Principles in Patterns (PiP):

Final Evaluation Report

WP7:40 Project evaluation synthesis

July 2012

University of Strathclyde

1. Acknowledgements

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3.1 Brief description of the project

The Principles in Patterns (PiP) project was funded by JISC under its Institutional Approaches to Curriculum Design Programme to develop new, innovative technology-supported approaches to curriculum design, approval and review. It is anticipated that such technology-supported approaches can improve the efficacy of curriculum approval processes at higher education (HE) institutions, thereby improving curriculum responsiveness and enabling improved and rapid review mechanisms which may produce enhancements to pedagogy. The aims of the PiP project were to develop and test a prototype online system (Class and Course Approval Pilot: C-CAP) and a linked set of support materials that could: a) improve the efficiency of course and class approval processes at the University of Strathclyde; b) support the alignment of course and class provision with institutional policies and strategies, and; c) integrate the course and class approval processes into the corporate information environment.

3.2 Summary of evaluation questions and methodology

The evaluation methodology was structured according to several evaluative phases, within which a number of quantitative, qualitative and theoretical techniques were deployed. Data collection approaches germane to a number disparate domains was used. Evaluation techniques included heuristic evaluation, protocol analysis, stimulated recall, questionnaire instruments (pre- and post-test), group interviews, Most Significant Change (MSC) approach, theoretical process analysis, qualitative benchmarking, Pareto analysis, and structural metric analysis. The evaluation was designed to enable better understanding of C-CAP's impact within particular stakeholder groups and on approval process efficacy. This included exploring the acceptance of C-CAP among users, its ability to support curriculum design tasks, and its potential for effecting improvements in approval process management and efficiency. An additional objective was to use findings from prototype testing to inform future practice and the embedding of C-CAP at the University of Strathclyde. More generally the findings were intended to inform the HE sector about the technology-supported approaches that can be deployed to improve curriculum design and approval processes.

3.3 Summary of main findings

Evaluation activity found the technology-supported approach to curriculum design and approval developed by PiP developed to demonstrate high levels of user acceptance, promote improvements to the quality of curriculum designs, render more transparent and efficient aspects of the curriculum approval and quality monitoring process, demonstrate process efficacy and resolve a number of chronic information management difficulties which pervaded the previous state. The creation of a central repository of curriculum designs as the basis for their management as "knowledge assets", thus facilitating re-use and sharing of designs and exposure of tacit curriculum design practice. However, further process improvements remain possible and evidence of system resistance was found in some stakeholder groups.

3.4 Summary of recommendations

Recommendations arising from the findings and conclusions include the need to improve data collection surrounding the curriculum approval process so that the process and human impact of C-

CAP can be monitored and observed. Strategies for improving C-CAP acceptance among the "late majority", the need for C-CAP best practice guidance, and suggested protocols on the knowledge management of curriculum designs are proposed. Opportunities for further process improvements in institutional curriculum approval, including a reengineering of post-faculty approval processes, are also recommended.

4. PiP background and evaluation context

4.1 Description of PiP and the evaluation context

The Principles in Patterns (PiP) project was funded by JISC under its Institutional Approaches to Curriculum Design Programme [1] to develop new, innovative technology-supported approaches to curriculum design, approval and review. It is anticipated that such technology-supported approaches can improve the efficacy of curriculum approval processes at higher education (HE) institutions, thereby improving curriculum responsiveness and enabling improved and rapid review mechanisms which may produce enhancements to pedagogy [1], [2]. Curriculum design in HE is a key "teachable moment" and often remains one of the few occasions when academics will plan and structure their intended teaching [3]. Technology-supported curriculum design therefore presents an opportunity for improving academic quality, pedagogy and learning impact [4]. Approaches that are innovative in their use of technology offer the promise of an interactive curriculum design process within which the designer is offered system assistance to better adhere to pedagogical best practice, is exposed to novel and high impact learning designs from which to draw inspiration, and benefits from system support to detect common design issues, many of which can delay curriculum approval and distract academic quality teams from monitoring substantive academic issues, e.g. [5], [6].

The rapid generation of new programmes of study, or the rapid adaptation of existing curricula, is also increasingly necessary. Institutions need to better respond to quickly changing academic contexts, the changing demands of employment marketplaces and the expectations of professional bodies [2], [7], [8]. Disciplines within the sciences and engineering appear to be particularly exposed to these pressures, with new technological or environmental developments increasingly necessitating the re-engineering of curricula or the rapid embedding of new skills [8], [9]. This scenario is also influenced by the globalisation of the HE sector more generally [10], [11] which, within the realm of curriculum design and approval, is placing additional pressure on institutions to devise specialist curricula designed to attract international students and/or suitable for delivery at international branch campuses [11–13]. Ensuring that high levels of academic quality are maintained also adds a further layer of complexity to an HE curriculum design and approval scenario that requires increasing levels of responsiveness and learning impact [2], [8].

The aims of the PiP project were to develop and test a prototype online expert system and a linked set of support materials that could: a) improve the efficiency of course and class approval processes at the University of Strathclyde; b) support the alignment of course and class provision with institutional policies and strategies, and; c) integrate the course and class approval processes into the corporate information environment. An additional objective was to use findings from prototype testing to inform future practice and the embedding of the system at the University of Strathclyde. Findings were also intended to inform the HE sector more generally about the technology-supported approaches that can be deployed to improve curriculum design and approval processes. Aspects of the above aims differ from the scope of the original project aims. Project reporting undertaken by PiP details this aspect of the institutional and project scenario in more detail and explains the reasons why adjustments were made to the project's scope [14].

The Institutional Approaches to Curriculum Design Programme [1] represents a unique example of funded innovation and development. Very little academic literature is therefore available to influence the evaluation of technology-supported approaches to curriculum design and approval. Dedicated theoretical tools to expose approval processes to systematic evaluation are also lacking. Rather than using informal evaluative approaches or relying on looser forms of evidence, the PiP project was ambitious in its desire to develop a programme of evaluation that was structured, rigorous and – to some extent - replicable, i.e. can be deployed by other institutions that might wish to improve their curriculum design systems and approval processes.

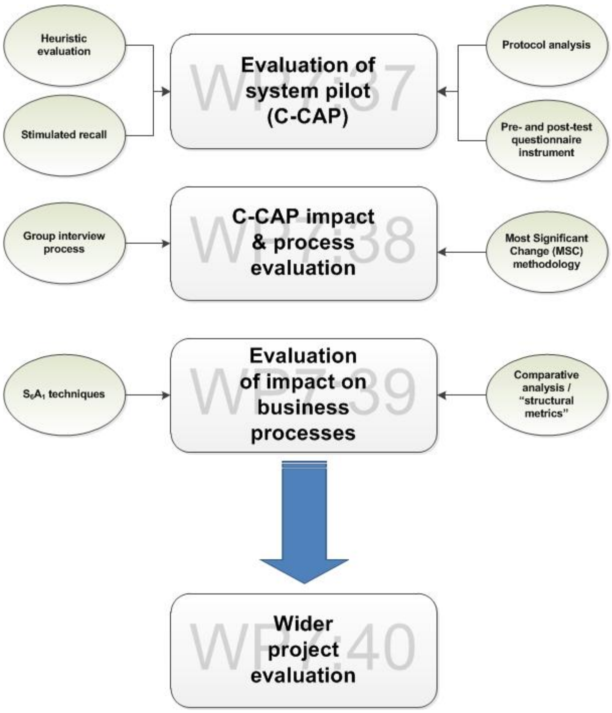

Figure 1: Overview of evaluative strands and evaluative sub-phases.

Within PiP there were essentially three phenomena of interest: the PiP system (the Class & Course Approval Pilot: C-CAP) which enables the design and approval of curricula; the curriculum approval process itself and the extent to which process change can be effected, and; the various stakeholders and the way in which the system and process supports and affects them. Academics and academic quality teams are probably among the most important within this latter group. The PiP Evaluation Plan [15] describes a series of evaluative strands that each align with these three phenomena, as well as components of the PiP workpackage plan.

The original PiP Project Plan [16] identified formal evaluation as an important component of the project and included a skeletal and embryonic evaluation plan. Institutional reorganisation at the University of Strathclyde in 2010 resulted in a revised project and workpackage plan to reflect the consequent restructuring of the project and its deliverables [14]. An alternative evaluation plan was therefore devised and finalised in November 2011 (Appendix A) and forms the basis of the evaluation work documented here [15]. This evaluation plan was sympathetic to the revisions made to the project's scope and detailed four distinct evaluative strands. These strands were as follows:

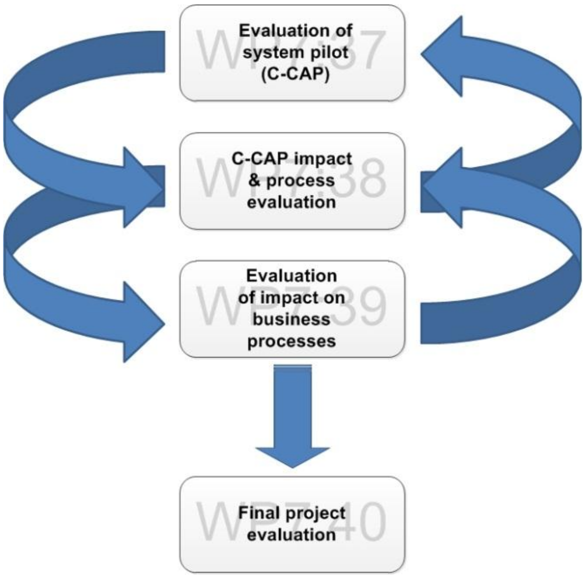

Figure 2: Overview diagram of PiP evaluative strands.

1. **Evaluation of system pilot (C-CAP system) (WP7:37):** Heuristic evaluation and C-CAP user acceptance testing
2. **Impact and process evaluation (WP7:38):** C-CAP impact and process evaluation
3. **Evaluation of impact on business processes (WP7:39)**: Critical analysis of BPI technique and C-CAP within class and course approval
4. **Final project evaluation (WP7:40)**

Each evaluative strand contained several evaluative phases (see Section 5 – Evaluation approach for details) (Figure 1) and although the evaluative phases within each strand were relatively self-contained, the evaluation was designed such that some phases would inform data gathering or analysis in other strands (Figure 2). The overall approach could therefore be described as a combination of formative and summative evaluation. In some circumstances this enabled triangulation to occur thus corroborating evaluative findings from other strands. It was also consistent with the overall incremental systems design methodology adopted by the project [17], [18]. For example, aspects of the "heuristic evaluation" phase (Figure 1) fed into the iterative development of the pilot system at an early stage in the evaluation process, thus improving the quality and validity of subsequent user acceptance testing. The importance of this approach will be highlighted throughout this report where appropriate; but in the above noted instance its relevance is described at the PiP Blog [19], the PiP YouTube Channel [20] and in the user acceptance testing report for WP7:37 [6] (see Appendix C). The exception to the overall recursive evaluation approach was strand four (Final project evaluation), the output of which is this document. This report synthesises, analyses and discusses the findings from previous evaluative strands and delivers summary conclusions and recommendations. Since it was not the purpose of this strand to gather or analyse new evidence, strand four is not detailed in the evaluation plan [15].

It should also be recognised that it was not feasible to implement all evaluation findings or recommendations within the lifetime of the project, either owing to insufficient project resources or because it was outside PiP's remit. These findings have formed the basis for project continuation and sustainability planning and feature in the conclusions and recommendations section.

4.2 Strand and phase evaluation reports

A series of detailed evaluation strand reports were produced and published on the PiP website throughout the lifetime of the evaluation (November 2011 – June 2012), including:

- Evaluation of systems pilot (WP7:37) - Heuristic Evaluation of Course and Class Approval Online Pilot (C-CAP) [21]
- Evaluation of systems pilot (WP7:37) - User acceptance testing of Course and Class Approval Online Pilot (C-CAP) [6]
- C-CAP impact and process evaluation (WP7:38) – Piloting of C-CAP: evaluation of impact and implications for system and process development [22]
- Evaluation of impact on business processes (WP7:39) - Critical analysis of BPI technique and Course and Class Approval Pilot (C-CAP) within class and course approval [5]

These reports are included as appendices to - and form the intellectual basis for the contents of – this document. Each strand report describes the evaluation processes in detail and provides further specificity on important aspects of the evaluation process (e.g. evaluation aims, methodological matters, data analysis, findings, conclusions, etc.). This report therefore synthesises headline findings or significant methodological issues. Those interested in the finer details of the PiP evaluation are encouraged to consult the above noted strand reports.

It is also worth noting that the strand evaluation reports have inspired recent project dissemination [19], [23] and it is expected that additional dissemination of evaluation findings will be conducted during the embedding phase of the project, scheduled to take place August 2012 - May 2013.

4.3 Related work and sector developments

As we have noted, the Institutional Approaches to Curriculum Design Programme remains a unique example of development and innovation activity, not just within the UK, but internationally. There has therefore been a limited foundation of academic literature or related work upon which to develop the various elements of the project, including the evaluation. The area of study also suffers from an insufficient body of conceptual or theoretical work from which to inform development or experimentation with technology-supported curriculum design and approval tools. Smith and Brown [24] and Lai [25] discuss the importance of technology facilitated approaches to design and approval for the purposes of improving pedagogy and, in Lai's case, in increasing the portability and sharing of curricula within specific educational contexts. However, both Smith and Brown [24] and Lai [25] discuss only the theoretical opportunities of technology-supported curriculum design and no prototype systems or approaches are proposed.

The transformative potential of design patterns in curriculum design have been explored more thoroughly by a number of researchers and, although the importance of this aspect of the PiP project has diminished since institutional reorganisation [14], it remains an important long term objective of the project and has influenced the technical development of C-CAP. Inspired by the work of Alexander [26] on their application within the architecture domain, the practical application of design patterns has been most prominent within the area of computing and software engineering [27–32], where instructors have developed patterns to capture and communicate knowledge on how best to teach complex technologies to disparate audiences. They have also been used as a way of representing successful models of technology implementation [32]. Effectively communicating complex technologies to learners is often problematic for IT instructors and is further complicated by the varying teaching experience of instructors. Even when advice from an "expert" instructor is found it may lack reflection or a rationale as to why a particular teaching strategy or approach is successful [33]. This has motivated research into mechanisms for sharing pedagogical patterns and establishing best practice [32], although it has been acknowledged that there are limitations to some patterns [28].

Activity from the computing domain has more recently stimulated interest and research within education and educational design more generally, with Goodyear [34] providing a useful theoretical basis for future work within the domain. Subsequent research, particularly via the E-LEN project [35], has tended to focus on pattern application within e-learning contexts since formalising best practice in this context has been most urgent and is arguably easier to codify and therefore share [36–39]. However, this research has focussed less on the specifics of curriculum design and is more concerned with identifying patterns in good e-learning experiences, e.g. to ensure pedagogical principles are adhered to and learning impact is maximised through appropriate learning tasks, critical success factors within specific e-learning activities, etc. [40]. Kolås and Staupe [39] propose the use of "design wizards" to help practitioners in harnessing pedagogical patterns, but they also note the difficulties in attempting to systematise pedagogical design patterns in online environments. Even within the context of C-CAP, where attempts have been made to homogenise curriculum design templates to improve academic quality monitoring and greater adherence to pedagogical "good practice", attempts to systematise the components of typical curriculum designs (e.g. learning activities, assessments, etc.) has been difficult [6]. More recently, Laurillard and her colleagues [41–43] have shown how generic learning designs could be captured in a Learning Activity Management System (LAMS) and its potential for sharing the pedagogic forms instructors design and how this could support other teachers. A useful framework for this approach has also been proposed by Laurillard and Ljubojevic [41] but has yet to be implemented computationally in any LAMS or technology used to facilitate tech-supported curriculum design.

The ability to share pedagogical designs is one aspect germane to the wider activity of knowledge management (KM) [44]; harnessing existing intellectual capital to support other organisational activities, whether this is to support the professional development of academics, make explicit curriculum design practice, or aid quality assurance. Along with the aforementioned examples, the re-use of curriculum design information is considered to support institutional efficiency and competitiveness, the importance of which has reflected the increased economic and operational pressures affecting the HE sector. Whilst many UK HE institutions are engaging in KM activities and recognise the importance of KM in improving competitive advantage [45], [46], it remains a relatively new development within the education sector and the overall institutional impact of KM activities is often limited by poor adherence to appropriate or coherent KM strategies [47]. Such limited success at HE has also been attributed to, among other things, the characteristics of academic staff, the academic culture, and the management structure and styles that tend to prevail in universities, all of which can stifle KM innovation [47], [48]; although it should be noted that this scenario is by no means peculiar to the UK, e.g. [49], [50]. As creators of knowledge, the silo-based approach to KM activity has often tended to prioritise the curation of research outputs and large-scale IT initiatives which do not necessarily facilitate KM [47], let alone the management of curriculum information and data. There is greater recognition that UK institutions need to improve their ability to capture explicit and tacit knowledge to facilitate re-use and sharing, particularly within the area of curriculum design [51]. Some overseas institutions have already taken steps to include curriculum design within their wider KM strategies and activities such is its importance [52], [53]. Wright [51] notes some of the typical approaches to managing explicit curriculum knowledge, such as creating repositories for assessments, interdisciplinary learning and curriculum improvements. As this report will demonstrate, C-CAP's creation of a central repository of curriculum design, whilst helping to resolve the issues identified in the baselining exercise [5], appears to be a positive contribution to better capturing, managing and sharing the University's collective curriculum knowledge.

Whilst the management of curriculum design information aligns with the broader KM aspirations of competitive advantage, the exploitation of digital technologies to facilitate responsive curriculum design and approval and to enable process improvement has attracted more interest. For this reason business process improvement strategies have been gaining traction within HE and the public sector more generally. PiP represents one such example, demonstrating a renewed focus on technology-supported approval techniques that support substantive process improvements [14]. Although there is growing academic interest in deploying business process change strategies within the public sector [54–59] and even within higher education [58], [60], very little detailed literature has been published on specific HE implementation strategies, or even how best to evaluate business process change within HE. In a comparative paper Macintosh [58] summarises the business change strategies of several HE institutions and compares them to private sector approaches. Although Macintosh provides useful case studies, evaluation approaches are not discussed and instead the research focuses on the adjustments required for public sector approaches to business change to be successful. The work of Kettinger and his colleagues [61], [62] is frequently cited as a template for business process change in the public sector such is its success in the private sector [56], [63]. In an exhaustive review of business process change methods, techniques and tools, Kettinger et al. [61] propose their Stage-Activity (S-A) Framework. The S-A Framework is designed to assist practitioners in developing and deploying new business change initiatives and has become one of the most widely recognised [55] and cited approaches [56], [64–67]. More specifically, Jain et al. [60] describe the successful use of business process reengineering (BPR) techniques to redesign curricula, using BPR and benchmarking as a means of identifying improvements to pedagogy within an undergraduate degree class. Jain et al.'s work represents a unique contribution to process thinking within curriculum design; but it is focused on a single degree module, relies on an analysis of student learning outcomes in order to validate its success, and does not explore a process encompassing numerous actors or sub-processes (e.g. a typical curriculum approval process).

The innovativeness of the PiP project has also limited the degree to which evaluation activity has been informed by cognate literature. PiP therefore represents a unique testbed with little academic research upon which to guide the evaluative approach adopted. As will described, the evaluation approach adopted by PiP, although influenced by the extant literature within the area of technology-support curriculum design and approval, has therefore drawn upon evaluation techniques from a disparate number of domains in order to compensate for the lack of any coherent indigenous evaluation framework. Some of these are linked to Kettinger et al. [61] discussed above, but most others are discussed in Section 5 and in more detail in other evaluation reporting and dissemination outputs [5], [6], [15], [20–22].

5. Evaluation approach

5.1 Purpose of the evaluation and core evaluation questions

PiP documentation [14] lists the current project aims to be the development and testing of a prototype online expert system and a linked set of support materials that could: a) improve the efficiency of course and class approval processes at the University of Strathclyde; b) support the alignment of course and class provision with institutional policies and strategies, and; c) integrate the course and class approval processes into the corporate information environment. An additional objective is to use the findings to inform local and external innovation and practice. The broad purpose of the formal evaluation was therefore to examine core project deliverables, to assess their fitness for purpose and their impact on wider institutional systems and processes. This involved - among other things - systems testing, the gathering and analysis of user data (from key stakeholders) using a variety of research techniques in order to identify opportunities for system and process enhancements, interpreting the perceptions and reactions of stakeholders to the Class and Course Approval Pilot (C-CAP) system, and assessing the overall institutional impact of the project.

The core evaluation questions were multifarious given the number of evaluative strands (see section 3) and were detailed in the PiP Evaluation Plan [15]. Each associated evaluation report explains the rationale behind the aims and objectives in further detail and readers interested in these aspects are encouraged to visit Appendices B, C, D, and E. The evaluation questions for each strand are summarised below:

Core evaluation objectives: Evaluation of system pilot (C-CAP system) (WP7:37)

There were two phases to this evaluative strand. The objective of the first phase was to identify significant usability problems with C-CAP prior to its exposure to stakeholders and to measure the extent to which C-CAP promoted established heuristic factors [68], [69]. The second phase was then to expose C-CAP to facets of HCI testing in order to validate aspects of the first phase and to evaluate C-CAP within in a real user context. This included a wider aim of attempting to capture data on C-CAP's ability to support academic participants in the design of curricula. The following broad research objectives influenced this phase of the evaluative design:

- Measuring the extent to which C-CAP functionality met users' expectations within specific curriculum design tasks
- Assessing the performance of C-CAP in supporting participants in curriculum design tasks and the approval process, and its potential for improving pedagogy
- Eliciting data on the current approval process and how C-CAP could contribute to improvements in the process (i.e. its fitness for purpose)
- Measuring the overall usability of C-CAP (e.g. interface design and functionality instinctive, navigable, etc.) and capturing data on users' preferred system design/features

Core evaluation questions: Impact and process evaluation (WP7:38)

This evaluation phase was primarily concerned with assessing the impact of the C-CAP system within specific stakeholder groups. Triangulating results from the previous evaluative strand was therefore an underlying objective; but more significantly it sought to understand the potential impact of the C-CAP system among stakeholders and the extent to which the system was considered to support them in the curriculum approval processes. The following series of related evaluation objectives were identified:

- The extent to which C-CAP effected change within institutional processes

- Eliciting and capturing data and evidence of the nature of change, efficiencies, outcomes, attitudes, etc.
- The nature of identified changes across stakeholder groups (e.g. patterns, discords, synergies, etc.)
- The aspects of C-CAP stakeholders consider to have the greatest potential for institutional change and which have effected greatest change in the curriculum design and approval roles normally assigned to specific stakeholder groups
- The extent to which the "three orbs model" – described in a PiP blog post [23] and the outcome of conclusions drawn from user acceptance testing conducted in strand WP7:37 [6] – accurately models curriculum design and approval reality.

The purpose of the "three orbs" model (Figure 3) was to better understand the conflicting information needs at the centre of the curriculum approval process and suggest that there are in fact three conflicting "information needs" within the process perspective: academic needs, operational needs and aspirational needs. These information needs could be described as three divergent sub-perspectives, all existing as important parts of an information ecosystem and all underpinning the wider process. The model is characterised by these divergent process information needs, each pulling away from each other (Figure 3). As these divergent needs pull away from each other the tolerance levels of the academic actor situated at the centre of the model becomes stretched as they attempt to satisfy these disparate information needs. Satisfying these needs is nevertheless required to facilitate the curriculum approval process. All the needs form part of a curricula information ecosystem. A successful framework for curriculum design and approval is therefore one that can square these divergent needs and ergo deliver a system and an underlying process that lies within actors' overall tolerance levels. Failure to achieve equilibrium (i.e. an imbalance in the information ecosystem) may foster the development of ill-conceived curricula (perhaps resulting in delays to approval) and may lead to cynicism about the overall process as academics' tolerance levels become stretched. Detail on interpreting the model can be gleaned from other evaluation activity [22] or dissemination outputs [23].

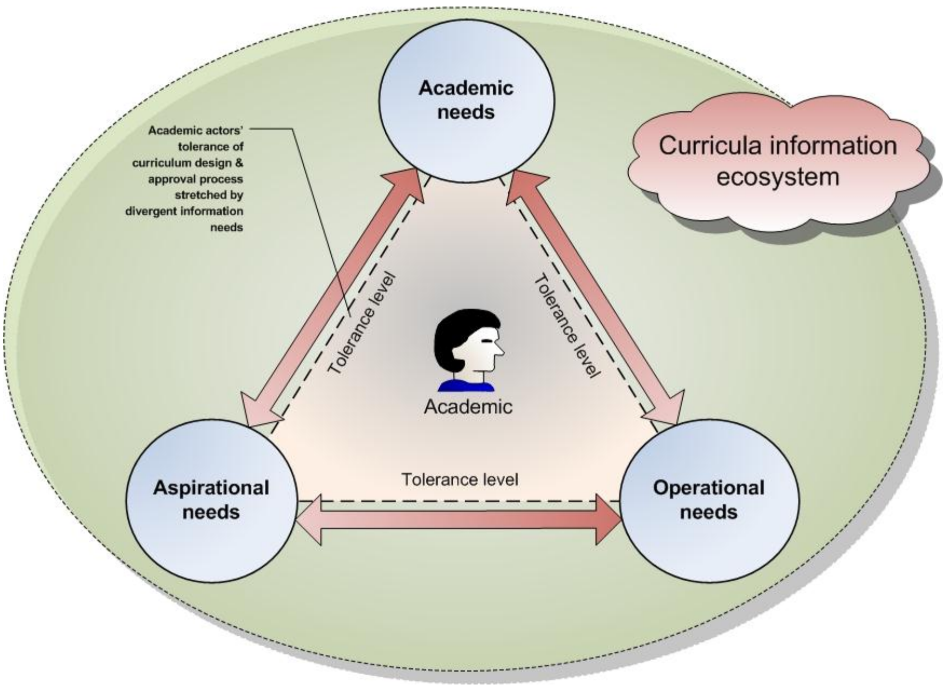

Figure 3: "Three orbs model", characterising the three conflicting information needs at the centre of the curriculum approval process, as proposed in [23].

It was also a requirement of this evaluation that additional qualitative data be gathered to validate specific findings from WP7:39, thus better understanding the nature of the business process improvements and changes effected by C-CAP. Additional qualitative data was therefore sought on the following aspects of WP7:39 for validation purposes:

- Qualitative benchmarking: As described in more detail below, a comparative qualitative benchmarking process was used in WP7:39 to establish whether five process and document workflow issues identified as part of the PiP baselining exercise [70] in the "previous state" had been addressed in the "new state" [5].
- Pareto analysis: Pareto analysis and charting was used in WP7:39 to identify and prioritise the most common problems under the "previous state" [5]. This problem data was then used to assist in assessing the potential impact of C-CAP on approval processes ("new state"). Some of the issues highlighted by the Pareto data were not addressed satisfactorily in the "new state" and, as per the recursive evaluation strategy, a conclusion of WP7:39 was therefore that the qualitative components of this strand should seek to identify "potential system support functionality" [5].

Critical analysis of BPI technique and C-CAP within class and course approval (WP7:39)

This evaluative strand (WP7:39) was interested in analysing the business process techniques used by PiP, their efficacy, and the impact of process changes on the curriculum approval process. Process changes were implemented via C-CAP. A broad evaluative objective was therefore to capture and evidence improvements in the curriculum design and approval process as instantiated by C-CAP and ergo the PiP project. The following broad evaluation objectives influenced the evaluative design:

- To what extent have improvements to the curriculum design and approval process – as instantiated by C-CAP - resulted in efficiencies, i.e. has the process been improved significantly?
- To what extent has C-CAP – and the process improvements it facilitates - resolved acknowledged approval process deficiencies?

An additional exploratory goal was to improve community understanding of the links between technology-supported approaches to curriculum design and the way process improvement initiatives can be embedded, integrated and function as a vehicle for process transparency, efficiency and effectiveness.

5.2 Design of the evaluation

The following sections present a summary of the overall design of the evaluation. More detail of the execution of the evaluation strands can be found in the associated strand reports [5], [6], [21], [22].

Evaluation of system pilot (C-CAP system) (WP7:37): Heuristic evaluation

Nielsen's [69] ten usability heuristics and associated severity scales [68] were used to evaluate C-CAP's heuristic compliance. Heuristic evaluation is an established usability inspection and testing technique and is most commonly deployed in Human-Computer Interaction (HCI) research, e.g. to test user interface designs, technology systems testing, etc. [68] Heuristic evaluation techniques enable a suitably trained evaluator(s) to examine the object of study (usually an interface or system) and assess its compliance with recognised heuristic evaluation principles, thereby testing its usability. Results of the heuristic evaluation are then used to inform system modifications. The approach is favoured in incremental design methodologies as an informal and relatively rapid means of engaging in usability engineering. By evaluating such heuristics early in the development or testing cycle those heuristics that are violated can be more easily addressed, thus reducing usability error detection at a later date [71]. Nielsen's ten usability heuristics are as follows:

1. Visibility of system status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Error prevention
6. Recognition rather than recall
7. Flexibility and efficiency of use
8. Aesthetic and minimalist design
9. Help users recognise, diagnose, and recover from errors
10. Help and documentation

The success of heuristic evaluation in detecting 'major' and 'minor' usability problems is well documented (e.g. [72–78]); although its inability to capture data on all possible usability problems [79] means that it is often used as a precursor to user testing, e.g. so that user testing focuses on deeper system issues rather than on those that can easily be debugged. The merits of such an approach are outlined on the PiP blog [19] and is reflected in the PiP Evaluation Plan [15]. Further detail on the execution of the heuristic evaluation can be found in the associated strand report [21], which can be found in Appendix B.

Evaluation of system pilot (C-CAP system) (WP7:37): User acceptance testing

The user acceptance testing sessions were designed to include four distinct sections: Pre-session questionnaire instrument, protocol analysis, stimulated recall, and a post-session questionnaire. Each session was circa 60 mins in duration, including ethical conditions (e.g. signing of consent form, explanation of research scope, etc). Data collection was conducted throughout January 2012 in a controlled IT lab setting.

Protocol analysis is a frequently deployed user testing methodology for software, interfaces, systems, etc. in which participants are asked to complete a series of tasks with the test/pilot system (in this case C-CAP) while simultaneously verbalising their thoughts. Verbalisations (or protocols) are sound recorded and transcribed for analysis. Additional data may also be gathered (e.g. screen captures, evaluator logs, etc). To best model a genuine curriculum design process and test the C-CAP system in supporting curriculum design and approval, participants were asked to bring a recently drafted curriculum design form with them to the session. Participants were then instructed to replicate their form using the C-CAP system while thinking aloud, recognising that the form structure in C-CAP was different and often more detailed than existing curriculum design forms. Participants were briefed on the process of thinking aloud, which was in line with established protocol analysis procedures [80] [81]. Screen capture software was used to record both participants' C-CAP interface interaction (visual data) and to sound record their "think aloud" protocols (audio data). Screen capture and associated audio data from the protocol analysis were uploaded into QSR NVivo 9 for content analysis, coding and further analysis. Data analysis was conducted according Holsti's [82] methodologies for content analysis and van Someren et al.'s techniques for category creation [81]. NVivo 9 was also used for audio transcription. Throughout the protocol analysis session evaluator logs were used to record "significant events" that occurred during participants' interaction with the C-CAP system, e.g. navigation was not located where the participant anticipated, C-CAP experienced a system error, participant experienced difficulty using the drop down menus for aligning assessment with learning objectives, etc.

Stimulated recall was used immediately after participants had completed their "think aloud" curriculum design task using C-CAP (i.e. after the protocol analysis). The stimulated recall technique (or "retrospective think aloud") is similar to protocol analysis but differs in that data are not collected until after the participant has completed their primary task [83], [84]. A recorded screen capture of the participant's system interactions is played back to the participant who is then asked to articulate their cognitive processes and actions at specific points of the recording. Stimulated recall is generally considered favourable because although the participant is asked to verbalise after they have completed the task, they are often able to provide more detailed verbalisations owing to reduced cognitive load [85]. A total of six participants provided stimulated recall data. Stimulated recall data were sound recorded and uploaded to NVivo 9 for transcription and analysis alongside protocol analysis data.

Pre- and post-session questionnaires were administered prior to the commencement of the protocol analysis and after stimulated recall. The pre-session questionnaire was designed to collect basic demographic information and capture participants' IT efficacy. IT efficacy was measured using an adapted version of Murphy et al.'s [86] original Computer Self-Efficacy (CSE) scale, modified by Torkzadeh et al [87]. The instrument was also designed to elicit from participants their opinions and perceptions of the current curriculum approval process and its current issues. The post-session questionnaire was administered after the completion of stimulated recall (if applicable). The post-session instrument was designed to capture data on users' success with the system and gather definitive data on the aspects of the system that participants perceived most favourably and those they did not. This was based on a customised version of the standard System Usability Scale (SUS) post-test instrument, first proposed by Brooke [88] and subsequently developed, deployed and validated by other usability researchers (e.g. [89], [90], [91], [92]). Brooke's instrument comprises a 10 item questionnaire using 5 point Likert scale response options. The Adjective Rating Scale (ARS) – proposed by Bangor et al. [89] to complement, validate and provide an overall qualitative explanation of user experience using SUS - was also used. The post-session questionnaire also sought to capture perceptions of how C-CAP supported them in the curriculum design process and its potential for improving approval processes at the University of Strathclyde.

Both questionnaire instruments were administered using Bristol Online Surveys (BOS), an online survey tool [93]. Data from BOS was exported to a .csv file for analysis in MS Excel and in SPSS. The post-session instrument was also imported to NVivo 9 for analysis of open-ended question responses (i.e. Q.3).

Further detail on the procedure and execution of the user acceptance testing can be found in the associated strand report [6], which can be found in Appendix C.

Impact and process evaluation (WP7:38)

The primary focus of this phase was to assess the impact of the C-CAP system and processes within specific stakeholder groups. The organisational nature of this focus necessitated appropriate data collection techniques. Qualitative data was therefore captured from stakeholders using group interviews and Most Significant Change (MSC) stories. Theorists and researchers within the domains of organisational theory and psychology note the importance of the "group method" for exploring and understanding institutional processes [94]. Group interviews are most suitable when the phenomenon being studied requires the exploration and description of ideas. Group interviews are similar to focus groups but differ in their management and focus. In the group interview method the facilitator performs an active role in directing and structuring group discussions. Aspects of this phase fed into WP7:39 and therefore sought further qualitative data on the extent of business process change using C-CAP. Note that one-to-one interviews were conducted with those stakeholders that were unable to attend the group interview sessions.

An adapted form of the Most Significant Change (MSC) technique was also used. MSC is a qualitative approach based on stories pertaining to changes that participants have experienced during and/or as a result of a particular project or initiative, rather than "abstract" pre-defined data indicators or metrics [95]. Qualitative research theorists and cognitive scientists have long reported the value of "story collecting" methods to understand complex research phenomena or systems, e.g. organisations and communities [96]. The MSC technique [95] can be classified as a story based method in which the changes participants have experienced in relation to a particular project or initiative are captured.

Its popularity is manifest in its ability to capture secondary outcomes, such as those of personal significance to the participants or particular groups of participants [97]. MSC was administered at the same event as phase 1 (i.e. during the same session as the group interview).

Prior to conducting the group interviews and the MSC approach, C-CAP was piloted within the Humanities & Social Sciences (HaSS) Faculty for three months starting from mid-March 2012. A HaSS specific implementation of C-CAP was created (Figure 2). Discussions with the HaSS Academic Quality Team identified two academics who intended to design new curricula and that were willing to participate in piloting. Their involvement generated one post-graduate course and four classes that were each used as the focus for piloting. Note that C-CAP was also piloted, albeit in a more informal capacity, within the Strathclyde Business School (SBS) and the Faculty of Science; however, piloting in these faculties was limited to "dummy" proposals as neither faculty had the administrative capacity to participate during the timescales required.

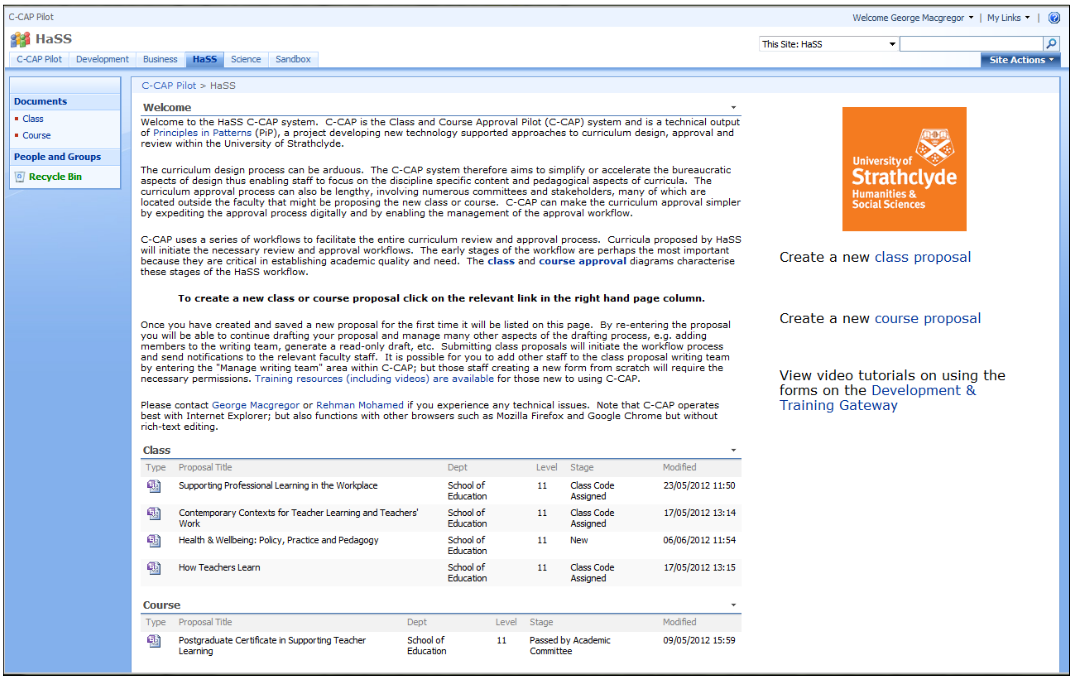

Figure 4: HaSS implementation of C-CAP. Screen dump of HaSS C-CAP home page, including status list of current / recent curriculum proposals.

Piloting involved participation from members of the following stakeholder groups:

- *Academics*: Academic staff responsible for designing and – if approved - delivering the curricula proposed.
- *Faculty Academic Quality Team*: Staff within the Faculty responsible for managing Faculty level curriculum approval processes and academic quality assurance.
- *Academic Quality Working Group*: A working group of academics from within the Faculty responsible for reviewing and providing feedback on proposed new classes and/or courses. The Academic Quality Working Group provides an initial level of academic scrutiny prior to consideration by the Faculty Academic Committee.
- *Faculty Academic Committee*: Academic Committee is the mechanism by which proposed curricula (specifically courses) are scrutinised, reviewed and formally approved (or not) by senior members of the Faculty. Successful approval at Academic Committee essentially concludes Faculty level approval processes, after which a number of University processes are initiated.
- *Student Lifecycle*: Student Lifecycle is located within the Student Experience and Enhancement Services Directorate (SEES) and is broadly analogous to registry. Whilst

Student Lifecycle is responsible for a wide range of administrative services at the University of Strathclyde, their remit within the curriculum approval processes is to assign class/course codes, record aspects of curriculum data for monitoring, registering news classes/courses in the catalogue, and so forth.

The class approval process was modelled and piloted in its entirety using C-CAP. All classes that were designed, approved and piloted with C-CAP therefore followed the process through to its conclusion. The course approval process was modelled and piloted up to Senate approval (the final process step). All curricula were successfully approved. Final Senate approval was omitted from the course piloting because suitable procedures for communicating curriculum information to Senate have yet to be established. The senior membership of the Senate is such that organising such procedures or their participation would have delayed piloting unnecessarily. It should however be noted that this is simply an administrative issue rather a technical one. Further detail on the nature of the curriculum approval process, including process flow diagrams and rich diagrams, can be found in the WP7:39 evaluation strand report [4].

Prior to piloting all relevant stakeholders received one-to-one C-CAP orientation sessions, each tailored specifically to their role within the curriculum design and approval process. Dedicated training materials were also created to support stakeholders and were delivered using the University of Strathclyde's Development & Training Gateway.

Evaluation of impact on business processes (WP7:39)

Stage 6 ("Evaluate"; S_6A_1) of Kettinger et al.'s [61] S-A Framework accommodates evaluation and details a suite of techniques which can be usefully deployed in the evaluation of business process change. Two of the most suitable techniques within the PiP context include: focus groups (group interviews) and employee and team attitude assessments. Given the lack of objective metrics upon which to base comparative analyses, the use of qualitative data sources was considered integral for this present evaluation and is considered by Kettinger et al. as important to understanding overall process performance. Similarly, Sarkis and Talluri [98] note the need for qualitative data to feature prominently in any evaluation of business process change. The recursive nature of the evaluation plan [15] is such that qualitative data collected from WP7:38 fed into the evaluative activities of this present phase (see above).

Pareto charting is also cited [61] as an important root-cause evaluation technique. To facilitate Pareto charting, data pertaining to the curriculum approval process in the Faculty of Humanities and Social Sciences (HaSS) during 2011/2012 was gathered. This data covered the curriculum approval period beginning October 2011 up to mid March 2012, when HaSS C-CAP piloting began. Data included the number of curriculum proposals for classes and courses that suffered delayed approval or rejection, as well as information on the nature of the problem ("cause") that resulted in delayed approval or outright rejection. Whilst such data is no substitute for genuine baselining data, its purpose in this instance was – via Pareto analysis - to identify significant problems within the current curriculum approval process and to use this problem data to assist in assessing the potential impact of C-CAP on approval processes.

Qualitative benchmarking was used to supplement - and compensate for - limitations in the Pareto data. The PiP baselining exercise [70] identified a series of process and document workflow issues. Whilst no metrics were gathered at this time, the qualitative outcomes of the baselining work provided a useful basis for qualitative benchmarking. Qualitative benchmarking refers to the "comparison of processes or practices, instead of numerical outputs" [99] and has been recognised as a useful general management approach [100]. The five principal process and document workflow issues identified by the baselining work and summarised in the associated strand report therefore sufficiently characterised the critical aspects of the previous state (i.e. the current curriculum approval process). Data on this previous state was used in comparative benchmarking, using the process under C-CAP as the "new state". An assessment of overall "project radicalness" [61] was also conducted to determine the suitability of the process change strategy adopted by PiP.

Table 1: Summary table of structural metrics for business process design and evaluation, as proposed by Balasubramanian and Gupta [101].

Structural metric	Description	Nature of overall performance impact
Branching automation factor (BAF)	BAF is a structural metric that reflects the extent to which process flow decision are determined by a system through definitive business rules.	Cycle time
Communication automation factor (CAF)	CAF is a measure of system driven communication in a process. It can be defined as the proportion of inter-participant information exchanges in a process where the information source is a system.	Reliability, cost
Activity automation factor (AAF)	AAF measures the extent to which system support is embedded in process execution.	Cycle time, cost, throughput
Role integration factor (RIF)	RIF denotes the level of integration in the activities carried out by a role within a process. Integration represents the continuity in execution of activities by a role during the process.	Throughput
Process visibility factor (PVF)	PVF attempts to measure the extent to which process states are visible to specific process stakeholders via process information reporting, recording or notification.	Reliability
Person dependency factor (PDF)	PDF calculates the extent to which process execution is dependent upon human discretion.	Reliability
Activity parallelism factor (APF)	APF measure the extent to which activities in a process can be executed simultaneously. It can be defined as the proportion of activities that are executed in parallel in a process.	Cycle time, throughput
Transition delay risk factor (TDRF)	TDRF is a measure of the potential delay that could creep in due to frequent transitions of process execution to humans.	Reliability

To further quantify the improvements effected by C-CAP in process performance, the approval process was subjected to Balasubramanian and Gupta's "structural metrics" [101]. Balasubramanian and Gupta [101] provide a formal yet flexible technique to evaluate the implications of process redesign on process performance. They propose a list of structural metrics that can be easily deployed to create a formal approach to business process change evaluation. These metrics and the nature of their impact on overall process performance are described in Table 1. Balasubramanian and Gupta's metrics synthesise, build upon and extend the work of others, including Nissen [102] and Kueng and Kawalek [103]. Many of Balasubramanian and Gupta's metrics are applicable to the HE sector and to the curriculum approval process and have been cited in the literature as useful for assessing performance impact [104–106].

Approach design informed by…

No single overarching evaluation philosophy influenced the approach adopted by PiP. As preceding sections have intimated, the PiP Project's multifarious nature spans numerous areas of academic interest, including information systems, Human-Computer Interaction (HCI), business process change, organisational behaviour, and the areas of education pertaining to pedagogy and curriculum design. The data collection techniques within the overall approach therefore reflect this heterogeneous context and were an attempt to deploy a suite of data collection techniques that are consistent with the aims of each evaluative strand. The evaluative strands therefore use a mixture of quantitative and qualitative techniques, as well as some theoretical techniques, from a disparate set of academic disciplines [20].

Evaluation limitations (e.g. related to methods, data sources, biases)

A number of limitations have been identified with the methods used in the user acceptance testing. Recall that to best model a genuine curriculum design process, participants were asked to replicate a recently drafted curriculum design form. Whilst this methodological compromise was necessary in order to recruit participants and to facilitate the logistics of protocol analysis (i.e. a "real world" curriculum design process is typically lengthy), it is probable that the artificial nature of the curriculum design task compromised data collection slightly. Indeed, the artificial nature of the curriculum design task was such that it limited participants' potential for creativity; the majority of their creative work was essentially complete, thus leaving little scope for reflection. A recommendation in the user acceptance testing strand report [6] was that future work should instead employ 'design diaries' in which participants would note or verbalise their experiences of designing curricula with C-CAP. Verbalisations and reflections could be captured via video diary [107]. Such an approach would lack the control enjoyed by the approach adopted in the user acceptance testing, but it would, a) yield useful data on how C-CAP can stimulate new curricula, b) would allow time for users to improve their C-CAP efficacy, and c) would enable participants to reflect upon their designs and how C-CAP inspired the adoption of innovative designs.

MSC story collection also demonstrated data collection limitations. Several participants clearly experienced difficulties identifying appropriate or "significant" stories and some of their stories consequently lacked detail or depth. The difficulties in capturing MSC stories have been investigated by Willetts and Crawford [108] who concluded that MSC stories can be difficult for participants to articulate, primarily owing to the higher-order skills that are required to provide a "good" story (e.g. the reflective skills). They also note the problems participants have in deciding which stories are "significant" and worthy of reporting. Both of these aforementioned limitations were expressed informally by most participants as reasons why they were dissatisfied with the stories they submitted. Some attributed their dissatisfaction to the length of time spent piloting C-CAP and their limited experience of using the system for sustained periods of time. Therefore an additional explanation for the disappointing quality of MSC stories may relate to the limited time that was set aside for Faculty piloting and the relatively small number of participants involved in the piloting. For example, in their MSC guide, Davies and Dart [34] recommend extended periods of story collection. Such periods are recommended to span a year, during which stories might be collected every three months. A shorter but more intensive period of story collection in this instance was predicated upon the assumption that more faculties would agree to participate in the piloting and would also agree to pilot earlier in 2012. The limited scope of the piloting was therefore attributable to the low administrative capacity of other faculties. Whilst all key process stakeholders were involved in piloting C-CAP and generating the subsequent MSC stories, the quality of the stories in this instance may have been better had the period of piloting been longer, thus exposing all users to the system for extended periods of time and better enabling them to recognise significant changes over time. Additionally, had more faculties participated in the piloting more MSC stories would have been generated, from which story selection may have been considered more satisfactory.

An additional limitation was identified in the evaluation of C-CAP's impact on business processes (Evaluation of impact on business processes (WP7:39)). This strand of evaluation was always problematic. The baselining exercise in mid-2009 [70] provided a useful basis for comparative analysis; but few performance indicators were recorded or collected at this time. To compensate for the lack of quantitative data, the evaluation approach adopted a number of complementary techniques, including qualitative benchmarking, group interviews, and structural metrics. The data used for the Pareto analysis, however, was limited to a single faculty and did not span a sufficient time period, nor did it reflect process performance using C-CAP over a similar period. These limitations were a result of data constraints and project timeframes, and whilst the data was useful to inform general conclusions, it was not in itself generalizable. Future work should therefore attempt to improve the quality of quantitative data preceding system implementation and mirror the data for the period after system implementation, such that more extensive and authoritative Pareto analyses can be conducted.

6. Evaluation findings

6.1 Findings for each evaluative strand

Evaluation of system pilot (C-CAP system) (WP7:37): Heuristic evaluation

The heuristic evaluation of the C-CAP system yielded a total of 27 heuristic violations. Of these violations, only 33% were classified at a mean severity rating ≥ 3. In fact, 67% of total violations were classified at a mean severity rating of ≤ 2.67, and of these 11% were classified at severity rating 1. Figure 5 charts the total number of recorded violations and the mean severity level per heuristic. The C-CAP system therefore performed well under heuristic evaluation, demonstrating good use of short cuts and accelerators, high levels of user control owing to the use of familiar rich-text editors enabling incorrect actions to be "undone", and minimalist and uncluttered design. The rich-text editors also demonstrated adherence to the de facto standard of the word processing dashboard. The heuristic evaluation nevertheless identified several problematic heuristic violations which required resolution. It should be noted that despite creating "catastrophic" usability problems on some occasions, many of the issues rated at > 2.67 were minor technical problems that were preventing critical user actions. The complexity of the curriculum design process is such at violations pertaining to Nielsen's heuristics #6 and #7 [69] are probably the most critical to long-term user acceptance. Neither of these issues presented a technical usability problem; but they occurred more than any other violations (total of 6 and 7 violations respectively) and demanded unnecessarily high levels of recall from the user which ergo exposed the user to high levels of cognitive load, thus contributing to what was already an intellectually onerous process for the user. The associated strand report provides full results from the heuristic evaluation and indicative examples of the violations identified.

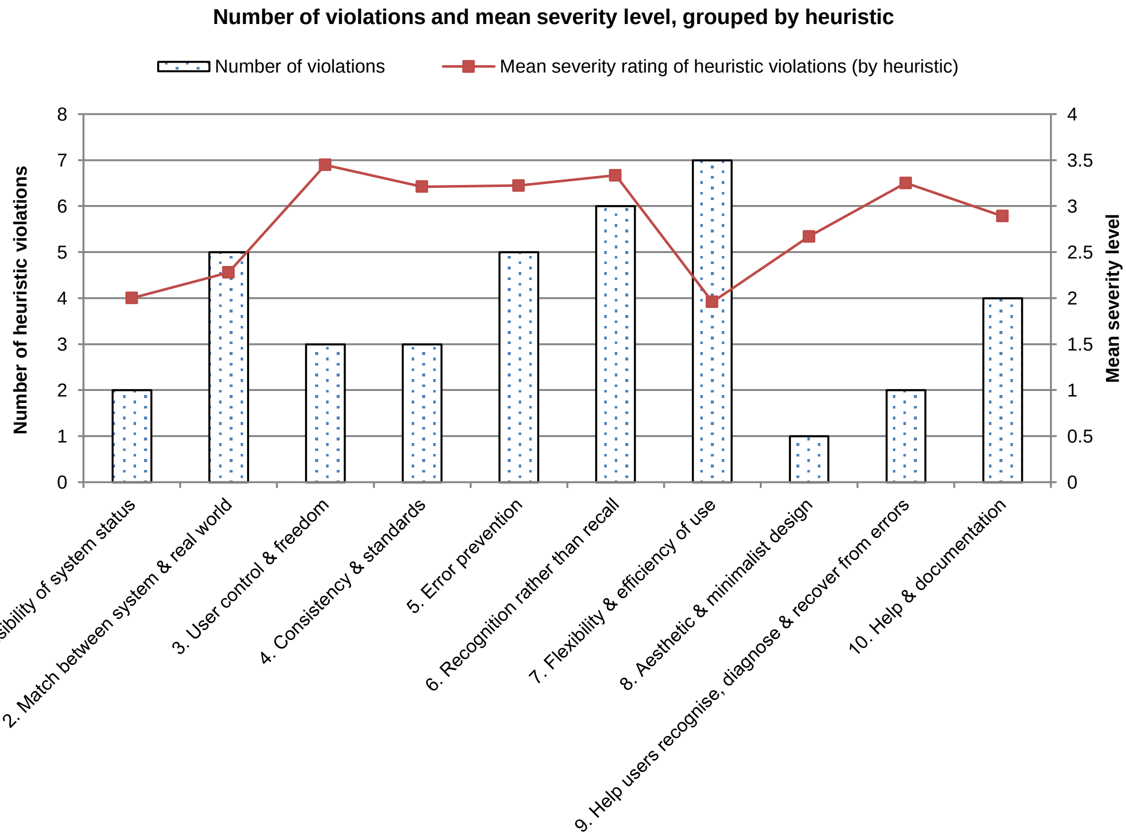

Figure 5: Number of violations grouped by heuristic and associated mean severity level by heuristic.

Solutions to all violations were prioritised and considered for implementation by the PiP technical team in advance of user acceptance evaluation and faculty piloting, thus minimising users' cognitive load and optimising the quality of data collected during user acceptance testing, e.g. [6], [19]. The user acceptance testing report [6] and the PiP Blog [19] discuss this strategy in more detail.

Evaluation of system pilot (C-CAP system) (WP7:37): User acceptance testing

In this phase of evaluation found the C-CAP system to be positively received. C-CAP achieved a positive System Usability Scale (SUS) score (SUS = 73.5) and ARS rating (ARS = 4.7). Researchers note [89] that "promising" SUS scores are generally > 70 therefore placing participants' perceptions of C-CAP at a favourable level. An ARS rating of 4.7 places C-CAP within the "Good" ARS user-friendless category. Whilst these results could be partially attributable to the high computer efficacy of the participants (M = 4.74; Mdn = 5), protocol and stimulated recall data revealed that participants were, in general, favourably disposed to the C-CAP system. Numerous problems with the usability of C-CAP were nevertheless identified. Where appropriate modifications to enhance user acceptance and accommodate users' preferences were implemented prior to faculty piloting in WP7:38.

Analysis of the qualitative data captured by the "think aloud" protocols, stimulated recall and open-ended questionnaire items generated a detailed hierarchical coding framework (see user acceptance testing strand report [6]). This framework directed further data querying. Two super-nodes emerged from the data: *system issues*, and; *process and pedagogical issues*. These super-nodes contained 32 and 18 sub-nodes respectively and reflected the nature of the user acceptance evaluation, which was deliberately designed to elicit data on the extent to which C-CAP could support participants in the curriculum design and approval process. It was also designed to expose system and usability issues which were not identified during the heuristic evaluation. The following additional super-nodes were also created: *participant*; *participant attitudes* (i.e. mixed, negative, neutral, positive), and; *interesting quotes*. These additional super-nodes were used to facilitate data querying and did not to reflect the intellectual content of the data, and were therefore omitted from the framework.

Analysis of the qualitative data exposed participants' overall perception of the C-CAP system. The results were detailed but – for the purposes of this final evaluation report - have been summarised below. Full details of the data analysis and results are available in Appendix C.

- C-CAP perceptions were generally positive, triangulating the positive SUS score from the post-session questionnaire instrument. Many participants frequently made positive comments throughout their interaction with the C-CAP system, whilst others commented more holistically of the potential of C-CAP to improve the curriculum approval process.
- Qualitative data analysis uncovered isolated participant hostility to the use of any system to aid the curriculum design and approval process. This was based on a deeper suspicion of University systems and their implementation across the institution, as well as their perceived inflexibility.
- The aspect of C-CAP that perhaps inspired most comment from participants related to their experiences while using C-CAP to complete learning activity and assessment details. Both sections were driven by drop down menus to promote efficiency in use and to minimise user error. A notes box was also provided to allow users to insert additional comments about their intended assessment activities. Although the values for these drop down menus mapped to the QAA's indicative learning and teaching methods list [109], almost all participants commented on the (in)appropriateness of these values for their particular discipline. Many participants suggested alternatives. Qualitative data querying suggested that those participants proposing alternative learning or assessment activities were from outside the Faculty of Science and – although their proposed learning and assessment activities could be captured by the list and notes field – there was a perception that the values failed to reflect the "non-standard" teaching delivery methods or assessment techniques used by these faculties.

- Only one participant used the context sensitive help (participant #6), which included detailed guidance on the learning activity values available and their scope. Had participants been more inclined to view this help then they may have been more likely to perceive their peculiar teaching delivery methods to fall within the scope of C-CAP's values.
- Aspects of assessment design that caused further confusion for many participants pertained to assessment deadlines. The collection of such data was intended to encourage curriculum designers and course leaders to consider cohort assessment load during semesters; however, many participants considered the collection of such information to be unfeasible because assessment activities and their deadlines are often only decided immediately prior to class delivery.
- Broader data themes pertaining to flexibility in teaching practice and the perceived pointlessness of some curriculum design requirements in C-CAP were found. Many participants reported their unease with drafting overly prescriptive curricula which might in future restrict their teaching practice and lead to further bureaucracy, whilst others felt it was disingenuous to provide prescription so far in advance of teaching delivery.
- One aspect of curriculum design that dominates educational literature is the idea of constructive alignment [110], [111]; optimising assessments to best measure student learning against the stated learning objectives. The version of C-CAP used for the user acceptance evaluation therefore required participants to engage in constructive alignment; however, few participants viewed this requirement favourably. Data analysis indicated that the majority of academics either considered their learning objectives to be assessed by all stated assessments, or felt it was irrelevant to include such detail as it can be highly ephemeral.
- Mandating constructive alignment did not appear to support C-CAP's ability to promote greater reflection of assessment strategy. Querying of the qualitative data indicated that only one participant considered C-CAP to inspire reflection during constructive alignment. This participant had experience of management responsibilities and was appreciative of C-CAP's ambitions in this respect; but even this participant recognised the difficulties in implementing such a system more widely.
- Questionnaire data suggested that participants were generally positive about the potential of C-CAP to support them in curriculum design, but were generally indifferent about the potential of C-CAP to improve their pedagogy or the quality of the curricula they design. An isolated participant was vehement in their view that such a system usurped the creativity inherent to the curriculum design process and restricted innovative practice.
- Many participants often expressed uncertainty about aspects of the approval process and certain information requirements, e.g. such as credit-to-hour weightings. Curriculum design practice was also found to be highly variable. For example, some participants included hours towards summative assessment, while others expected the time spent on completing assessments to be in addition to the stated study hours. Some participants also acknowledged the disparate practice and its absurdity from an operational perspective.

Impact and process evaluation (WP7:38)

Analysis of the group interview data produced a hierarchical coding framework which was used to direct analysis and data querying (see pilot impact strand report [22]). This framework detailed the principal themes that emerged from the data and provided details of all the sub-nodes, node definitions and indicative supporting quote(s). Owing to the detail of the findings produced from this particular strand, we limit ourselves to summarising the key findings. Full details of the data analysis and results are available from the associated strand report [22], available in Appendix D.

Analyses of interview data found participants to support many of the findings from other evaluative strands, e.g. [5], [6]. System perceptions were generally positive, with C-CAP highlighted as impacting positively in its ability to support curriculum drafting and approval process management. Other positive themes emerging from the data included:

- *Simplicity of the drafting process*: The structured approach to drafting, as implemented within C-CAP, was found to simplify the drafting process for academics and was considered by academic quality team members as something that could potentially solve the common process misunderstandings experienced by academics.
- *Clarity of design and approval expectations*: Forms were considered to be more prescriptive and to clarify the curriculum information expectations for writing teams, thereby helping to improve the specificity and ergo the quality of curricula.
- *Improved process transparency and visibility*: Issues surrounding a lack of process visibility or transparency were reported as having been resolved in other evaluation activity [5] and was further verified through analysis of interview data. Transparency was considered to have improved because C-CAP not only supported curriculum design by providing greater prescription in terms of the information expected in curriculum designs but also because it made transparent the various approval process milestones and enabled stakeholders to observe process statuses (or be notified of them). Academic Committee participants were similarly pleased about the improvement in transparency, particularly with respect to the delivery and capture of review feedback within C-CAP. Improved transparency was therefore a clear change that was effected by C-CAP; although it should be noted that were minor concerns that the transparency of departmental decision making was not what it should be, particularly in relation to decisions about whether new curricula should be proposed in the first place. The resolution of this issue, however, was found to fall outside the responsibility of C-CAP.
- *Enhanced process control*: For academic quality team members the new state was considered to have increased the level of control they had when managing the academic quality monitoring and approval process, something that was lacking under the previous state owing to the decentralised nature of the design process. C-CAP was therefore embraced as a better mechanism for controlling, monitoring, structuring and minimising errors in the approval process. The increased control given to academic quality staff was not identified explicitly by academic participants as a source of annoyance; instead academics perceived C-CAP to provide higher levels of control too and, in some circumstances, found it to be empowering. This also appears to be intimately connected to the underlying transparency made possible through improved process visibility, something that was confirmed by the qualitative data. Process control was also highlighted as the "most significant change" resulting from C-CAP implementation, as captured via the MSC story collection approach. Further discussion of MSC data is provided later in this section.

In a number of specific areas, such as the validation of the qualitative benchmarking analyses undertaken during other evaluation activity [5], interview data verified the resolution of a number of process and document workflow issues, such as version control and the management of curriculum review feedback. Improvements to version control enables central management of the approval process and "a single point of truth"; only the most up-to-date versions of curricula are visible to all stakeholders and no version conflicts can arise. Review comments are added to proposals within C-CAP and any additional review comments provided by reviewers are made visible. The status and tracking of proposals is monitored by C-CAP and is made visible to all, thus improving process transparency to stakeholders. The disparate curriculum approval forms that were found to exist across the institution in the previous state have been conflated into a "super" form which standardises curriculum design and incorporates features designed to improve curriculum design and subsequent pedagogy. In fact, this latter point was considered by some group interview participants to be further evidence that version control - at a fundamental level - had been resolved by C-CAP. An interesting and additional insight was the importance of improved version control and feedback mechanisms in supporting academic quality, with an academic quality team member conceding that the chronic information management problems that arose in the previous state - including the associated version control problems highlighted in WP7:39 [5] - often compromised quality assurance processes by making the review of curricula by multiple reviews untenable.

Further validation of findings of the qualitative benchmarking analysis undertaken in strand WP7:39 corroborated a reduction in the size of curriculum templates and associated information. The standardised curriculum design and approval forms served by C-CAP have been further rationalised and the technical platform has been harnessed to deliver system logic such that features of the curriculum design process are hidden to members of the writing team unless specific options are selected, or their curriculum design context demands it. This logic ensures that those form elements rarely used in curriculum design remain hidden to writing teams unless they are explicitly required, thus reducing form length and suppressing irrelevant elements of the form. Improved guidance has been embedded within C-CAP, providing additional guidance on University policies (where they are available) and recommended best practice. This has been supplemented by extensive C-CAP training materials. Curriculum information requirements have also been pared back in line with University requirements.

The reduction in the superfluous paperwork used to facilitate the design and approval process in the previous state was considered a particularly noteworthy change. It is also a change that assumes added significance owing to its status as the most common Pareto cause for course approval delay or rejection [5] (discussed in section Pareto analysis: HaSS case study). C-CAP has reduced the design burden normally associated with the previous state and has simplified academic review, thus corroborating findings from other evaluative strands [5]; but it has also brought about a renewed focus on those aspects of curriculum design that are integral to good pedagogical practice and to high academic quality standards. In essence, the drastic reduction in superfluous bureaucracy has meant that C-CAP can better focus on the quality and specificity of essential curriculum approval information (i.e. that which is required by the University to facilitate approval) whilst simultaneously serving forms that are less likely to stifle innovation and that are neither “daunting” nor “onerous”.

The development of a central repository of approved curriculum designs was revealed by participants to be one of the most important changes to have been facilitated by C-CAP, again corroborating qualitative benchmarking analysis [5]. Analysis of the data exposed among stakeholders a latent cognisance of knowledge management principles and their potential for transforming curriculum design. The curation of curriculum designs as “knowledge assets” was considered to support a number of key academic quality processes and better enable responsive curriculum design. Providing repository access to a broad range of curriculum designs was embraced due to its potential to inform the development of new curricula and its ability to support professional teaching practice. Data supported the view that a “shared intelligence” about the quality of existing curricula would be established and thus tangible curriculum design and quality benchmarks set. The repository would also provide a platform from which to disseminate explicit and tacit curriculum design practice, which would maximise the value of institutional knowledge assets by enabling the re-use of curriculum designs. thereby contributing towards institutional competitive advantage. The importance of a central repository of curriculum designs has long been a project objective [16] and the importance of such tools is summarised in the extant literature [51–53]. Its delivery via C-CAP and its positive impact on business process and document management were reported in other evaluation work [5]. Its qualitative verification in this instance is therefore a positive finding and, unlike the qualitative benchmarking analysis which relied on mechanistic indicators of success, provides a well-articulated human account of its wider significance.

Recall that MSC stories were collected from stakeholder participants towards the end of the C-CAP piloting period, with the curriculum design and approval process constituting the “domain of change”. These stories highlighted the following significant changes for participants:

- Removing the administrative burden for those academics engaging with the curriculum design and approval
- Enabling process transparency and visibility
- Enabling better control over the design and approval process
- A new "shared intelligence" of curriculum design at the University

It is noteworthy that these changes align with many of those already discussed by participants during the interviews, but also identified as a result of the analysis of C-CAP business process impact [5].

The most detailed story – and the one selected to highlight the significance of C-CAP's impact – was provided by a member of the HaSS Academic Quality Team. This story is reproduced in Table 2 and was unique in that it conflated a number of significant changes relevant to the management of academic quality within the HaSS Faculty. These changes not only included improved control and monitoring of the approval and academic quality process (as listed above in other stories) but included a series of unintended changes pertaining to improved staff understanding and knowledge, as well as motivating the creation of new team mechanisms for providing advice to academic staff. It is perhaps unsurprising that a member of the Academic Quality Team provided the richest MSC story. More than any other stakeholders, they were exposed to most of the system's functionality, as well as functionality denied via permissions to other stakeholders. They also enjoyed sustained exposure to the system thus potentially making their generation of richer MSC stories easier.

Table 2: Selected Most Significant Change (MSC) story, using Davies and Dart's story report format.

<table>
<tr><td>Title of story</td><td>Greater control and improved knowledge and understanding</td></tr>
<tr><td>Name of person recording story /OR/ Job role</td><td>[HaSS Academic Quality Team member], HaSS</td></tr>
<tr><td>Date of writing</td><td>16.04.2012</td></tr>
<tr><td>Who/what was involved?</td><td>AQST Staff</td></tr>
<tr><td>When did it happen?</td><td>Since C-CAP was introduced to HaSS</td></tr>
<tr><td colspan="2">What happened?

The C-CAP system in its entirety has given greater control to the Faculty staff in the Academic Quality Support Team (AQST), in improving the co-ordination of the overall process. This does present some challenges for AQST colleagues in the future but will allow them to develop a greater depth in knowledge and understanding of the processes involved. The previous system used for course approval/review only allowed AQST staff in the Faculty to be distributors of information on the approval/review process by providing a set of guidelines for staff to utilise for the whole process.

The new system has meant that colleagues in AQST have to understand the nuances of course approval/review and be able to interpret the information required to assist academic staff in completing the online form. A greater number of meetings have been held with the academic staff involved in creating their online course proposals which means AQST staff now provide a greater support mechanism as well as providing advice to academic staff on who to contact about specialist information required in the online form. This level of support has never been apparent in the previous system. Staff in AQST will ultimately feel more valued by academic staff proposing the courses and AQST staff will be able to develop a specialist knowledge which can be used across other areas of work within the Faculty.

The new C-CAP system also allows greater monitoring and control of the course approval procedural process by Faculty AQST staff to ensure 'every box is ticked' and that the process is as smooth as possible for all concerned in order to get the course approved.</td></tr>
<tr><td colspan="2">And why was it significant to you?

This change means there is a greater onus on Faculty AQST staff to comprehend the complexities of the process to allow academic staff to complete the online form successfully. More comprehensive support is provided to academic staff through meetings about the new system as well as being required to network with other staff in the Faculty/University to assist with matters relating to international recruitment, alumni relations, professional accreditation, finance, resources, marketing and communication.

This wide-ranging involvement for AQST Faculty staff means a greater time commitment. But being able to make links and connect knowledge developed in areas of the course approval process means the Faculty and University will benefit in the long-term.</td></tr>
</table>

Recall that this strand of evaluation was also intended to explore the accuracy of the "three orbs model" (Figure 3) [6], [23]. The purpose of the model was to better understand the conflicting information needs at the centre of the curriculum approval process and suggest that there are in fact three conflicting "information needs" within the process. Discussion of the “three orbs model” generated rich qualitative data that captured a series of conflicting participant views, which from one perspective validated the model but from the other refuted it. Contrary to the theoretical assumptions at the centre of the model, academics were generally found to support the collection of “academic”, “operational” and “aspirational” information as part of the curriculum approval process and judged its collection to be a positive requirement. The model was validated insofar as participants recognised the divergent information needs required to facilitate the approval process, the need to gather “better information” and the potential this had to overload academics; but this overload was not considered to emanate from the information requested and was rather attributed to the poor mechanisms used to collect it, the high level of duplication and the “needless” repackaging of existing information, all of which were perceived to hinder the efficacy of the previous state.

A disappointing finding that emerged from the group interviews was a preference among *some* academic participants for adhering to MS Word as the basis for the curriculum design and approval process. This perspective, articulated by two academic participants, appeared to have strong links to previous working practices and their comfort with everyday software applications. This preference among academic participants for using MS Word was found not to be just theoretical but was also observed during C-CAP piloting. Piloting of C-CAP revealed unexpected system use behaviour whereby certain sections of course and class proposals were left incomplete; instead, the requested curriculum information was contained in a number of separate MS Word attachments, uploaded at various sections of the proposal. The consequence of such system behaviour for the other approval processes C-CAP supports is catastrophic. Important curriculum information or data cannot be captured in a structured manner, thereby compromising subsequent information extraction or reuse and subverting the underlying process. Further discussion of this scenario is therefore warranted.

The issues surrounding collaborative working with single-user applications (such as MS Word) has been extensively reviewed in the literature, particularly by researchers focusing on their use within business and organisational contexts, e.g. [112–115]. For example, Adler et al. [113] summarise the problems intrinsic to collaborative working with single user applications, highlighting a lack of collaborative transparency (e.g. understanding the activities of others to avoid neglecting or duplicating work) and version control as particular issues. In their case study of implementing a participatory protocol design system within the health sector, Weng et al. [112] note the inefficient and “error prone” use of MS Word and email in the collaborative design of ethics protocols. Some of these issues were raised in PiP as a result of the baselining exercise [70] and evaluation activity conducted as part of WP7:39 [5] has noted the potential for C-CAP to resolve these particular issues. Weng et al. [112] also explore the change management and “change explanation” issues that arise from persuading users in large organisations to embrace new systems of collaborative working. Whilst better integration of single-user applications is now offered by document management and sharing platforms (e.g. MS SharePoint), the information and data contained within these uploaded documents often lacks structure and therefore evades most types of extraction or computation.

Information systems resistance has been investigated by scholars for decades (see for example: [112], [113], [116–124]) and is often cited as the principal cause of many system implementation failures [118]. System resistance is generally viewed using a series of theoretical perspectives [112], [121], [123], [124]. Kling’s [123] seminal work examining theories of resistance has been distilled by others to include people-orientated, system-orientated and interaction perspectives [121]. The people-orientated theory suggests that system resistance is provoked by certain internal factors peculiar to the groups or individuals exposed to the system. For example, citing a number of researchers, Jiang et al. [124] note a body of research that appears to support the view that user characteristics (e.g. age, gender, etc.) can influence the acceptance of new systems or technology, as well as the differing backgrounds, values and belief systems held by users. The system-orientated perspective assumes that resistance is created externally by the system or its design and, again, research has noted that resistance increases when users are presented with technically deficient systems [112], [121], [124]. Heuristic evaluation work [21] and further user acceptance testing of C-CAP [6] by PiP was partly to address subsequent user resistance issues [19]. The interaction perspective, however, is almost relativist in its assumptions and attributes the cause of resistance to be within a complex web of factors germane to people and systems and the way in which they both interact. Fundamental to this view is that systems assume different social and political meanings and their consequences are interpreted differently depending on the user's role or position [124]. Markus [121] provides common indicative examples of the interaction perspective in practice, such as:

- Systems that are resisted on the basis that they centralise control over data within organisations that otherwise exemplify decentralised structures.
- Systems that alter the power balance within organisations such that it is resisted by those who lose power.
- Resistance that arises from the interaction between the technical design of a system and the environmental or social circumstances in which it is used.

It should be emphasised that this issue has emerged as an issue for only a minority of academic participants throughout the entire PiP evaluation programme. It is nevertheless a significant minority and appears to be borne out by the interaction perspective of system resistance, in which the system is perceived to benefit administrators at the expense of academic freedom. This view appears to be corroborated by anecdotal observations of academic quality processes at a number of faculties whereby it was not uncommon for incomplete or substandard curriculum designs to be submitted for faculty consideration. Designs often followed no particular template, omitted key information (e.g. number of student contact hours, resource implications, constructive alignment, etc.), and were left for academic quality teams to "sanitise". Due process was also occasionally subverted at the behest of senior academics. The design process under the previous state therefore afforded some academics significant freedom in the curriculum design process, and this freedom no longer exists in the new state. C-CAP seeks to standardise curriculum designs and centralise data. It also renders process subversion more difficult. Yet, the perceptions of some participants clearly relate more to people-orientated theories of system resistance; a comfort with familiar working practices with single-user applications, personal attachment to physical documents or a lack of training or IT literacy.

Evaluation of impact on business processes (WP7:39)

Qualitative benchmarking

Table 3 provides a summary of the qualitative benchmarking findings. This includes the principal baselining findings [15] ("previous state") against the C-CAP implementation and resolutions ("new state"). Baselining issues 2-5 have been resolved in the "new state"; issue 1 (Process bottlenecks) has been ameliorated but ultimately remains unresolved. The reasons for this are explained below. As per the recursive evaluation plan, the findings set out in Table 3 are based on data collected from this evaluative strand and WP7:38. Table 3 also characterises the process innovation achieved using Davenport's IT process innovation categories [57]. Definitions of Davenport's process innovation categories are provided in Table 4.

The previous state of the curriculum approval process was characterised by poor feedback looping (issue #2) [70]. The new state under C-CAP, however, was found to have facilitated improved feedback mechanisms throughout the curriculum approval process, e.g. [125], [126]. Central management of the approval process and its workflow in C-CAP enables reviewers at various stages of the process to deliver feedback. This feedback is specific to each section of the curriculum proposal and is visible to other reviewers. Author details, date of feedback delivery, and so forth are recorded and remain visible throughout the process so that subsequent reviewing can verify that previous feedback has been addressed by the writing team. There is no limit to the feedback that can be delivered or a limit to the number of individual comments that can be left by reviewers per proposal section. Since C-CAP provides a central repository for feedback comments - and because the approval process is governed by workflows and is to a certain extent *automational* [127] - feedback is always communicated to key members of the writing team and members of academic quality / faculty. The use of human intermediaries to relay feedback has also been minimised such that feedback delivered at later stages of the process is visible and delivered directly to those at the beginning of the process thus facilitating a certain level of disintermediation [127].

Table 3: Summary table of qualitative benchmaking. Includes principal baselining findings [70] (previous state) against C-CAP implementation and resolutions (new state) based on data gathered in WP7:38 [22] and WP7:39 [5], as per the recursive evaluation plan. Table also characterises the process innovation achieved using Davenport's IT process innovation categories [127].

Previous state			New state		
#	**Baselining issue**	**Baselining issue summary definition**	**Status of issue under C-CAP**	**C-CAP summary description**	**Impact: Davenport's IT process innovation category**
1	**Process bottlenecks**	Scheduling of meeting dates of key committees resulting in late decisions; primary stakeholders (e.g. library, timetabling, disability services, etc.) informed too late to sufficiently discharge function.	**Partially resolved**	PiP (and ergo C-CAP) unable to change meeting schedules; although C-CAP piloting has facilitated discussion of this by key stakeholders. Nevertheless, C-CAP enables quicker processing of curriculum proposals prior to crucial decision making milestones and ensures communication of curriculum information to primary stakeholders. 'Automational' and 'disintermediating' impacts also improve process efficiency.	Automational Disintermediating Tracking Intellectual
2	**Poor feedback looping**	Poor feedback mechanisms throughout process resulting in inadequate change tracking and poor communication of feedback/changes to key stakeholders, including academics.	**Resolved**	Improved feedback mechanisms throughout the process as facilitated by C-CAP; feedback communicated to key members of academic quality / faculty and members of the writing team.	Automational Disintermediating
3	**Absence of version control**	No version control or unique identifiers in operation resulting in administrative and review issues; lack of standardisation between curriculum design forms.	**Resolved**	Version control and unique identifiers imposed facilitating 'tracking' impact. Curriculum design forms for both class and course standardised.	Tracking
4	**Absence of central repository**	No central repository of approved curricula to function as "single point of truth". Creates issues for reviewers / faculty and periodic review.	**Resolved**	Since C-CAP provides the focus for the entire curriculum design and approval process, it functions as the single point of truth from which the status of proposals can be monitored and approved curricula revisited or amended.	Intellectual Tracking Analytical
5	**Form size and lack of guidance**	Forms considered "daunting and onerous" and obstacle to pedagogical improvement. Lack of guidance associated with curriculum design process resulting in confusion about approval expectations both at academic and review level.	**Resolved**	Curriculum approval forms have been rationalised and "show and hide" approach to interface design enhances accessibility. Guidance on curriculum design and University policies embedded within C-CAP guidance areas.	N/A

Table 4: Davenport's [127] categories of potential impact on process innovation of IT and system solutions.

Impact	Explanation
Automational	Eliminating human labour from a process.
Informational	Capturing process information for the purposes of understanding.
Sequential	Changing process sequence, or enabling parallelism.
Tracking	Closely monitoring process status and objects.
Analytical	Improving analysis of information and decision making.
Geographical	Coordinating processes across distances.
Integrative	Coordination between tasks and processes.
Intellectual	Capturing and distributing intellectual assets.
Disintermediating	Eliminating intermediaries from a process.

Under the previous state poor document versioning and tracking was identified as a serious issue (issue #3). This situation had been created as a result of the various MS Word templates used by faculties for curriculum proposals. Problems tracking and identifying proposals were exacerbated by the fact that the process was often facilitated via paper or through email communication. The lack of version control or unique identifiers meant that considerable effort had to be expended by key stakeholders in order to reconcile versions of proposed classes or courses, significant aspects of which may have changed during the approval process (e.g. change in class or course title, format of study, etc.). Under the new state C-CAP demonstrates *tracking* improvements [127]. C-CAP assigns unique identifiers to curriculum proposals as soon as they are generated on the system (during "Core Information" entry, see for example [128]). This identifier remains associated with the proposal throughout the approval process and therefore enables even the most radically altered proposals to remain identifiable and trackable. Enhanced version control also means that C-CAP tracks up to 100 versions of the same proposal, allowing the effects of any changes to be rolled back should the need arise. Since C-CAP provides central management of the approval process and "a single point of truth", only the most up-to-date versions of curricula will be visible to all stakeholders. The status and tracking of proposals is monitored by C-CAP and is made visible to all, thus improving process transparency to stakeholders. Disparate curriculum approval forms have been conflated into a "super" form which standardises curriculum design across faculties and incorporates the features best known to improve design and subsequent pedagogy [110], thus presenting opportunities for an *analytical* impact on process [127].

An additional issue identified under the previous state was the absence of version control when proposals were resubmitted in response to conditions set by committees, making it is difficult for secretaries and committee members to keep track of feedback or the conditions that accompanied previous proposal rejections. All feedback pertaining to proposals is captured within C-CAP. The use of identifiers and the automational benefits brought about by workflow management within C-CAP means that proposals re-entering the approval process (e.g. perhaps as a result of previous rejection or major revisions) are never disassociated from previous feedback and remain uniquely identifiable.

The absence of any central repository (or "single source of truth") of approved curriculum proposals and descriptors was identified as a serious issue under the previous state. Lacking a definitive source of approved curriculum information created problems when curricula were scheduled for periodic review as pulling together the latest versions of all relevant curriculum information was often unachievable. Curriculum information had often been subsequently updated by a number of different actors and updates were not always recorded, tracked or shared among relevant stakeholders. This also had implications for proposals that may have been re-introduced into the approval process as reviewers often encountered difficulties in understanding how, for example, a class contributed to an the overall course (programme) because definitive and up-to-date information on the course was unavailable. In the new state C-CAP provides the focus for the entire curriculum design and approval process. It functions as the single point of truth for the most up-to-date curriculum information, from which the status of proposals can be monitored and approved curricula revisited or amended. Central management of the approval process – and the central repository of curriculum information it creates – facilitates version control and proposal tracking. As well as *tracking*, the central repository also demonstrates *intellectual* impact and *analytical* potential. Intellectual impact is characterised by capturing intellectual or knowledge assets which can then be distributed more widely to inform the activities of other groups [127]. Curricula are now being captured, managed and distributed by a central system, providing a consistent source of knowledge that can be accessed by anyone with the intellectual desire to do so.

The central repository as a vehicle for such knowledge management was considered by participants of the group interviews (WP7:38) to be a significant benefit of the repository by enabling the following activities [22]:

1. Access to a broad range of curriculum designs to inform the development of new classes and/or courses by other academics and to support professional teaching practice.

2. Dissemination of all curriculum designs to improve transparency and move to a system that captures explicit and tacit curriculum design practice.
3. A "shared intelligence" about the quality of existing curricula and would set a tangible curriculum design and quality benchmark, e.g. access to the design of exemplar classes and courses against which new curricula could be compared.
4. The re-use of curriculum knowledge assets to contribute towards institutional competitive advantage.

The central repository offered by the new state also offers considerable analytical potential. Andersen [129] details several examples of IT enabled process innovation in the public sector using Davenport's framework [127] and notes the reporting and decision support potential of such approaches. This is no exception with C-CAP. Although such analytical tools remain unspecified and have yet to be implemented, only limited technical work is required to provide institution-wide reporting of curriculum issues for the purposes of curriculum monitoring, strategy formulation and decision making. These analytical options have only been made possible as result of form standardisation and a central repository of curriculum information.

Curriculum proposal forms were found to be "daunting and onerous" in the previous state and were reportedly an obstacle to pedagogical improvement or innovation [70]. Those staff designing modules also reported the lack of guidance accompanying the forms as an additional impediment. C-CAP has standardised curriculum design and approval forms and, where possible, has either rationalised the forms or taken advantage of the technical platform (InfoPath) to deliver "show and hide" forms. Data gathered during the group interviews (WP7:38) supported this analysis. C-CAP was found to have reduced the design burden normally associated with the previous state. This, in turn, was found to have simplified academic review and to have brought about a renewed focus on those aspects of curriculum design that are integral to good pedagogical practice and to high academic quality standards. In essence, the drastic reduction in superfluous bureaucracy has meant that C-CAP can better focus on the quality and specificity of essential curriculum approval information (i.e. that which is required by the University to facilitate approval) whilst simultaneously serving forms that are less likely to stifle innovation and that are neither "daunting" nor "onerous". To facilitate this C-CAP incorporates aspects of logic such that features of the curriculum design process are hidden to members of the writing team unless specific options are selected or their design context demands it (see for example [130]). This logic ensures that those form elements that are rarely used in curriculum design remain suppressed unless they are explicitly required. Improved guidance has been embedded within C-CAP [131], providing additional guidance on University policies (where possible) and recommendations for best practice. Training materials for C-CAP and its operation (including videos) have been created and made available via the University's Development and Training Gateway [132].

Where C-CAP appeared to be less successful was in its ability to resolve fundamental issues surrounding "process bottlenecks". Qualitative benchmarking found that C-CAP demonstrated an *automational*, *disintermediating*, *tracking* and *intellectual* impact on the curriculum approval process, manifesting itself in a variety of process efficiencies [5]. These efficiencies were consistent with well understood models of IT-supported process innovation [127] and contributed towards an amelioration but not a resolution of the process bottlenecks prevalent under the previous state. An inability to effect change in the scheduling of key meeting dates (particularly that of Senate) meant that despite the process efficiencies only a "partial resolution" of this issue was possible. A number of factors contributed to PiP's inability to resolve this baselining issue entirely [4], including a lack of project authority to radically redesign approval procedures. Group interview data gathered in WP7:38 appeared to highlight the timing of these "crunch" meetings as a significant issue confronting the approval process and one that neither PiP nor C-CAP could address since it could only be resolved by radically altering long established University practices. There was also a suggestion by some participants that it was also an issue to which they were resigned and attempting to alter the "mysterious" mechanics of the University's upper echelons was futile. The current approval process mandates that curricula be "approved" by Senate. As process analysis conducted throughout the lifetime of PiP has discovered, process reality aligns with this stated process insofar as curricula are "approved" by Senate; however, it is worth noting that Senate do not scrutinise curriculum proposals that have already been successfully approved by Ordinances and Regulation (O&R) and ergo by faculties.

Pareto analysis: HaSS case study

A total of 60 class proposals and 6 course proposals were processed by HaSS during the 2011/2012 timeframe. Tables 5 and 6 set out the curriculum approval process problems recorded by HaSS for classes and courses respectively during this period and their frequency. These problems (or "causes") resulted in the delayed approval of curricula and their re-entry into the approval process or, in some cases, their outright rejection. Pareto representations of this data with a cumulative percentage threshold of 80% are also provided in Figures 6 and 7. Note that these data do not include those proposals submitted during C-CAP piloting.

Table 5: HaSS class approval process problems 2011/12 and status in the new state: data and cause definitions with cumulative percentage cut-off set at 80%.

#	Cause definitions	Frequency	Cumulative percentage	Status in new state
1	Cause # 1: Proposer fails to incorporate feedback changes in time for approval through targeted meeting of Faculty Academic Committee.	9	28.1%	***Partially addressed:*** The ability for reviewers to deliver targeted feedback on specific aspects of the proposal (i.e. section by section feedback is possible) should theoretically assist writing teams in implementing feedback more expeditiously. However, as noted, addressing this cause satisfactorily is challenging since C-CAP is unable to influence writing team behaviour outside the system.
2	Cause # 2: Time delay in reviewer providing feedback due to workload constraints.	6	46.9%	*Unaddressed*
3	Cause # 3: Proposers not fully completing the class proposal proforma with requisite information.	6	65.6%	***Addressed:*** Under the new state class proposals cannot be submitted for review if the "core information" requirements have not been satisfied. Where information is not mandated but considered central for the approval process, system logic is used to either remind the writing team if such an area of the form remains empty, incomplete or incorrect. Embedded user guidance and additional training materials are also used to ensure writing teams complete proposals to a sufficient approval standard. Addressing this cause is particularly noteworthy owing to its "vital few" status.
4	Cause # 4: Proposers not completing a class code allocation form which can delay amendments to course regulations.	4	78.1%	***Addressed:*** Under the new state class code request forms are generated automatically. Most of the request form content is extracted automatically from the class proposal by C-CAP. This minimises unnecessary bureaucracy thus removing one of the principal reasons for staff postponing its completion and speeding up the form submission process. Submission of the form is an explicit part of the C-CAP system and writing team members are reminded to submit the form. Addressing this cause is particularly noteworthy given its "vital few" status.
5	Cause # 5: Assessment criteria / details flagged up by reviewers as a potential issue, e.g. insufficient detail.	3	87.5%	***Partially addressed:*** C-CAP is structured to capture specificity in assessment activities and the alignment of assessments with learning objectives. Such specificity is facilitated through a series of drop down menus, auto calculations and system logic. A supplementary description field is available in which the writing team can focus on a description of the assessment activity and its design.
6	Cause # 6: Resources required to deliver the class not taken into account.	2	93.8%	***Addressed:*** Under the previous state curriculum design and approval forms across all faculties failed to address the issue of non-standard resources. Specifying non-standard resources is now an explicit part of the design process in C-CAP. As part of this process the writing team must provide details of how this resource is to be provided, its availability and estimated cost.
7	Cause # 7: Competition and duplication of classes run elsewhere in the University not taken into account.	1	96.9%	***Addressed:*** Internal competition and/or duplication is now explicitly addressed by the curriculum design and approval forms served by C-CAP. Writing teams are now required to provide a statement on the distinctiveness of the proposed class and the extent to which it overlaps or competes with any other classes offered elsewhere in the institution.
8	Cause # 8: No contact from proposer after feedback provided. Class approval elapsed.	1	100.0%	*Unaddressed*

The causes listed in Table 5 and 6 provide a useful insight into *actual* rather than *perceived* process issues confronted by faculties during curriculum approval. Although data highlight the most frequently occurring causes in class and course approval processes, a Pareto effect cannot be observed. Cumulative percentages in the first two to three categories, known as the "vital few" [133], should equate to circa 80% of the effects [134]. However, causes #1 - #3 within the class approval process only account for 65.6% of the total effects (Table 5), with the cumulative threshold being broken at cause #5. Similarly, the cumulative threshold within the course data is broken at cause #5; although it should be noted that in both cases the cumulative percentage at causes #4 are sufficiently close to 80% at 78.1% and 78.9% respectively. As the associated Pareto charts illustrate (Figures 6 and 7), a gradual decline from left to right is demonstrated and the chart profiles do not follow a prototypical Pareto profile. In this instance the “useful many” are actually in the minority. It is nevertheless worth noting that the 80% threshold is an approximation [135], thus 78.1% and 78.9% is reached at cause #4 in both class and course approval processes.

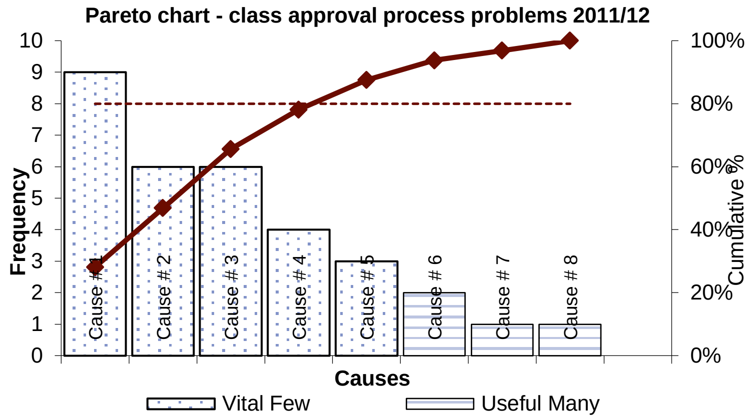

Figure 6: Pareto representation of class approval process problems 2011/12.

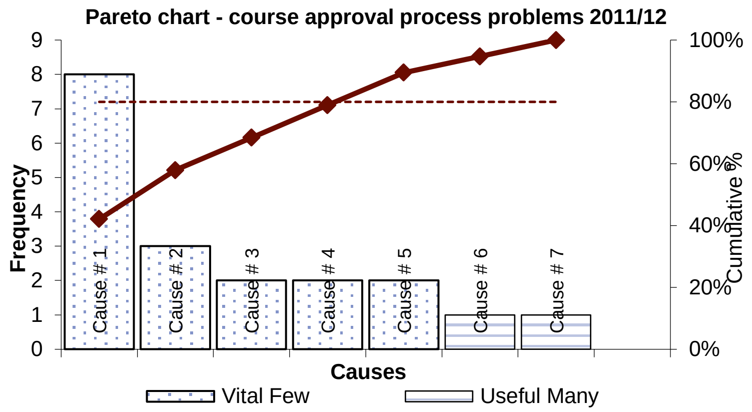

Figure 7: Pareto representation of course approval process problems 2011/12.

One of the most interesting observations from this data is that it identifies a series of process approval issues that were not identified during the original baselining exercise [70]. With the possible exception of class cause #3 (“Proposers not fully completing the class proposal proforma with requisite information”) and course cause #1, all the recorded causes represent new approval issues requiring attention. Several of the causes exist in areas of the process that C-CAP either has limited influence over or cannot control. For example, C-CAP is unable to influence the staff workload constraints (class cause #2) that may cause approval to be delayed or abandoned, nor can C-CAP control some of the issues surrounding the single biggest cause (class cause #1). The question of why most of the causes were not identified in the baselining exercise requires some reflection. It appears that both exercises (i.e. baselining exercise and Pareto analysis) examined curriculum approval processes from different perspectives (i.e. qualitative and quantitative) and in so doing identified different issues within the same process. Indeed, relying on a single data collection technique is discouraged [136] and instead mixing qualitative and quantitative data sources is considered essential to better understand process issues and “give meaning” to numeric data [136–

138]. It is also possible that the perceived process issues (as identified by respondents in the baselining exercise) focused on the tacit, holistic and/or fundamental process issues, whilst Pareto analysis exposed important day-to-day issues which would otherwise evade treatment in any holistic discussion of process. Further discussion of this issue is available at the PiP Blog [139].

Although Pareto analysis identified a series of alternative issues within curriculum approval processes, Tables 5 and 6 set out the "causes" that – as a corollary of addressing the baselining issues via qualitative benchmarking – have either been theoretically "addressed" or "partially addressed". Those causes that are marked "addressed" are considered to have been successfully eliminated in the new state, while those marked "partially addressed" are considered to have been the ameliorated in the new state. The status of some causes are marked "unaddressed", in most cases these causes occur in the course approval process and are those that are either difficult for C-CAP to influence or located outside the process. Such causes evade process modelling and there are few technical solutions that can be incorporated into C-CAP that could address them satisfactorily. Their amelioration may therefore be the best that can be aspired to. For example, group interview data gathered during WP7:38 suggested that email reminder notifications would contribute towards the resolution of class cause #2 [22].

Table 6: HaSS course approval process problems 2011/12 and status in the new state: data and cause definitions with cumulative percentage cut-off set at 80%.

#	Cause definitions	Frequency	Cumulative Percentage	Status in new state
1	Cause # 1: Issues surrounding the volume/size of proposals and the time needed for review, which encroaches on other activity.	8	42.1%	***Addressed:*** C-CAP has standardised curriculum design and approval forms and, where possible, has either rationalised forms or taken advantage of the technical platform to deliver "show and hide" forms. Forms are therefore shorter. Opportunities for appending additional information, which under the previous state was often collected but performed no purpose or function in the approval process, has been removed.
2	Cause # 2: Level of course fees set by Course Leader required clarification by Student Experience & Enhancement Services Directorate (SEES).	3	57.9%	*Unaddressed*
3	Cause # 3: Revisions of class descriptors required to update current teaching practice.	2	68.4%	***Addressed:*** Under the previous state revisions to extant curriculum designs was difficult and could be time consuming owing to the lack of a central repository and any definitive course of curriculum information. A central repository of definitive curriculum information has ameliorated this by providing an efficient mechanism through which extant curriculum designs can be identified, retrieved, and their intellectual content modified.
4	Cause # 4: Clarity on the total staff teaching hours needed to deliver the course required.	2	78.9%	***Addressed:*** The unstructured nature of curriculum design and approval forms associated with the previous state were such that extracting unambiguous data on the total staff teaching hours required to deliver a course was cumbersome and time consuming. C-CAP captures structured information on the percentage time involvement of other departments or external partners and gathers structured data on the learning activities to be delivered, the number of activities, their nature and duration. Total teaching delivery hours per class are automatically calculated.
5	Cause # 5: Information within the Programme Specification must align with the course proposal information.	2	89.5%	*Unaddressed*
6	Cause # 6: Difficulty in obtaining external panel members to attend review meeting.	1	94.7%	*Unaddressed*
7	Cause # 7: Staffing and associated risk assessment not fully investigated by the Course Leader.	1	100.0%	*Unaddressed*

Structural metrics

Structural metric analysis yielded perhaps the most positive quantitative data on C-CAP's impact on business processes. It provided numerous positive figures and demonstrated C-CAP's improvement on the extant process. Results for structural metric analysis on the class and course approval processes are provided in Tables 7 and 8 respectively and provide details of the percentage improvement in the new state for each structural metric. The comments column summarises the benefits that have resulted from the new state. Those interested in the metric calculations should consult the strand report, which demonstrates the calculations and discusses the nature of the metrics in more detail [5].

Table 7: Structural metric results for course approval, summarising structural metric results under previous and new states. Note that metric calculations are explained and demonstrated in the strand report [5].

Applicable structural metric	Previous state	New state	Comments
Communication automation factor (CAF)	0/20 (0%)	13/20 (65%)	System driven communication contributes towards improved reliability, throughput, cycle time and cost reductions. Includes use of additional systems driven communication to notify the library and timetabling of the newly approved classes.
Activity automation factor (AAF)	0/15 (0%)	6/15 (40%)	C-CAP provides several instances of interactive automation contributing to efficiency by decreasing activity turnaround time and contributing to cycle time reductions. System support promotes task reliability.
Process visibility factor (PVF)	0/11 (0%)	11/11 (100%)	Process status information easily shared via C-CAP contributing to improved process visibility, consequent staff time efficiencies, improved process tracking and improved cycle times.
Person dependency factor (PDF)	6/15 (40%)	6/15 (40%)	Owing to the qualitative process this remains unchanged; although opportunities for reducing PDF are available.
Activity parallelism factor (APF)	0/15 (0%)	2/15 (13%)	Only minor APF improvements. Further implementation of APF in future may be difficult owing to sequential process activities and since earlier stages in the approval process requires high levels of human discretion (i.e. PDF).
Transition delay risk factor (TDRF)	14/14 (100%)	12/14 (86%)	Only minor improvements. Frequent transitions of process execution to humans within both previous and new state.

Table 8: Structural metric results for class approval, summarising structural metric results under previous and new states. Note that metric calculations are explained and demonstrated in the strand report [5]

Applicable structural metric	Previous state	New state	Comments
Communication automation factor (CAF)	0/10 (0%)	9/10 (90%)	System driven communication contributes towards improved reliability, throughput, cycle time and cost reductions
Activity automation factor (AAF)	0/11 (0%)	6/11 (55%)	C-CAP provides several instances of interactive automation contributing to efficiency by decreasing activity turnaround time and contributing to cycle time reductions. System support promotes task reliability.
Process visibility factor (PVF)	0/9 (0%)	9/9 (100%)	Process status information easily shared via C-CAP contributing to improved process visibility, consequent staff time efficiencies, improved process tracking and improved cycle times.
Person dependency factor (PDF)	2/11 (18%)	2/11 (18%)	Owing to the qualitative process this remains unchanged; although opportunities for reducing PDF are available.
Transition delay risk factor (TDRF)	10/10 (100%)	8/10 (80%)	Only minor APF improvements. Further implementation of APF in future may be difficult owing to sequential process activities and since earlier stages in the approval process requires high levels of human discretion (i.e. PDF).

Through theoretical process analysis C-CAP demonstrated potential for improving approval process cycle time, process reliability, process visibility, process automation, process parallelism and reductions in transition delays, thus contributing to considerable process efficiencies. In particular:

- *Communication automation (CAF)*: C-CAP has enabled communication automation improvements of up to 65% and 90% in the course and class process respectively, contributing to better process reliability and reduced costs. Such large improvements are partly attributable to the poor support for communication and, more specifically, automated communication in the previous approval process.
- *Activity automation (AAF)*: Up to 40% and 55% improvements in course and class process respectively have been made possible with C-CAP. Levels of activity automation can contribute to process efficiency by decreasing activity turnaround time and contributing to

cycle time reductions. Process reliability can also be increased as system mediated tasks are less prone to human error

- *Process visibility (PVF)*: Improvements in process visibility contributed the single biggest enhancement to the process under C-CAP. Process visibility was found to be improved by up to 100% in both the course and class approval process, contributing towards improved process reliability. Process visibility in the previous process was non-existent so enhancements with C-CAP have resulted in massive improvements in this respect. Under the new state changes to the approval status of curriculum proposals is either triggered automatically or is updated by those staff responsible for coordinating the process via C-CAP (e.g. academic quality teams). The status of all class and course proposals is now completely transparent and visible to all stakeholders via the C-CAP home page, thus eliminating many of the bottlenecks and inefficient practices caused by poor process visibility.
- *Activity parallelism (APF)*: Increased levels of activity parallelism are possible using C-CAP, with up to a 13% increase achieved in the course approval process. Such an increase contributes to improvements in cycle time and throughput. Note that the class approval process is significantly shorter and is therefore less conducive to parallelism.
- *Transition delay risk (TDRF)*: C-CAP has enabled a potential reduction of > 15% in transition delay risks across both course and class approval processes, thus minimising potential delays that could emerge as a consequence of frequent transitions of process execution to humans. It should be recognised that transition delays are inevitable in most processes and human intervention in a curriculum design and approval process can never be completely eliminated.

Analysis also identified several stages or activities in the process that required fundamental adjustment in order to improve overall process performance. This is particularly true of *RIF* (role integration) and *PDF* (person dependency) (see Tables 6 and 7). Improving role integration at crucial steps in the approval process such that conceptually related activities can be actioned sequentially by a single actor (*RIF*) was identified as an area for further process improvement, as was the process wide promotion of knowledge ecosystems to promote tacit knowledge transfer thus minimising PDF. Even a factor such as *PVF* (process visibility), which achieved 100% under the new state for both class and course approval, could be adjusted to provide stakeholder specific process visibility.

6.2 Unexpected findings

To facilitate analysis using Balasubramanian and Gupta's structural metrics [101], the curriculum approval process for courses and classes in the Hass Faculty under the previous state was formalised using ISO 5807:1985 compliant symbology [140]. The flow charts modelled approval process and were used to inform calculations of the structural metrics. However, it was acknowledged in the associated strand report that the charts provided only an "ideal type" of the class and course approval process, in a Weberian sense [141], with some sub-processes remaining un-modelled. The charts formed an ideal type because requirements analysis and stakeholder engagement conducted with all faculties throughout the project lifetime has failed to generate a model of the approval process that all stakeholders can agree upon. The reasons for this are complex and are discussed in more detail within the strand report [5] and on the PiP blog [142]; but it appears to relate to widespread misunderstanding of how the curriculum approval processes function. This situation is further compounded by stakeholder specific perceptions of how the approval process operates, and myths about organisational procedures and a stakeholder's role within certain procedures, some of which are themselves mythic. Myths are not uncommon in organisational contexts and are often considered necessary in functioning bureaucracies [143–145]. For example, it remains not uncommon to encounter stakeholder "X", who confidently states than their role in the process is to pass information to stakeholder "Y" for processing. Stakeholder "Y", when questioned, reports that the information stakeholder "X" communicates is unnecessary and is not required for them to discharge their function; yet stakeholder "X" remains adamant that it is within their role to behave in this way and by doing so they are adhering to the "process". In effect, a variety of myths surrounding the approval process have emerged over many years at the University of Strathclyde. These myths have become pervasiveness and are subscribed to by many actors, thus subverting the process as it currently exists and undermining attempts to formalise or model the true process, let alone effect process change. Exposing the mythic core of an established organisational process and the consequent stakeholder misunderstanding that emanates from this was therefore both a significant and unexpected finding. It has implications for the way in which future embedding of C-CAP across the institution should be directed; but the use of an ideal type approach to process modelling is also proposed as a way to formalise processes for the purposes of structural metric analysis.

7. Conclusions and recommendations

7.1 Conclusions

This report has sought to summarise and synthesis the evaluative approach and the findings of the evaluation strand reports [5], [6], [21], [22]. Section 4 has summarised the PiP rationale underpinning the institutional need to effect improvements in curriculum design and approval process responsiveness. Central to achieving this is the development of innovative technology-supported approaches to curriculum design, approval and review. It is anticipated that the improvements effected in process efficacy as a result of adopting innovative technology-supported techniques can better assist HE institutions in reviewing or updating curriculum designs to enhance pedagogy or maintain academic quality, as well as making institutions more responsive to the demands of a rapidly changing and globalised HE context.

As a result of an extensive programme of evaluation activity set out in the PiP Evaluation Plan [15], it has been possible to evidence a wide variety of positive findings in the new state. Although there were some methodological constraints, the evaluative approach adopted was of value and exposed rich quantitative and qualitative data on a multitude of systems and process issues, all of which provided an evidence base upon which to assess C-CAP's impact. Indeed, PiP has developed a technology-supported approach to curriculum design and approval that demonstrates high levels of user acceptance, promotes improvements to the quality of curriculum designs, renders more efficient and transparent aspects of the curriculum approval and quality monitoring process and resolves a number of chronic information management difficulties which pervaded the previous state. The PiP Institutional Story enumerates the "Headline achievements" of PiP. Many of these achievements were facilitated by C-CAP and have been evidenced as a result of this extensive programme of evaluation activity. A more considered appraisal of the evidence is therefore required to conclude this synthesis of the PiP evaluation activity.

As the results of user acceptance testing revealed, C-CAP as a system was positively received, achieving a positive SUS score and ARS rating. Whilst this could be partially attributable to the high computer efficacy of the participants and the improvements to C-CAP made possible as a result of heuristic evaluation, protocol and stimulated recall data did reveal that participants were, in general, favourably disposed to the C-CAP system. These findings were corroborated by the rich qualitative data captured as a result of the group interviews in strand WP7:38. System perceptions were again found to be generally positive, with C-CAP considered to better support the design process. Simplicity of the drafting process within C-CAP and its potential to minimise common process misunderstandings were cited as particular benefits. Interview participants from all stakeholder groups also considered the forms to be more prescriptive and to clarify the curriculum information expectations of writing teams, thereby helping to improve the specificity and ergo the quality of curricula.

C-CAP was found to promote a variety of Davenport's process innovation techniques by demonstrating automational, disintermediating, intellectual, analytical and tracking properties [127]. In point of fact, it is in the area of improving curriculum approval processes that C-CAP has arguably demonstrated most impact. In many cases process resolutions have also produced curriculum design or academic quality gains. Qualitative benchmarking undertaken in WP7:39 found the streamlining and process improvement approach adopted by C-CAP to enable the resolution – or partial resolution – of all the five process and document management failings, as identified by the PiP baselining exercise [70]. Deficiencies inherent in the previous state, such as inadequate feedback looping, insufficient version control and the absence of any central repository of curriculum proposals or designs, were all found to have been resolved in the new state. Triangulation of data collection from

WP7:38 corroborated theoretical analysis undertaken in WP7:39. "Form size and lack of guidance" – a qualitative benchmark attracting only partial resolution in WP7:39 - was also found to have been resolved in light of data gathered in WP7:38. A reduction in the superfluous paperwork underpinning the design and approval process in the previous state was considered a particularly welcome change by interview participants. It is also a change that assumes added significance owing to its status as the most common Pareto cause for course approval delay or rejection [5]. C-CAP has reduced the design burden normally associated with the previous state and as a consequence has simplified academic review; but it has also brought about a renewed focus on those aspects of curriculum design that are integral to good pedagogical practice and to high academic quality standards. In essence, the drastic reduction in superfluous bureaucracy has meant that C-CAP can better focus on the quality and specificity of essential curriculum approval information (i.e. that which is required by the University to facilitate approval) while promoting responsiveness in curriculum design and approval. This better supports the work of academic quality teams and whilst exposes academic staff to design templates that are less likely to stifle innovation or to be considered "daunting" or "onerous".

Pareto analysis exposed a series of everyday process approval issues which were not identified via baselining and qualitative benchmarking. Most of these issues (or "causes") were found to have been explicitly and successfully addressed by C-CAP, or were resolved by virtue of addressing the baselining issues (e.g. class code allocation form delays, clarity on total number of teaching hours, etc.). Some "causes" remain unaddressed; although it should be noted that in most cases this is because these issues exist in areas of the process that C-CAP either has limited influence over or cannot control (e.g. proposers failing to incorporate feedback in time for Academic Committee consideration, time delay in the delivery of reviewer feedback as a result of staff workload, etc.). Such issues evade process modelling and there are few technical solutions that can be incorporated into C-CAP that could address them satisfactorily. Their amelioration may therefore be the best that can be aspired to. Similarly, the data and analysis from WP7:38 and WP7:39 failed to evidence the resolution of the "process bottlenecks" issue, an issue identified by the baselining exercise as being particularly disruptive to approval process efficacy. It also failed to identify potential solutions, other than those related to process reengineering, an approach that was found to be inappropriate given the "change radicalness" context of C-CAP's deployment (see WP7:39 for further details). Reengineering was also found to be outside PiP's remit. Process reengineering was recommended in previous evaluation work [5] thus suggesting that a productive area of future work should be to explore opportunities for reengineering the latter stages of the existing approval process. A new project using the SLEEK method has been commissioned to address these issues as part of a comprehensive business improvement exercise.

Structural metric analysis [101] yielded perhaps the most positive quantitative data on C-CAP's impact on business process, providing numerous positive figures and evidencing a huge improvement on the previous state. Through theoretical process analysis C-CAP demonstrated potential for improved approval process cycle time, process reliability, process visibility, process automation, process parallelism and reductions in transition delays, thus contributing to considerable process efficiencies and evidencing C-CAP's ability to better support responsive curriculum design. Analysis also identified several stages or activities in the approval processes that could be adjusted to effect further improvement. This is especially true of *RIF* (role integration) and *PDF* (person dependency). Improving role integration at crucial steps in the approval process such that conceptually related activities can be actioned sequentially by a single actor (*RIF*) is necessary, as is the process wide promotion of knowledge ecosystems to promote tacit knowledge transfer thus minimising *PDF*. Even a factor such as *PVF* (process visibility), which achieved 100% under the new state for both class and course approval, could be adjusted to provide stakeholder specific process visibility. To some extent this latter example highlights an inherent limitation in using theoretical approaches to measure process improvement: it is theoretically possible for a new state to achieve maximum improvement when, in reality, additional process enhancements could be made. A more general but related limitation to such theoretical approaches is the difficulty in accurately modelling business process in an "institutionalised organisation" where organisational myth, process misunderstanding and process subversion are pervasive. Any analysis is dependent upon the use of generalised ideal types which may not yield the most precise results or accurately reflect "process reality". The process improvements and streamlining instantiated by C-CAP and quantified from this aspect of the evaluation, though not entirely generalizable in themselves, were nevertheless corroborated qualitatively in the group interviews conducted as part of WP7:38.

The issue of promoting tacit knowledge transfer within knowledge "ecosystems" was not only confined to specific improvements within process modelling and execution. The development of a central repository of approved curriculum designs was also revealed by participants to be one of the most important changes to have been facilitated by C-CAP. The significance and implications of such a central repository was evidenced theoretically in WP7:39; but subsequent analysis of interview data gathered during WP7:38 exposed among stakeholders a latent cognisance of knowledge management principles and their potential for transforming curriculum design. The management of curriculum designs as "knowledge assets" was considered to support a number of key academic quality processes and better enable responsive curriculum design. Providing repository access to a broad range of curriculum designs was embraced due to its potential to inform the development of new curricula and its ability to support professional teaching practice. Data supported the view that a "shared intelligence" about the quality of existing curricula would be established and thus tangible curriculum design and quality benchmarks set. The repository would also provide a platform from which to disseminate explicit and tacit curriculum design practice, and would maximise the value of institutional knowledge assets by allowing the re-use of curriculum designs, thereby contributing towards institutional competitive advantage. The importance of a central repository of curriculum designs has long been a project objective [16] and, as we noted in Section 4.3, has attracted wider interest in the literature [51–53]. Its delivery via C-CAP and its positive impact on business process and document management were reported in previous evaluation work [5]. Its qualitative verification in this instance is therefore a positive finding and, unlike the qualitative benchmarking analysis which relied on mechanistic indicators of success, provides a well-articulated human account of its wider significance.

Structural metric analysis found up to 100% improvements in process visibility on both the class and course approval processes. This analysis was reflected in the results of qualitative data collection in WP7:38. Issues surrounding a lack of process visibility or transparency were considered to have improved because C-CAP not only supported curriculum design by providing greater prescription in terms of the information expected in curriculum designs but also because it made transparent the various approval process milestones. Whilst a series of technical solutions have been implemented to improve process visibility to all stakeholder groups (e.g. status indicators, notification emails, etc.), C-CAP has more generally improved process understanding and transparency within the institution. By virtue of being a single curriculum approval system, C-CAP has come to embody the approval process and has rendered transparent hitherto tacit practices and processes. It has become a single point of engagement with curriculum approval and functions as the process mediator, making explicit to stakeholders the process milestones. Improved transparency was therefore a clear change that was effected by C-CAP; although it should be noted that there were minor concerns that the transparency of departmental decision making was not what it should be, particularly in relation to decisions about whether new curricula should be proposed in the first place. Resolving this issue was something that was found to fall outside the responsibility of C-CAP and is expected to be addressed by the SLEEK initiative. More generally, though, transparency was found to have improved as a result of C-CAP and its improvement under the new state was a recurring theme that emerged from the findings of WP7:37, WP7:38 and WP7:39.

The improved transparency is also likely to assist in the long term demystification of the approval process at the institution. For example, the myths and process misunderstandings that were found to be held by some stakeholders, though an unexpected finding, can now be confronted with a single point of truth, not just of the data that C-CAP collects and holds, but of the process itself. As noted above, C-CAP has now become the single point of engagement with the curriculum approval process and therefore it can be expected that over time many of the erroneously held beliefs surrounding the approval process will recede. The strand report for WP7:39 explores in detail the role of myth in large organisations; suffice to state that researchers in organisational behaviour [144] note that the highest chance of myth elimination and ergo successful organisational change is in the latter stages of the “myth lifecycle”, during which the validity of the myth will be questioned owing to its numerous anomalies. C-CAP – and the participative way in which stakeholders were involved in the design of the system – has initiated the questioning of particular myths under the previous state. Verification of this questioning is anecdotal and has noted been evidenced by the evaluation activity of PiP; however, it is worth noting that during the development and refinement of C-CAP numerous process improvements were introduced, some of which included jettisoning previous mythic sub-processes or collection of data that was intend for some mythic purpose.

Linked to the improved process visibility and transparency available under the new state was the concept of process control. The ability to track, monitor and control aspects of the curriculum design and approval process was identified in the interview data as an important change effected by C-CAP, the significance of which was then corroborated by the “winning” MSC story. The MSC stories identified a number of significant changes including the reduced administrative burden associated with curriculum design, improved process transparency and opportunities to harness knowledge assets; but better control over the design and approval of curricula was cited as significant for both academics and those involved in academic quality. It was found to empower academics by enhancing their control of designs once they had entered the approval cycle; academic quality staff welcomed it as a better mechanism for controlling, monitoring, structuring and minimising errors in the quality approval process.

Although the system was on the whole positively received, data collected from academic participants during WP7:37 and WP7:38 appeared to reveal a dichotomy between the *system* (which received generally positive feedback) and the overall curriculum design *process* (which was less well received). Anecdotal evidence from the WP7:37 indicated that those participants who had been exposed to the curriculum approval process from a managerial perspective were the most encouraged by the potential of C-CAP to assist in the approval process; their views clearly influenced by their professional practice and an holistic understanding of the approval process issues involved. Whilst other users lacked this insight, data from both from this strand of the evaluation indicated that all participants were dissatisfied with the existing process, tacitly acknowledging that adjustments and improvements were justified. At many stages during user acceptance testing with C-CAP system, participants were not required to produce more information than they otherwise would – and, in fact, qualitative data from WP7:38 and WP7:39 confirmed that the volume of bureaucracy associated with curriculum design and approval has drastically reduced in the new state; yet the demands of the University’s policies and regulations on curriculum approval meant that many participants were unconvinced of the underlying process, as facilitated by C-CAP. Whilst the resulting “three orbs model” attempted to understand this tension, qualitative data captured during the group interviews (WP7:38) revealed a series of conflicting participant views, which from one perspective validated the model and the scenario painted by the user acceptance testing; but from the other refuted it. Contrary to the theoretical assumptions at the centre of the model, those academic involved in WP7:38 were generally found to be supportive of the “information need tension”. Collection of “academic”, “operational” and “aspirational” information as part of the curriculum approval process was judged to be positive. The model was validated insofar as participants recognised the divergent information needs required to facilitate the approval process, the need to gather “better information” and the potential this had to overload academics; but this overload was not considered to emanate from the information requested and was rather attributed to the poor mechanisms that have historically been used to collect it, the high level of duplication and the “needless” repackaging of existing information. All of these issues were perceived to hinder the efficacy of the previous state. Whilst this is clearly a positive finding and aligns with C-CAP's renewed focus on academic quality and the essential curriculum design information that facilitates this, it should nevertheless be remembered that this phase of evaluation was conducted within a single University faculty. Academics' fervour for increased specificity in curriculum design may not therefore be shared elsewhere, particularly when previous evaluation activity involving participants from other faculties during user acceptance testing suggested otherwise.

The development of C-CAP has to date followed an incremental design methodology [17] which has been informed by on-going evaluation [5], [6], [21]. Not only was system development participative but participative system implementation strategies [124] were adopted prior to Faculty piloting. It was therefore disappointing to find academic participants to be attached to using MS Word to complete curriculum design tasks, and perhaps more disappointing still since this finding corroborated the attitudes of some participants during previous evaluation activity [6]. Further data analysis and reference to prevalent systems resistance typologies suggests that the loss of academic freedom (via the interaction theory), an attachment to habitual working practices, and low levels of IT literacy were partly to blame for resistance. It may therefore be the case that a gentler transition between the previous and new state is required for some academic users. Such an approach aligns with prominent innovation diffusion techniques [146] and their application within the information systems domain [112], [147–151]. Emphasis here is on coaxing the "late majority". Forcing such users to abandon familiar technologies can be counterproductive and the use of bridging options are often advocated whereby some choice in system adoption is provided, at least temporarily [112], [152]. Such an approach carries several inherent risks, not least the potential for academics to subvert the process as previously described, but could be successful in promoting C-CAP acceptance, assuming appropriate safeguards are implemented and policies are communicated to academics (e.g. faculty and academic quality policies relating to the rejection of proposals that seek to subvert due process, rejection of proposals that fail to meet basic curriculum information thresholds, etc.).

7.2 Recommendations

In accordance with the evaluation strategy and its link to the incremental systems design methodology responses to many of the evaluation findings were implemented during C-CAP development or are in the process of being addressed. A number of recommendations can nevertheless be formulated as a result of the PiP evaluation activity. These recommendation are likely to form the basis of embedding activity scheduled to take place August 2012 – April 2013; but may also interest others in the HE sector seeking to pursue technology-supported approaches to curriculum design and approval. Findings in support of recommendations are linked to, where appropriate.

- *Improving the data surrounding approval process efficacy*: WP7:39 noted some of the difficulties in evaluating the impact of process improvements when few performance indicators are gathered on the previous state. To monitor the longer term impact of C-CAP on approval process efficacy there is a general requirement to increase quantitative data collection on the performance of the approval process so as to improve future process monitoring. The comparative potential of analysis techniques such as Pareto can be optimised if data were collected over defined temporal periods, with each period exposed to specific process changes or improvements, thereby facilitating "before and after" analysis. Subsequent data collection under the new state is therefore required to enable the monitoring of process improvements during the faculty embedding of C-CAP. In line with the above noted need to improve process monitoring, future work should also attempt to verify the extent to which the process improvements identified using structural metrics are reflected in the "real world" implementation of C-CAP.
- *Organisational impact monitoring*: Improved mechanisms for observing change within stakeholder groups is required to monitor and assess the longer term "human" impact of C-

CAP. The periodic use of the MSC approach would be one such mechanism owing to its suitability in organisational contexts and its ability to capture secondary outcomes, such as those of personal significance to shareholders.

- *Best practice guidance*: PiP has improved the quality of guidance materials made available to academics during the curriculum design process; however, there remain aspects of the approval process that lack the same level of guidance. Future work should also seek to establish C-CAP "best practice" guidance or training to ensure key change agents (such as academic quality teams) maximise the effectiveness and impact of C-CAP. Such orientation would better assist those responsible for the administrative management of the curriculum approval process and would contribute towards improved system acceptance levels during future embedding of the system.
- *Further process improvements*: Analysis of the process improvements effected as a result of C-CAP's implementation enabled the identification of several process stages, or process activities, that should be further adjusted to improve overall process efficacy. Whilst all the structural metrics are worthy of revisiting to ensure the process C-CAP models is optimised, there are obvious opportunities for improving *APF* (activity parallelism), *RIF* (role integration) and *PDF* (person dependency). Improving role integration at crucial steps in the approval process such that similar but related activities can be actioned sequentially by a single actor (*RIF*) is necessary, as is the process wide promotion of knowledge ecosystems to promote tacit knowledge transfer thus minimising PDF. C-CAP makes possible higher levels of activity parallelism (APF) in post-Faculty approval processes but currently demonstrates only low levels of APF. As C-CAP enters its institutional embedding phase (August 2012 – April 2012), it is anticipated that fundamental process improvements and aspects of process reengineering will be introduced by the SLEEK initiative.
- *Resolving "process bottleneck" issue*: Owing to the disruptive bottlenecks that occur in the approval process as a result of Senate meeting dates, an investigation should be undertaken to establish the true nature of Senate's role in the approval process and whether Senate notification of approved curricula is sufficient to satisfy University regulations. Process reengineering was recommended in previous work [5] thus suggesting that a productive area of future activity should be to explore opportunities for reengineering the latter stages of the existing approval process. Since effecting such radical change to the approval process is outside the remit of PiP, it may be necessary for other significant bodies (e.g. Ordinances and Regulations, Student Experience and Enhancement Services Directorate) to make recommendations for Senate on this matter.
- *Improving cross-Faculty consistency in curriculum design practice*: System logic and guidance notes within C-CAP promote greater consistency in aspects of proposed curriculum designs and supports adherence to curriculum frameworks, e.g. Scottish Credit and Qualifications Framework [153]. However, there remains a need to clarify ad hoc design practices across the institution. This is required to render the process and its requirements more transparent to academics, but also to establish equitable learning pathways for students, particularly as radical differences in assessment practice and study hours allocation were found to exist during WP7:37.
- *Policies on the KM of curriculum designs*: Owing to the *analytical* and *intellectual* potential of the curriculum designs captured in the C-CAP central repository, it is essential that an appropriate KM policy accompany their long term curation. Such a policy should seek to formalise the technical management of the designs, their re-use and sharing, the promotion of exemplar designs, establish protocols for design adaptation and resubmission to the approval process, and policies to foster institution-wide promotion of the repository.
- *Coaxing the "late majority"*: Bridging mechanisms are essential to improve system acceptance among those who are particularly resistant. Systems resistance – which in this instance lies in user attachment to MS Word - has been shown to be extremely disruptive to the success of new systems and strategies for combating it are therefore critical to the

success of the institutional embedding phase of PiP. The provision of MS Word templates (using form controls) should be made temporarily available to potentially resistant users. These forms should model those served by C-CAP thus enabling existing drafting behaviour to continue while simultaneously exposing users to the structure of the form; however, curriculum designs will need to be reproduced in C-CAP and will - as users' system familiarity and confidence increases - encourage drafting to occur directly within C-CAP in future.

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9. Appendix A: PiP Evaluation Plan

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10. Appendix B: Evaluation of systems pilot (WP7:37): Heuristic evaluation of course and class approval online pilot (C-CAP)

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11. Appendix C: Evaluation of systems pilot (WP7:37): User acceptance testing of course and class approval online pilot (C-CAP)

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12. Appendix D: Impact and process evaluation (WP7:38): C-CAP impact and process evaluation

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13. Appendix E: Evaluation of impact on business process (WP7:39): Critical analysis of BPI technique and C-CAP within class and course approval

Macgregor, George. *Principles in Patterns (PiP): Evaluation - WP7:39 Evaluation of Impact on Business Processes*. Glasgow: University of Strathclyde, 2012. http://www.principlesinpatterns.ac.uk/Resources/Evaluation.aspx.