Project EPCOS

Project EPCOS (**E**ffective **P**rojectwork in **CO**mputer **S**cience) aims to identify, make explicit and systematize existing best practices in Computer Science student project methods and techniques.

1. Introduction

The proposers are a consortium of Computer Science Departments from the Universities of Exeter, Imperial College, Kent, Leeds, Manchester, Southampton, Teesside and York, and from the Centre for Informatics Education Research at the Open University (CIER) and the Computer Science Discipline Network (CSDN). The consortium represents the full spectrum of University Institutions - large/small, rural/ metropolitan, "old"/"new". The consortium takes advantage of diversity in expertise and recognised teaching excellence. It offers a natural framework for organisation, management and first stage evaluation of the work proposed.

The 10 partners of our consortium include 70% of the Computer Science departments rated excellent by the HEFCE quality assessors.

2. Scope of Project EPCOS

Project work is an integral part of all accredited Computer Science undergraduate degree programmes. The Engineering Council requires all courses leading to Chartered Engineer to "embody and integrate theoretical, practical and project work". The British Computer Society (BCS) and the Institute of Electrical Engineers (IEE), the relevant professional accrediting bodies, emphasise this learning mechanism. Also, experience of this method of working is becoming commercially and industrially crucial.

Yet managing project work is problematic, because Computer Science projects are: - **expensive**, demanding considerable supervision as well as technical resources; - **complex**, marrying design, human communication, human-computer interaction, and technology to satisfy objectives ranging from consolidation of technical skills through provoking insight into organizational practice, teamwork and professional issues, to inculcating academic discipline and presentation skills; - **continually demanding**, set in the context of a rapidly changing technology which affects technical objectives and demands ever-evolving skills in both students and supervisors. In a young and changing discipline, some aspect of project work is questioned in almost every institution.

Existing publications devoted to generic pedagogical techniques for project work offer some guidance, and the "known practice" (methods, tools, and experiences) described in this literature will be synthesised as part of this project. This literature includes work by Jacques, Boud, Slavin et al, Tessmer, Zuber-Skerritt, the *Staff and Educational Development Association*, the *Association For Learning Technology* and some contributions in the *Journal of Assessment And Evaluation in Higher Education*,

and the *Journal of Artificial Intelligence in Education*. There have also been contributions within other disciplines, such as Design, Physics, and Humanities.

However, this body of literature on the dynamics and personal skills involved in project work in general does not address many of the issues raised by Computer Science's peculiar mix of social, technical, and technological components. There is comparatively little literature which is Computer Science specific. Although there have been scattered contributions (in the SIGCSE *Bulletin*, IEEE *Transactions on Education*, the Software Engineering Institute Software Engineering Education Conference proceedings, and occasional papers in the *Software Engineering Journal* and IEEE *Transactions on Software Engineering*) the subject-specific material in the literature is diffuse, and no single-source reference material is known to us.

The Computer Science academic community regards project work as an essential component of any course. However, there is less agreement on the most appropriate objectives of such work. Although this proposal is focussed on the single learning mechanism of project work it encompasses many aspects, including the delivery of subject content alongside or interleaved with the on-going student project, management of student allocation and staff resources, assessment procedures, consideration of technical outcomes and methods of maximising the educational experience for students.

3. Aims of project EPCOS

3.1 To identify, make explicit and systematize existing best practices in Computer Science student project methods and techniques in order to make existing knowledge and experience readily accessible for the achievement of threshold standards in Computer Science graduates. (In this work project EPCOS will be informed by the emerging work on "threshold standards" from HEQC's graduate standards programme initiative.)

3.2 For each EPCOS partner to document and evaluate its work with student projects and to realise and improve the contribution of project work to threshold standards in its own area of particular interest. (see 9, below)

3.3 To realise techniques for transferring project work practices between institutions; and

3.4 to execute and evaluate such transfers.

3.5 To contribute Computer Science-specific material to the literature on project work.

4. Method of project EPCOS

The EPCOS project adopts a model of 'distributed ownership', implementing collective objectives through distributed responsibility. The project plans to use both an Executive Committee and CSDN as mechanisms to oversee and coordinate the

distributed activities. Each will have a roles in both the monitoring and management of the project (See 7.3.1, 7.3.3., 8.1, 8.3 below). The work of project EPCOS will be divided into three phases: phase one, making existing practice accessible; phase two, realising techniques for transfer; phase three, implementing and evaluating changes in practice.

Investigations within specific areas of interest will be driven by the respective partner institution (see 9, below), and each will review the practices catalogued in that area.

4.1 Phase one: Making existing practice accessible

4.1.1 Survey: In phase one, we shall undertake a three-level initial survey of current practice in context:

i)The partner institutions will be the first level of information, where the survey will be the most detailed, including interviews and the collection of example material.

ii)The second level will survey other institutions who express active interest. Four workshops will be held in different geographical regions in which the wider community shall be invited to identify current best practices across the sector. Interesting examples of project work practice identified in the workshops will be followed up in detail.

iii) The third level will survey all remaining Computer Science departments in England, Wales and Northern Ireland by postal questionnaire.

4.1.2 The Development Officer

The Development Officer will have two areas of responsibility: compilation of a catalogue of practice and experience and coordination of evaluation planning (see 7, below). The job of the Development Officer will be to set down the structures and mechanisms which will provide coherence, comparability, and definition to the project, based on the aims of the consortium partners. Hence, the Development Officer will be responsible for the surveys of practice, will be involved in workshops to identify best practice, will be responsible for the analysis, structuring and compilation of the resulting examples, and will liaise with each consortium partner in order to develop an evaluation plan for the work of each.

4.1.3 Catalogue of Practice

Raw data, evaluation and analysis of the survey material will be made available to all Computer Science departments (see 5.1.1, below). Additionally, the material gathered in the surveys shall be digested into a catalogue of practice and experience, with each example presented in a standard form designed to enable comparison and taking into account factors such as: learning goals, teaching methods, original context (for example students, problems, facilities), integration into the curriculum, assessment criteria and methods, expected and observed technical outcomes, professional issues embedded in this delivery mechanism, competencies and transferable skills, management models and formative and/or summative evaluations. Feedback will be

sought from industry representatives and professional bodies. This catalogue will be published in both paper and electronic form.

4.2 Phase two: Realising techniques for transfer

4.2.1 Each partner institution will undertake to evaluate the necessary pre-requisites for transferability of the particular aspect under consideration, between institutions and between contexts, and act as consultant to any other institution seeking to make such a change (see 6.3 below)

4.3 Phase three: Implementing and evaluating changes in practice

4.3.1 Each partner institution will undertake to adopt a new project method or technique investigated by another member of the consortium and to feed back experience of this method and of its of transferability. (see 5.3.1 and 5.3.2, below)

By such methods, which constitute a model of distributed ownership, we take advantage of the expertise and excellence represented within our consortium and we model the dissemination and transferability we intend.

5. Project EPCOS Milestones and Deliverables

Project EPCOS is divided into three phases. We anticipate that to achieve the outcomes of phase one will take up to eighteen months. However, much of the material gathered in this phase will be made available to partner institutions at an earlier date, allowing phase two activities to overlap phase one. Likewise between phases two and three. All phases will be completed within three years. For monitoring purposes (see 8.3, below) each contributing partner will be required to submit a progress report every six months. Full details are contained in the Activity Plan Gantt Chart.

5.1 Phase one: Making existing practice accessible

5.1.1 Survey of Computer Science departments (by the contracted Development Officer) which will identify project techniques in current practice in context. This data will be published on the CSDN web pages (http://www.ukc.ac.uk/CSDN/), as hard copy (as required) and distributed free of charge to all contributing institutions.

5.1.2 Initial planning meeting, hosted by CIER to discuss and develop evaluation criteria. A report will be internally published within the consortium.

5.1.3 Four workshops for input from the wider community to identify current best practices across the sector. Each workshop may adopt a theme to focus interest. (see 6.2, below)

5.1.4 A catalogue of practice (both methods and experience) derived from the surveys and workshops which will use a general template format which facilitates comparison, re-use, and transfer of methods and which will incorporate a compilation of project

work management mechanisms and models and a directory of re-useable technical material.

5.2 Phase two: Realising techniques for transfer

5.2.1 Each collaborating department will investigate and develop a method of management or assessment which is clearly transferable, based on outcomes from Phase one.

5.2.2 Each collaborating department will produce an evaluated model of transfer.

5.2.3 Each collaborating department will produce a report on its work undertaken in phase two which will be presented at phase two workshops. This subsumes progress report 3.

5.3 Phase three: Implementing and evaluating changes in practice.

5.3.1 Each collaborating department will adopt and evaluate a transferable method from Phase two.

5.3.2 Each collaborating department will evaluate the transfer experience and will identify problems and potential solutions in terms both of the specific method under study, and the overall issue of transferability of management and assessment methods.

5.3.3 Four dissemination workshops (see 6.3). We believe that project EPCOS will not only generate and document new and important material (see 5.1.4 and 5.2.3, above) but also investigate and demonstrate vital methods of working which will be of interest to a large spectrum of academics. We intend to gather papers from each participating institution, edited by CSDN and published in book form at the end of the funding period.

6. Strategy for Dissemination

6.1 The dissemination of results will be through CSDN which is an existing initiative, part funded by the Department for Education and Employment, with the aim of promoting good practice in the teaching and learning of Computer Science. All papers, materials and workshop reports will be made available on the CSDN web site, by ftp and in hard copy (as required). CSDN has a reputation and recognised role in the discipline with an active membership spanning the entire HE sector. Simply making materials available however is not dissemination. We recognise three levels of dissemination: disseminating awareness of the project, so that other interested parties can involve themselves at an early stage; disseminating knowledge of the project to a level where the rationale and methodologies used can be understood, extracted and adapted to local conditions; and disseminating the use of the results to change practice. We intend to employ strategies which address all levels.

6.2 We will disseminate *awareness* of the project in the first phase through regular reports on the CSDN web site and to the CSDN-teaching mailing list. We will also utilise other discipline-specific organisations which cover different constituencies,

such as the Computers in Teaching Initiative journal Monitor. The workshops in the first phase will be concerned with gathering inputs and will be geographically distributed to allow maximum attendance. These workshops will also act as dissemination mechanisms for awareness of the project.

6.3 We will disseminate *knowledge* of the project through the materials collected and the distribution of the analysis of the materials and recommendations arising from that analysis (see 5.1.4, 5.1.5, 5.2.2, and 5.2.3, above). We will disseminate this through publication of the catalogue, phase two and phase three workshops, papers prepared for journals and constituting a panel of consultants from the partner institutions who will be electronically available to answer questions on the material and aspects of its use.

6.4 Dissemination of *use* is the most difficult area. Quality in teaching and learning is neither generated nor encouraged by prescription and it is consequently difficult to require the adoption of new methods or techniques. Equally, this is the hardest area in which to discover the effectiveness of dissemination efforts as feedback is frequently patchy, and largely concerned with complaint, not plaudit. Consequently, we would assist this process through the third phase workshops by offering "partnerships" between any HE institution wishing to change practice and the original consortium partner institution which most closely matches the changes identified and requested. A condition of this "partnership" would be evaluation and feedback mechanisms.

6.5 At the end of the project life, project EPCOS will make representation to the FDTL Advisory Committee to ask for their help in promoting adoption and transfer of the project outcomes.

7. Strategy for Evaluation

Project EPCOS has several layers of evaluation experience and expertise upon which it can call. Firstly there is the experience of the individuals committed to the project. Secondly, project partners may consult with quality assessment and survey units in their own institution, although the variety of institutional experience and provision in this area is such that this cannot be made a requirement of every partner. At a higher level, the consortium's academic evaluation expertise is focussed in CIER, with its substantial experience in empirical and evaluation studies, and where the contracted Development Officer will be based.

The strength of our proposed evaluation strategy lies in an emphasis on planning. The available expertise will be used to establish criteria and protocols for all evaluation activities and to ensure that each of the consortium partners has clearly defined plans for the evaluation of its own work. Continuing support will be provided to the consortium partners: as well as explicitly focussed events, a portion of each workshop and project meeting will be reserved for evaluation matters. Overall criteria for monitoring and evaluation will be defined early in the project, derived from the project objectives.

The evaluation strategy for project EPCOS has two parts: evaluation of the work of individual partners to document and transfer techniques (hereafter "appraisal"), and evaluation of the project as a whole (hereafter "monitoring")

Appraisal:

7.1 Each partner in the consortium will conduct formative evaluation of the aims, materials and methods of its own work to highlight both the learning opportunities and the potential difficulties to be resolved in the adoption of the area under study. The criteria for these evaluations will be in accordance with the project-wide parameters.

7.2 Three parties will be involved in the evaluation of each transfer of practice: the source institution, the institution to which the method is transferred, and another consortium member who will observe the transfer process and act as an "auditor".

The auditor will participate in planning the evaluation, but will not participate in the transfer activity. The auditor role is intended to maximise the spread of evaluation expertise within the project consortium, to encourage accountability among the partners and to provide coherence to the evaluations. In addition, CSDN will act in a similar "auditor" role where external institutions and EPCOS members act in "partnership". (see 6.4, above)

Monitoring

7.3.1 CSDN will undertake a longitudinal evaluation of the process methodologies adopted by each partner institution. 7.3.2 The BCS and the IEE will be invited to attend workshops, view the materials prepared by the Development Officer and consortium partners, and make reports to the Executive Committee (see 8.3, below).

7.3.3 The Executive Committee will monitor the project as a whole. In the first two years, it will monitor the contribution of each partner on the basis of reports received. In the final year, it will be able to assess the performance of the project as a whole, given the interim reports, the completed catalogue, reports from the BCS and the IEE, the evaluation reports of each contributing partner, and any other materials it chooses to request.

7.3.4 Project EPCOS as a whole will be subject to summative evaluation, in order to assess its effectiveness in terms of the project criteria and the value delivered, by an external consultant.

8. Strategy for Management

8.1 Day-to-day Central Management

The consortium will require central management in terms of inter-institution communication, financial co-ordination and administration. This central management of project EPCOS will be undertaken by CSDN. The Project Manager will be Sally Fincher.

8.2 Distributed Management

Each partner institution will be responsible for the management of its own aspect of project EPCOS, within the general framework of the project plan. The consortium will not encroach on the autonomy of individual academics, which would not produce good results in the academic environment.

8.3 Executive Committee

The day-to-day management provided by CSDN will be augmented with a three-member Executive Committee which will monitor the progress of the project (see 7.3.3, above) and approve staged distribution of funds to particular institutions, based on their having achieved their targets and submitted reports.

The membership of this committee will be: Professor Derek Fraser, Vice Chancellor and Chief Executive of the University of Teesside, Professor Diana Laurillard, Pro Vice Chancellor (Technology Development) of the Open University, and Professor John Slater, Professor of Computer Science at the University of Kent at Canterbury.

9. Areas of specific interest of partner institutions

During consortium discussions, two principal areas of student project work emerged for investigation by project EPCOS. The first was a consideration of "core" areas, common to all our experience: Allocation, Management Models, Technical Outcomes, Professional and Assessment Issues, etc. The second area consisted of examples of interesting, sometimes unique, project work practices which were imaginative and progressive currently in use at partner institutions. Amongst these were: Cross-institutional projects, Negotiated learning contracts, Quality Management methods, large team projects and the interleaving of project work with taught work.

Each consortium partner will work on one of these specific areas, according to interest and expertise. Allocations below are provisional, and are based on expressed preference.

9.1 Core areas

9.1.1 Technical Outcomes: The Victoria University of Manchester

Rapid technological change in computing influences the scope of projects, the tools to be used and the objectives of projects. Projects which would have been appropriate a few years ago are rendered pointless by the availability of new tools and techniques. Effective use of many modern tools requires considerable learning time, which detracts from the time available to execute the project. This investigation of technical outcomes will first seek to identify current practice in Computer Science departments and the extent to which that practice has changed in the light of technological changes and other pressures. It will identify the technical expectations of students, academic staff and professional bodies. It will investigate the extent to which differing expectations are compatible. It will then propose ideal models and styles of project together with the expected technical outcomes of each style.

9.1.2 Allocation: Imperial College

How computing students are allocated to projects and groups varies from department to department. Types of group organisation include random groups, heterogenous groups, groups chosen by group leaders, common interest groups and friendship groups. Unless all students undertake the same project, projects will be perceived as more or less desirable and more or less difficult.

This component will focus on the questions: How should the allocation of students to projects be made? How much choice should students have over the subject matter of the projects they undertake?

9.1.3 Management Models: University of Kent at Canterbury

Good project management is about helping students to practise and develop technical, organisational, management, communication and social skills through involvement in a large-scale piece of work. Traditionally, only a single model of supervision has been used. In this model, support has relied on frequent face to face meetings between students and a member of staff who effectively acts as the project supervisor. Recent increases in both student numbers and pressures on academic staff time have led some departments to develop alternative and more cost-effective mechanisms for supervising and guiding project work.

The purpose of this part of the project is to identify and disseminate effective models for organising and running projects.

9.1.4 Assessment Issues: University of Southampton

The assessment of project work is based on the grading of each student or group on predetermined scales for one or more of the deliverables or activities

This section of the work will examine alternative assessment strategies, paying particular attention to: how the assessment scheme quantifies the deliverables or activities in terms of its contribution to the project's aims and objectives, the significance, if any, of the choice of assessor, the effectiveness of feedback mechanisms, the way the assessment is fed back to the students and the perceived fairness of marking schemes.

9.2 Progressive Areas

9.2.1 Negotiated Learning Contracts: University of Teesside

Negotiated cooperative learning is the notion that individuals and teams can negotiate their own learning objectives in projects. Negotiation takes place between student and student (within teams), between teams and tutors, and between individual students and tutors. This is a desirable objective because it can be argued that a negotiation process can improve learning autonomy in students. Learning autonomy is the ability to identify learning needs (or objectives), marshall the resources required to address

the needs, learn effectively, and self-assess outcomes, or to have the outcomes assessed by someone else. These are key transferable skills for life-long learning.

The purpose of this work is to devise a transferable management framework within which negotiation regarding learning can be carried out through the use of learning contracts.

9.2.2 Large team projects: University of York

Staff at York have many years experience of running large-team projects as part of the undergraduate curriculum. Major components of such projects include:

planning and determination of project outcomes; communicating shared perceptions to staff involved in supervision; team organisation and management; scheduling operations; task completion; process evaluation.

This component will focus on the aims, objectives, strategies and tasks associated with large-team projects; the structures and procedures that need to be put in place to enable large-team projects to be effective; whether the structure of the traditional large-team project can be extended to advanced work.

9.2.3 Integrating project and curriculum: University of Exeter

Project work requires students to draw on disparate knowledge and various personal transferable skills (PTS). The knowledge and skills are not usually addressed in a single taught degree module. By this separation of concerns we remove the student from the real world technical difficulties, pressures, and problems. Instead we present them with isolated, contrived, and individual pieces of work that are irrelevant to the real world of team-based interactive systems development, and which often are scheduled too late (in the final year) for lessons to be learned and consolidated.

The purpose of this work is to investigate how projects may be integrated more closely with taught components, drawing on Exeter's considerable experience in this area.

9.2.4 Inter-institutional Group Projects: University of Leeds

For the future it will become important that group and team working skills are transferable from a face-to-face to a remote environment. This section of the project has direct relevance to issues identified in many of the HEFCE TQA reports and the work of *Higher Education for Capability*, by embedding level four/five competencies in good teaching practice.

The collaborative nature and flexible nature of electronic media, the decreasing cost of the technology and the cultural changes of working at a distance would indicate that these will be core skills for the future.