marking applications. Information will be presented using visualisation tools to assist students in understanding their results in comparison with their peers, and academics in understanding the validity and reliability of their instruments.

Core systems then, now, and implications for the future

Over the past 15 years there has been a continuing concern about 'sizing' the LMS to meet expected demands – often building in a matter of hours to completely challenge the engineering design. In the beginning we created multiple servers and adjusted the load of each server to provide optimal response times. Continued vigilance was the 'secret' to excellent response times as the art of load balancing was learned and applied. The rule of thumb we adopted was to build a system three times the usual daily load. The real impact of students can be observed in Table 4, and some sense of what drives this activity was noted in a paper on procrastination. (Sheridan & Jenkins, 2008)

Historically the up-time of Cecil was nearly 100% and been maintained although we transitioned from desktops to IBM 6600 series, to current virtualised servers. Storage began with low cost RAID followed by Storage Area Networks (SAN) with fibre optic plumbing as Cecil became viewed as 'mission critical' for the university. Team Cecil maintained a wariness with regard to plugging into central systems following their discovery that money spend on fitting gigabyte communications within the Cecil domain was frustrated by a 10 mbps connection to the university backbone which itself was running at <5%! SQL Services Limited became our external auditors and their biggest customer in 1998. Colin Anderson and his team were essential backup for a young group of programmers and an institution that was very much reliant on a exemplary Quality of Service.

Virtualisation technology is now a seemingly stable solution for optimisation of hardware investments – as multiple operating systems each running many applications can run on one CPU. Thus each operating system has its virtual machine. It is certainly an economical solution that will be pursued given the logins and hits for 2009 (Table 1). Note that the learning materials are still primarily Adobe Acrobat files (PDF) and MS Office files, File Type Analysis (Table 2) and the File Size by Type Analysis (Table 3) indicate the creeping threat of large files, often videos – which academics may upload to Cecil and subsequently compromise Quality of Service. (See: "Downloads" (Table 4)) Our current solution is to capture the most significant assets, lecture archives, and place these on specialised media servers. We are also cautiously observing academics as they take advantage of approximately 50 television channels through UniSat and e-cast with the ease of use tools found in Office 2010. (Collie, Shah & Sheridan, 2009)

Table 1 Logins & hits for 2009

2009	Number
Max concurrent logins (15 min)	2561
Max concurrent logins (60 minutes)	4516
Max daily logins	39527
Max weekly logins	206807
Page hits per hour	188,874
Page hits per day	1,828,766

Table 2 File type analysis 2008

File Type	%
PDF Related	46.49%
MS Office Related	46.27%
Binaries	1.89%
Images	1.37%
Text	0.95%
Video	0.86%
Flash	0.82%
Compressed Files	0.82%
Audio	0.45%
Unknown	0.08%

Table 3 File size by type analysis 2008

File Type	GigaB	%
MS Office Related	34.0	38.14%
PDF Related	30.0	33.67%
Video	9.5	10.65%
Flash	8.5	9.53%
Audio	2.5	2.86%
Binaries	1.9	2.15%
Compressed Files	1.6	1.82%
Images	0.9	1.00%
Text	0.1	0.10%
Unknown	0.1	0.09%

The assessment engine: Robust, reliable and irreplaceable

The most important contribution an LMS can make to teaching and learning is the provision of feedback. Hattie (2009) provides a meta analysis with specific emphasis on 'what works' Petty (2009) quickly followed with a four page summary of Hattie's findings with a rank ordering of what has an 'effect' Both Hattie and Petty identify 'feedback' as a major, positive contribution to improvements in learning. Cecil was designed with this service in mind and so from the beginning had a variety of assessment questions each capturing the response as well as the time stamp of the response. Cecil provided multiple-choice, weighted multi-right, and random number / word embedded problems and was adapted to provide criteria-based assessment as well (White, 2002). Feedback may be provided in a number of ways so that formative and summative assessment could contribute to learning events as well following the final exam. To the extent that academics provided on-line assessment and imported off-line assessments, Cecil is a repository for the strengths and weaknesses of tens of thousands of students through out their time at the university. It was this design that contributed to the vision of life-long learning and the institution's potential role for prompting professional 'continuing' education with mass customisation for each student. (Sheridan & White, 1997)

A relatively new feature is the provision of online student evaluations of teaching. This has been growing significantly over the past few years because the processing is much easier and quicker plus the students comments are automatically incorporated with the survey. Some concern was expressed about the participation rates for these online surveys so we examined the grades of students who participated to better understand 'who was saying what'. The results confounded most academics because it was the better students who were making most of the detailed comments. (Sheridan & Kan, 2007). Many courses of study are now using online surveys exclusively with good results. One programme provides a credit only if a majority of students participate. This 'incentive' seems to work well.

The assessment engine was written in Borland's Delphi and used the Excel engine to compute or parse the questions in real time. Given the millions of questions provided by Cecil the robustness of this design is amazing. See: "# of questions answered by students" (Table 4) With the demise of Delphi programmes a solution was sought and QuestionMark™ was selected two years ago. Unfortunately the QM the tools appear underdeveloped for tertiary level academics. A recent review of a knowledge base of authoring

tools provided by Brandon-Hall narrowed the field to ~6 relatively weak options. We are now at a cross roads: either rebuild our own applications with a new suite of tools or consider a toolset such as Respondus™ and build a bridge to Cecil (Sharepoint).

The challenge of social networking

Both academics and students requested chat rooms and discussion boards to fulfil the need to exchange opinions, have debates, leave messages, etc. Through the use of a succession of commercial products we failed to deliver the functionality and educational setting required. For example, we believed if assessment of contributions needed to be credited we needed tools that would aggregate each student's contributions, manage threads so that merging could occur, feature photographs or ensure anonymity if necessary, search through threads for common themes, etc. In the end we built our own discussion system to meet the requirements. Of course with hundreds of classes and many with huge enrolments we needed a means to assign students to smaller groups so that social interaction had some usefulness. Along the way we applied a strange product called PieSpy to provided a way for academics to visualise discussions quickly to see if any significant interactions were being made. (Sheridan & Witherden, 2006). The growth in discussions can be appreciated under "Online Collaboration" (Table 4). Given more than 2 million 'readings' the collaboration feature of Cecil is important. At this point we are now implementing the collaboration features of SharePoint (2007) with anticipation for the known improvements in SharePoint (2010)

In a somewhat oblique entry into social networking Cecil negotiated an arrangement with Vodaphone in 2000 to send short text messages to students who were willing to register their mobile numbers. The announcements in Cecil were abbreviated to fit the viewport of a mobile phone. In the four months the feature was available 400,000 txt messages were sent by Cecil advising students of changes to their assignment dates, lectures, etc. Given the success of this innovation, perhaps the first in the world. Given the competitive market, it was surprising the vendor ceased to provide the service free of charge.

Where to from here?: Microsoft Office sharepoint server as an LMS foundation

For the first time in the authors' experience, spanning more than thirty years, we now have a system that bridges both academic and administrative interests. We believe we can leave the 'back-end' to a vendor and build the features and functions into it that the academy desires. The opportunities as we see it are to have authentication control over every part of the system based upon the roles of the individuals concerned. As persons become employees, students, transition between students and employees or finally leave the university we can grant access and control across all of the LMS. Document management is assured with versioning and access controlled. Staff and students will have personal websites, wikis, blogs, and portfolios without huge administrative problems. Staff and students may form sub-groups, invite others to participate, integrate their email, project plans, discussions, RSS feeds, etc. without undue difficulty. SharePoint 2010 and Office 2010 will appear the same through common and bridging interfaces. Location independence will be possible for our MBA and part-time students. We can have joint viewing (chat), discussions - asynchronous learning. Team-aware calendaring will assist in coordination. We can organise libraries of resources: documents, media, and links for classes or teams. Academics can 'drop in' to see how things are going anytime, from anywhere. In effect we can create environments that are aligned with the real-world working conditions.

We also plan to introduce workflow solutions to cover assignment submissions, criteria marking , and feedback. Administrative tasks such as pay sheets have already been implemented with no paper passing between teaching assistants, supervisors and the department managers. We look forward to solving other time consuming tasks.

At this point we have two years of experience in delivering several classes via the SharePoint crafted LMS. Features of Cecil are been gradually provided in a SharePoint context through the familiar web-based interface in parallel with the current Cecil functions. Web 2.0 services are being provided simultaneously to other applications within the university. Software developers are beginning to see the advantages of a layer of high abstraction on which to deliver solutions..

Throughout this process we have been determined that our ability to capture transactions and subsequently analyse our data is not impeded. Fortunately there are hundreds of academic institutions who are building web parts, web objects and general functionality. Based upon what we know about

educational institutions in the USA and UK there should be a lively exchange of designs, templates, patterns, workflows and consultants! No institution needs to remain captive to a single LMS vendor.

Final thoughts

Computer supported learning (CSL) remains our goal. Over the years we put a huge effort behind 'listening' and then attempting to deliver on their requests. The continuous, evolving change in platform technologies often delayed the range and improvements in features and functions. We now see many opportunities through the adoption of Sharepoint(TM) that will allow us to address enterprise level improvements in teaching & learning.

Table 4: Operational capacity and growth

General Cecil Utilisation 2007 / 2008				
		2007	**2008**	**+/- %**
Announcements				
# of announcements made		65,414	66,769	2
# of courses that made announcements	(2)	3,665	3,668	0
Online Collaboration				
# of discussion messages posted		36,696	52,399	43
# of discussion contributors		4,758	7,405	56
# of times discussion messages were read		2,244,365	2,401,6	7
Marks				
# of marks recorded		1,385,182	1,372,1	-1
# of courses that recorded marks	(2)	3,193	3,304	3
Online Tests				
# of online tests attempted		620,256	575,193	-7
# of courses that delivered online tests	(2)	203	162	-20
# of questions answered by students		8,681,389	7,337,0	-15
Online Student Evaluations				
# of student evaluations completed		9,458	12,944	37
# of courses that used student evaluations	(2)	290	403	39
Downloads				
# of files available for download		56,617	68,255	21
# of courses that have files for download	(2)	2,664	3,032	14
# of file types distributed to students		125	172	38
Total Size of files available for download (Mb)		60,396	91,286	51
General Utilisation				
# of Logins		4,658,181	5,610,0	20
# of courses that actively use Cecil	(1)	3,835	3,878	1
# of courses offered	(2)	5,347	5,310	-1
% of total courses offered		71.72%	73.03%	
# of staff involved in the active courses	(3)	2,515	2,719	8
# of students enrolled in active courses		35,615	35,615	0
# of students enrolled in all courses		38,602	38,515	0
% of total enrolled students		92.26%	92.47%	
# of enrolment in active courses		216,924	214,631	-1
# of enrolment in all courses		227,168	224,456	-1
% of total enrolment		95.49%	95.62%	

Note:
(1) *Active Course* is defined as a course which has activities setup OR has made announcements OR has marks recorded and has at least one student enrolled in course.
(2) The term *Course* is equivalent to the *Class with enrolled component* defined in nDeva.
(3) Staff includes Course Coordinators, Lecturers, Tutors and Markers specified in Cecil

Many advances in technology are poorly understood and the learning curve is assumed to be very steep. Our emphasis is to provide common tools and support targeted at research, teaching and service improvements. We believe we can adapt current, productive working environments used by industry for the benefit of the university, convince our academics to use them effectively, and thereby better prepare the students for their professional careers.

If you build it they will come? In fact, our agents of change were principally our students who were employed as ELFs – extroverted learning facilitators. ELFs became a remarkable group of people who visited academics and assist them in understanding how Cecil can be used most effectively in their discipline and specifically in their classes. "No one should under estimate the power of an ELF".

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