

"Open Learning Support for the Mathematical Education of Engineers".

The full bid document, submitted to FDTL-4 which resulted in the award of £250,000.

1 Introduction

This proposal concerns the mathematics provision for Year 1 & 2 engineering students as stipulated by the engineering profession's SARTOR requirements (Standards and Routes to Registration). It is based upon Loughborough's Open Learning Project (OLP) which has supported mathematics learning for over 3000 engineering students since 1996.

This proposal seeks funding for the dissemination of the OLP materials throughout England & NI. This will entail enhancement through critical feedback and the inclusion of further materials from other consortium members (Hull, Reading, Sunderland, UMIST) and trialling partners.

This proposal is not concerned with remedial help, which is the subject of the separate FDTL4 Leeds bid: *National Mathematics Support at the Transition to University*. We plan to have a member of that project, which complements ours, on our Steering Group.

2 Aim

The overall aim of this project is to enhance the mathematical education of engineering undergraduates in England & NI by the provision of flexible teaching and learning materials which may be integrated into existing engineering programmes by selection of individual stand-alone units or by adopting the whole scheme. The primary target group comprises departments and academics teaching mathematics to engineering undergraduates. (The materials may also prove useful to FEIs involved in HE provision.)

The overall aim will be achieved by the following.

Actions already underway or completed

- Identification of successful aspects of OLP materials and enhancements needed
- Identification of gaps in the existing OLP materials
- Identification of additional materials already available which may be used, with modification, to complete the scheme.

Actions for the project

- Implementation of Project website
- Compilation of additional material
- Testing and evaluation of all materials, and revision

- Evaluation of effectiveness in comparison to current approaches (in the consortium)
- Preparation of support materials for teaching staff
- Running workshops and contributing to conferences
- Dissemination of the final product (assisted by LTSNs)
- Evaluation of all processes and products, especially dissemination strategies
- Development of a network of consultants (consortium members) to assist wider implementation
- Ongoing support for those adopting the materials

Output

- 37 Workbooks covering mathematical materials for Year 1 and Year 2 engineering
- Associated Computer Aided Learning (CAL) and case study segments
- A comprehensive Computer Aided Assessment (CAA) Question Bank for each workbook
- A Guidebook for teaching staff

3 The National and Local Background

3.1 National issues

Numerous recent reports testify to the severity of the ‘mathematics problem’ faced by HE. Consequences of the recent high AS failure rate are sure to exacerbate the position.

In 1995, the report *Mathematics Matters in Engineering* [1] was published on behalf of various institutions of Engineers and Mathematicians. It concluded that "too many graduate engineers are perceived to be deficient in mathematical concepts and fluency". The report also highlighted the many pressures to reduce and simplify the mathematical content. In the same year, the Engineering Council published *The Changing Mathematical Background of Undergraduate Engineers* [2] containing the results of a detailed study into the difficulties which undergraduate engineers face with mathematics. It concluded that "students are now accepted on engineering degree courses with relatively low mathematics qualifications", which many lecturers believed undermined the quality of their degrees. The 2000 Engineering Council report *Measuring the Mathematics Problem* [3], confirmed the decline in basic mathematics skills between 1990 and 2000, quantified by Lawson [4] and echoed in the recent Roberts Report [5].

QAA External Subject Review (ESR) reports (1996-2000) have repeatedly linked high failure and withdrawal rates with the ‘mathematics problem’ [6].

Given the above, and the WP agenda, there is a clear need for a more accessible and flexible mathematics curriculum for engineering students, which this proposal provides.

3.2 Mathematics teaching and learning in the Consortium

Loughborough

The Department of Mathematical Sciences has an international reputation in the field of the mathematical education of engineers. Dr Mustoe chaired the IMA *Engineering Mathematics Matters* Working Group (1999) which outlined curriculum proposals to

meet SARTOR 3 requirements. Dr Harrison edits the *International Journal of Mathematical Education in Science and Technology*. The IMA conferences on the *Mathematical Education of Engineers* are held at Loughborough. Dr Green was a main author of the University's Learning and Teaching Strategy (2000).

The Department has shown its forward thinking and commitment by developing its pioneering *Mathematics Learning Support Centre*, by promoting the OLP, and by establishing (in May 2002) the *Mathematics Education Centre* whose core members are involved with this bid.

Lesley Davis of the Department of Manufacturing Engineering will provide a valuable link to the FDTL3 BALANCE project which she directs.

Hull

The Engineering Department offers degree programmes in Electronic Engineering and Mechanical Engineering. Electronic Engineering achieved a Teaching Quality Assessment score of 24 in 1998. The Department is carrying out a FDTL3 funded project on the experience and retention of engineering students (PROGRESS). Undergraduates entering the Department are given a diagnostic test and, if appropriate, are encouraged to make use of the University-wide *Mathematics Advisory Centre*.

Reading

The Mathematics Department has long experience of successfully teaching mathematics to scientists, while teaching a much smaller amount to engineers. It has a long-standing reputation in teaching numerical analysis, including pioneering work introducing computer tutorials, which will feed into this project. The Department won a competitive internal grant in 2002 for the development of computer animations of various mathematical techniques; these will be made available to the project.

Sunderland

The School of Computing and Technology teaches mathematics and statistics to a wide variety of students including Business, Automotive Engineering and Computing. In addition, a centrally based and centrally funded Mathematics Help Scheme has operated for many years. Over this period, learning materials – of use to this proposal – have been developed. Substantial quantities of these have been used in other HEIs. School staff have recently been involved in a variety of nationally funded projects (e.g. MathWise) and European teaching technology transfer projects (under TEMPUS and TACIS).

UMIST

The Department of Mathematics provides service courses in mathematics to around 1000 students in almost every discipline including engineering, science and foundation studies. A prominent feature is assigning students to streamed courses matched to their personal needs, informed by a diagnostic entry test. CAA is a component of these courses.

3.3 ESR outcomes

The teaching of mathematics to engineers at Loughborough has been evaluated many times within engineering reviews, with excellent results. The OLP has received specific mention as being “commendably innovative”. ESR grades for HEIs associated with this

bid are tabulated below for *Curriculum Design, Content and Organisation* (CDCO) and *Student Support and Guidance* (SSG) – the most relevant aspects for this project.

Consortium Institution	Department or School	CDCO	SSG
Loughborough (lead)	Mathematical Sciences	4	4
Hull	Engineering	4	4
Reading	Mathematics	3	4
Sunderland	Computing & Technology	3	4
UMIST	Mathematics	4	4

Trialling Institution Year 1	Department or School	CDCO	SSG
Aston	Information Engineering	4	3
City	Electrical Eng / Mathematics	4 / 4	4 / 4
Coventry	Electrical Eng / General Eng	3 / 3	4 / 3
Northumbria	Computing and Mathematics	4	3
Southampton	Mathematics	3	4

CAA Databank Partner	Department or School	CDCO	SSG
Brunel	Mathematical Sciences	3	4

The LTSN MSOR in 2001 cited *Service Teaching* as an area of specific concern and a recent LTSN Engineering survey revealed that the decreasing mathematical knowledge and skills acquired at A level was a top issue among engineering academics [7].

3.4 History of Loughborough's Open Learning Project

The OLP was launched at Loughborough University in 1996 to address pedagogic issues arising from the diversity of ability and qualifications, and a general lowering of basic mathematical facility on entry. It was supported by a competitive grant from Loughborough's Development Fund for Teaching Innovation which enabled the appointment of specialist staff and an external evaluator. The Department provided additional materials and staff time amounting to about £200,000. The outcome was 25 workbooks, a 2,500 question electronic data bank and approximately 60 CAL segments.

3.5 The Open Learning Project materials

The thrust of OLP is threefold:

3.5.1 Printed Materials

High quality printed materials (workbooks *not* textbooks) cover much of the basic mathematics required by undergraduate engineering students. Each workbook – typically 50 to 60 pages – includes a prerequisites section and a learning outcomes section. The workbooks are written specifically with the typical engineering student in mind and over-rigorous mathematics is avoided. The material is attractively presented with numerous diagrams, worked examples and "guided exercises". Jargon is minimised. At Loughborough this material is made freely available to students and enables them to better structure their learning and, to a certain extent, learn at their own pace. This material liberates staff to change the nature of lectures: from rushed exercises in note taking to a better and more relaxed exposition of the subject material. This material has been highly praised by staff and students alike in numerous feedback exercises (see [8]).

3.5.2 CAL Segments

Many of the workbooks have an associated CAL segment available over the web which includes audio, animation and self-assessment aspects. These are especially useful for supporting students of moderate mathematical ability, and for revision (although students in general are most attracted by the availability of the workbooks themselves).

3.5.3 Assessment Regime

Students following the OLP are tested three or four times each semester with questions delivered over the web. Most of the 2,500 questions have a page of feedback. Students are encouraged to engage in learning by allowing them to access trial tests over and over again (with feedback) before taking a one-attempt summative test. Students are very appreciative of this composite formative and summative assessment regime and, almost without exception, participate fully. This regime strongly motivates students to keep up with their studies and thereby improve achievement and progression.

3.6 Progress to date and future plans

Phase 1	1996-1999	Development of printed Workbooks, CAL segments and an Assessment Regime for Year 1, informed by external evaluation.
Phase 2	1999-2001	Full implementation of the Year 1 materials. Development of Year 2 materials.
Phase 3	2002-2003	Completion of two further Year 2 Workbooks etc (Complex Numbers), which will feed into the work for this proposal.
Phase 4	2002-2005	Extension, enhancement, trialling, revision and dissemination of OLP materials to other HEIs, which is the subject of this proposal.

Phases 1 and 2 of the OLP are completed. The existing materials have been thoroughly tested at Loughborough, and have been used over the web by individual staff and students in many parts of the world (as many complimentary emails testify).

Phase 3 – the addition of two more workbooks and concomitant materials – will be undertaken in 2002-2003 funded by Loughborough.

Despite the OLP's success, certain aspects need refinement whilst others need broadening, to enhance their usefulness to other HEIs. The quality would be further assured by trialling at a range of institutions. This refinement, broadening, trialling and dissemination constitutes the aims of Phase 4 of the project for which FDTL funding is sought.

4 FDTL4 Project Proposal

We propose to carry out the following tasks in a three-year programme.

4.1 Deliverables

4.1.1 Materials

- 37 Workbooks – typically 50-60 pages each, divided into 4 or 5 ‘blocks’ comprising:
 - Mathematics for engineering, and associated mathematics problems
 - Engineering related problems for each block of most workbooks
 - A page of more complex problems at the end of most workbooks best tackled using a Computer Algebra package or Spreadsheet
 - Engineering case studies emphasising modelling at the end of about 6 workbooks
- CAA Question Bank for each workbook
- CAL segments for most workbooks
- Guidebook for teaching staff

Each project workbook will have a specified critical reader who will both comment on material and produce material for the Guidebook. This will relate success stories and challenges and encapsulate good practice derived from a variety of institutions with their individual contexts and cultures. The Guidebook will also include reference to usage of common computer packages.

4.1.2 Additional materials

Most of the materials already exist or will be provided by Loughborough but some additional workbooks will be developed from existing materials currently being used by consortium members:

- Numerical Analysis – 4 workbooks (Reading)
- Statistics – 4 workbooks (Sunderland)
- Vector Calculus and Multiple Integrals – 2 workbooks (UMIST)

Additional Question Bank items will be provided by UMIST and Brunel.

4.1.3 Availability of materials

During the project, all materials will be available free to project members (in electronic form or as photocopiable masters), together with limited hard-copy sets. After the project, all materials will be available free (in electronic form) for **all** England & NI HEIs. Photocopiable masters or printed workbooks will also be available at-cost.

4.1.4 Support

- One team workshop (December 2002) focusing on trialling issues and bringing consortium and partner institutions ‘up to speed’ on the OLP regime.

- Six regional workshops for interested HEIs, two per year (Summer 2003, 2004, 2005). [Wherever feasible these will be shared events with the two relevant LTSNs or other FDTL4 projects. (Discussions have already taken place and agreement in principle reached.) These will focus on publicising the project's aims to a wider community, illustrating materials and reporting on lessons learned by trialling institutions.]
- Visits to support individual institutions with implementation of the materials (throughout project and – funds permitting – subsequently).
- Receiving visitors at consortium institutions to discuss project activities.
- Website maintained during and after the project by the *Mathematics Education Centre*.
- Guidebook for teaching staff.

4.2 Accessibility issues

4.2.1 Academic issues and delivery modes

The project addresses the varying levels of ability, prior knowledge, motivation, self-confidence and preferred mode of learning (which may be cultural or gender related) by allowing different modes of delivery, from standard lectures through to distance learning.

4.2.2 Disabilities

The Special Educational Needs and Disability Act (SENDA) presents challenges to all HEIs and will affect how teaching and learning are planned and take place. This project will reflect this legislation. We intend to link with national programmes for which this is a focus (e.g. projects funded under HEFCE 02/21 and the JISC funded TechDis). It is our aim that institutions adopting our materials will be on the correct path to compliance.

Dyslexia

Loughborough has expertise and experience in supporting dyslexic engineering students. The *Mathematics Education Centre* has a dedicated tutor to help dyslexic students who will advise the project team on learning, language and presentational issues. For many dyslexic students note-taking is especially difficult. Having printed workbooks, which can be provided on any colour of paper, in A3 enlarged format, and in different fonts, helps the dyslexic student and support tutor alike.

Visual impairment

Loughborough has experience in supporting visually impaired engineering students and has a Braille embosser that can generate tactile diagrams. All the workbooks are available in Latex source code which can be read by an ASCII reader or Braille interpreter.

4.3 Links to other projects

We see a clear need for continual monitoring of other nationally funded projects and this task will be assigned to team members.

PROGRESS: Improving Student Progression and Achievement in Electronic Engineering

This FDTL3 project is researching and disseminating the strategic Learning and Teaching responses made by UK HEI Engineering Departments to difficulties which students experience with progression. Salient among these is inadequate mathematical preparation. The project is also looking at pragmatic approaches to supporting incoming

cohorts through conducting a systematic needs analysis and re-designing the Year 1 Mathematics curriculum for Engineering at Hull.

BALANCE project

This FDTL3 project is gathering and disseminating good practice in attracting and retaining females into engineering. Experiences gained have identified practices that females prefer in their learning activities, which will be valuable to this project.

TQEF

Loughborough has been using TQEF funding for a Secondment Project (2000-2002). Materials developed and experiences gained by seconded staff will be tapped.

LTSN MathsTEAM project

Three LTSNs are collaborating to assemble information for the HEI community on entry diagnostic mathematics tests, support on arrival, and linking mathematics to engineering contexts. This is clearly relevant to our project and close liaison will be maintained.

4.4 Review of other materials

MathWise

This material suffers by not being web-deliverable and has no paper-based resources, which students prefer. Some problems may be useful to our project. (Walter Middleton authored two MathWise units.)

Maths for Engineers WebDisk

This appears very impressive as it contains video and animation segments but currently it lacks sufficient structure, making navigation difficult for the learner.

Mathletics (Brunel)

This is a very large question bank. Planned developments using QM Perception are of relevance to our project. Collaboration with the author Dr Greenhow has been agreed.

Metric (Imperial College)

This is (primarily) a web-based learning resource with a limited range of mathematical topics and the mathematics is not properly embedded in the text. The interaction pages are unsophisticated and quite unlikely to engage the average engineering student.

Open University

There is a considerable body of excellent and relevant open learning material produced by the Open University (specifically courses MU120, MST121 and MST207) including provision for disabled students. The review of these materials is ongoing. However at this stage it is noted that the OU materials:

- (a) are intended primarily for self-study rather than to augment face-to-face teaching
- (b) are intended for a wider audience and so do not emphasise engineering
- (c) are dependent on specific software (MathCad)
- (d) are not generally available at no cost as is intended for this proposal

Professor Attenborough was involved in the creation of MST121 and MST207 materials.

4.5 Project scheme of work

An outline schedule for the project is presented in tabular form and as a Gantt chart.

	Task	Responsibility	Start	End
0	Recruit technical author and administrator/secretary	LU	By Sept 2002	
1	Formulate detailed dissemination strategy	Dr Harrison, Administrator	Oct 2002	Dec 2002
2	Initial Trialling with selected Y1 materials	Dr Harrison, Administrator	Oct 2002	Dec 2002
3	Project Steering Group meeting Confirm aims and working timetable for Project Decide on detailed Criteria and Evaluation Strategy	Dr Green and Steering Group	Dec 2002	Dec 2005
4	Year 1 Dissemination: Trialling selected material.	Dr Harrison, Administrator	Oct 2002	Sep 2003
5	Student evaluation	Dr Mustoe	Oct 2002	Sep 2003
6	Initial dissemination at UMTC, IMA MEE conference	LU Management team	Apr 2003	Sep 2003
7	Adapt Y1 written materials (numerical) Adapt Y1 written materials (statistics) Adapt Y2 written materials (complex numbers) (funding: LU)	Dr Chamberlain (Reading) Mr Middleton (Sund) Dr Mustoe (LU)	Oct 2002	Oct 2003
8	Write engineering supplements Y1S1	Prof Attenborough (Hull) Dr Steele (UMIST)	Oct 2002	Jun 2003
9	Implement website	Technical Author	Oct 2002	Dec 2002
10	Complete CAL segments for Y1S1	Technical Author	Oct 2002	Sep 2003
11	Test Assessment Package for suitability in other HEIs	Dr Ward, Mr Danson	Oct 2002	Mar 2003
12	Workshop for Consortium and Partners	Dr Harrison, All	Dec 2002	
13	Internal evaluation of Y1S1 materials	Critical readers (all)	Jan 2003	Jun 2003
14	Student evaluation	Dr Mustoe	Jan 2003	Jun 2003
15	External evaluation of Y1S1 material External evaluation of project regimes	Dr Green + External Evaluator External Evaluator	Jun 2003	Aug 2003
16	Extend question Libraries to all Y1S1 topics	Dr Ward	Apr 2003	Jul 2003
17	2 Regional Workshops for Consortium, Partners plus other HEIs	Dr Harrison, All	Summer 2003	
18	Steering Committee to assess progress at Year 1 milestone. Reports from consortium team members.	Dr Green, Steering Group and Project Team	Sep 2003	
19	Year 2 Dissemination: Trialling selected materials Student evaluation.	Dr Harrison, Administrator Dr Mustoe	Oct 2003	May 2004
20	Dissemination at UMTC	LU Management Team	Sep 2004	
21	Write engineering supplements Y1S2	Prof Attenborough (Hull) Dr Steele (UMIST)	Jul 2003	Jan 2004
22	Extend question libraries to all Y1S2 topics	Dr Ward	Aug 2003	Jan 2004
23	Adapt Y2 written materials (numerical) Adapt Y2 written materials (statistics) Adapt Y2 written materials (Vector Calculus, Multiple Integrals))	Dr Chamberlain (Reading) Mr Middleton (Sund) Dr Steele (UMIST)	Oct 2003	Oct 2004
24	Produce CAL segments for Y1S2	Technical Author	Oct 2003	Sep 2004
25	Write engineering case studies	Prof Attenborough (Hull)	Oct 2003	Jun 2004
26	2 Regional Workshops for Consortium, Partners plus other HEIs	Dr Harrison, All	Summer 2004	
27	Internal evaluation of Y1S2 materials	Critical readers (all)	Oct 2003	Mar 2004
28	Student evaluation	Dr Mustoe	Oct 2003	Mar 2004
29	External evaluation of Y1S2 materials External evaluation of project regimes	Dr Green + External Evaluator External Evaluator	Mar 2004	May 2004
30	Steering Committee to assess progress at Year 2 milestone. Reports from consortium team members.	Dr Green, Steering Group and Project Team	Oct 2004	
31	Extend question libraries to Y2 materials	Dr Ward	Nov 2004	May 2005
32	Year 3 Dissemination. Trialling selected materials	Dr Harrison, Administrator	Oct 2004	Sep 2005
33	Student evaluation Y2 materials	Dr Mustoe. All.	Nov 2004	Mar 2005
34	Internal evaluation of Y2 materials	Critical readers (all).	Jan 2005	May 2005
35	External evaluation of Y2 materials External evaluation of project regimes	Dr Green + External Evaluator External Evaluator	Apr 2005	Jul 2005
36	Produce CAL segments for Y2	Technical Author	Oct 2004	Jun 2005
37	Steering Committee to assess progress at Year 3 milestone. Reports from consortium team members. Finalise project. Formulate plans for future dissemination	Dr Green, Steering Group and Project Team Dr Harrison	Jun 2005	
38	2 Regional Workshops for Consortium, Partners and other HEIs	Dr Harrison, All.	Summer 2005	
39	Dissemination at UMTC. Project Completion	LU Management Team	Sep 2005	
40	Ongoing support (funding: Consortium or tbd)	All	Oct 2005 onwards	

4.6 QM Perception and transferability

CAA is an essential part of the project and this raises potential difficulties over transferability as each HEI would need to support this on completion of the project.

Question Mark Perception (QMP) is used at Loughborough for web-based CAA and has the significant benefit of being IMS QTI compliant. IMS QTI is the accepted standard for question mark up. All questions in the OLP libraries are currently stored in QML (Question Mark-up Language) and can be exported to IMS QTI. Other HEIs using any QTI compliant assessment engine will be able to import the Loughborough question banks for use in their own institutions. Within the time-span of the project most forward looking institutions will be able to exploit the Loughborough University testing regimes.

There are alternative test engines being developed (e.g. CUE) which we will assess.

5 Project organisation

5.1 Introduction

We recognise the importance of project management and administration and will commit appropriate effort to these activities.

A Project Team, Management Team and Steering Group have been assembled to provide the requisite academic, technical, pedagogic, evaluation, dissemination and project management expertise. Biographies are presented in Appendix 1.

5.2 Project team and Project management

A Project Team, a Management Team and a Steering Group will be formed. The Project Team (see table) will be supported informally by many other colleagues in their institutions.

The Management Team will provide support for the Project Manager and will provide a forum for planning, monitoring, dissemination and evaluation.

The Steering Group will involve representatives of the major stakeholders and will provide strategic advice and access to networks. They will be kept informed on a regular basis through a discussion group on the project website.

Team Member	Primary Area of Responsibility	University post	FTE p/a
<i>Loughborough</i>			
Dr David Green	<i>Management Team / Core Team</i> Project Management	Associate Dean Teaching and Reader in Mathematical and Statistical Education	0.3
Dr Martin Harrison	<i>Management Team / Core Team</i> Dissemination Management	Senior Lecturer in Mathematics	0.2
Dr Leslie Mustoe	<i>Management Team</i> Student Evaluation Management	Director of the Science and Engineering Foundation Studies Programme	0.15
Dr Joe Ward	<i>Management Team / Core Team</i> Technical Management and Authoring	Senior Lecturer responsible for Mathematics Service Teaching	0.6
Dr Andrew Wilson	<i>Management Team</i> Internal Evaluation	Director of Staff Development	0.1
Dr Aruna Palipana	CAL, CAA, Web	Technical Author	0.8
<i>To be appointed</i>	Administrative	Administrator/secretary	1.0
Ms Lesley Davis	BALANCE Project Link, Accessibility	Lecturer in Engineering	0.05
<i>Hull</i>			
Professor Keith Attenborough	Engineering Applications	Professor of Engineering	0.05
Dr Susan Pulko	Progress Project Link, Engineering Applications	Senior Lecturer in Engineering	0.05
Gavin Cutler	Engineering Applications Comparative study	Engineering Project Officer § in Year 2 only	0.4§
Don Maskill	Case Study authoring	Mathematics Advisory Centre Manager	0.15
<i>Reading</i>			
Dr Peter Chamberlain	Numerical Analysis Booklets	Lecturer in Mathematics	0.2
Dr David Stirling	Numerical Analysis Booklets	Head of Mathematics	0.05
Prof David Malvern	External Evaluation	Professor of Education	n/a
<i>Sunderland</i>			
Mr Walter Middleton	Statistics Booklets	Reader in the School of Computing and Technology	0.2
Dr Malcolm Farrow	Statistics Booklets	Lecturer in Statistics	0.2
<i>UMIST</i>			
Dr Colin Steele	Mathematics Booklets, Question Bank items	Director of Service Teaching	0.1
<i>To be appointed</i>	Mathematics Booklets, Question Bank items	Project Officer * reduced to 0.2 in Years 3	0.3*

5.3 Management Team

The full Management Team will meet every four to six weeks at different consortium venues and a Core Team (comprising the Project, Technical and Dissemination Managers) will meet more regularly. Job specifications will be prepared.

- Project Manager – responsible for management of the project, budget, project team, day-to-day control
- Technical Manager – contribute substantially to both academic and technical work, direct the Technical Author, effect liaison throughout associated HEIs
- Dissemination Manager – oversee and co-ordinate all aspects of dissemination, direct the administrator / secretary assigned to dissemination
- Student Evaluation Manager – oversee and co-ordinate student evaluation and its analysis
- Internal Evaluator – monitor and advise on processes
- Representatives of the consortium (as appropriate).

5.4 Steering Group

The Steering Group will meet three times a year. Terms of reference will be prepared.

- Chair: Prof Ian Morison, Pro-Vice Chancellor (Teaching) (Loughborough)
- Deputy Chair: Prof Christopher Haines, Dean of Students (City)
- Dr Adam Crawford, Engineering Learning and Teaching Support Centre Manager (Loughborough)
- Mr Myles Danson, CAA Manager (Loughborough)
- Dr Stephen Hibberd, Senior Lecturer in Mathematics (Nottingham)
- Prof David Malvern, Professor of Education (Reading) *External Evaluator*
- Dr Andrew Wilson, Director of Staff Development (Loughborough) *Internal Evaluator*
- Two representatives of the consortium partners: tbd
- A student representative: tbd
- LTSN MSOR representative: Dr Joseph Kyle
- LTSN Engineering representative: Dr Sarah Williamson
- NCT representative: tbd
- Dr David Green *Project Manager*
- Project Team members (by invitation)

Staff Recruitment

Recruiting staff can take far longer than expected and may prove impossible in the time available between confirmation of funding and intended start date. This should not be a problem for us for the following reasons:

- The Management Team are all in permanent posts and have made plans to free their time ready to commence in Oct 2002. Most other team members are similarly placed.
- The administrative / secretarial support will be provided by staff already in post who will transfer to project duties in Oct 2002.
- The Technical Author will be recruited by the *Mathematics Education Centre* to be in post not later than Sept 2002 (i.e. independently of the FDTL4 bid).
- The Project Officer (Hull) will transfer from another project.

5.5 Institutional commitments

5.5.1 All consortium member institutions

All institutions will provide considerable support by absorbing overhead costs. All will contribute:

- accommodation
- use of computer hardware and software
- library facilities
- facilities for meetings
- facilities to test materials on students, and to evaluate the outcomes
- general administration and overall management of the project within each institution
- staff time
- telephone and mail
- secretarial support

Letters detailing institutional contributions are provided in Appendix 2. Some specific contributions are indicated below.

5.5.2 Loughborough

Role	Allotted time (FTE)	Paid by Loughborough (FTE)
Project Manager	0.30	0.20
Technical Manager	0.60	0.40
Dissemination Manager	0.20	0.13
Student Evaluation Manager	0.15	0.10
Technical Author	0.80	0.40
Project Administrator/Sec	1	1
Senior Management oversight of the project	As required	As required
Financial administration	As required	As required

5.5.3 Hull

- Support for staff involved from the Mathematics Advisory Centre
- 0.05 FTE of Prof Attenborough
- 0.05 FTE of Dr Pulko
- 0.1 FTE of Project Officer in Year 1 and Year 3

- Through links to the FDTL3 PROGRESS project, subsidy for a comparative survey of performance on engineering courses of groups of students either studying regular mathematics service provision or OLP materials.

5.5.4 Reading

Reading fully supports this project which is consistent with the University's Strategy for Teaching and Learning, particularly its intention of broadening the available teaching and learning methods. The University will provide the time of staff, particularly Drs Chamberlain and Stirling, supported by others as appropriate.

5.5.5 Sunderland

Sunderland fully supports this proposal and endorses its central objectives as being both attainable in the time span of the project and highly relevant to the needs of the School, the University and the sector in general. The University will be a fully active partner offering staff with interests, enthusiasm, skills and experience in the areas of the project. The University will also assist in the provision of necessary resources including:

- facilities of the University-Wide Mathematics Help Scheme for trialling materials
- selection and supervision of Sunderland staff contributing to the project.

Additionally, the University will encourage the selection of Sunderland staff for project secondment on a part-time basis.

5.5.6 UMIST

UMIST is committed to active involvement in the planning and implementation of this project, which should lead to a significant enhancement of the learning experience for students in its engineering departments. The support that UMIST would provide includes:

- active involvement of academic staff from the Department of Mathematics;
- access to the staff and expertise available in the Teaching and Learning Support Centre (Director :- Mr. Bland Tomkinson) and the Learning Technologies Group.

Work is currently ongoing on a project funded (£10 000) by the Joint Curriculum Initiative Fund (UMIST and University of Manchester) to produce web-based and other resources for the Mathematics Service Courses at UMIST. Results and deliverables of that project will be made available to this FDTL4 project. An application for further funding will soon be submitted.

5.5.7 Initial trialling partners

Letters of intent are supplied in Appendix 2.

6 Evaluation and Dissemination

6.1 Criteria for success

At a quantifiable level, success may be judged by uptake of the materials, positive feedback from students experiencing the materials, approval by the academic community, and further long-term developments to which this leads within individual institutions or future consortia. An early task of the Steering Group will be to extend the identification of appropriate measurable criteria, which can be subsumed into the evaluation strategy.

We intend that the number of HEIs involved with the project will be (at least):

Year 1: 10

Year 2: 15

Year 3: 20

and anticipate that at least 15 departments will continue using most of the materials.

6.2 Evaluation

This will involve various aspects:

- baseline – determining the current situation (furnishing a basis for comparative evaluation). It is intended to incorporate control groups and use pre-and post-testing where feasible in order to assess the impact of the project. The consortium members' experience with diagnostic testing, CAA and other projects will be called upon.
- deliverables – fitness for purpose and quality of all learning and staff support materials.
- processes:
 - the management of the project itself and support for consortium members and trialling partners
 - dissemination in all its aspects.

Feedback from students and staff, derived through questionnaires and focus groups, will be key elements of the evaluation process. The Student Evaluation Manager will report to the Steering Group on a regular basis.

An internal evaluator with extensive evaluation and project management expertise, having no direct link to the mathematics provision at Loughborough, will join the Management Team.

An external evaluator with mathematical, pedagogical and evaluation expertise will approve evaluation instruments and will perform a formative evaluation of the project at the end of Years 1 and 2, and a summative evaluation towards the end of Year 3.

6.3 Publicity and publications

Activities will include:

- establishing an *image* and *corporate ID*.
- information brochures for HEI (and FEI) departments (once each year) – mailshots via LTSN MSOR and LTSN Engineering
- materials for distribution at academic conferences
- articles in LTSN publications and elsewhere
- presentations to professional groups
- website regularly updated.

Fuller details are given under dissemination.

6.4 Dissemination

6.4.1 Target groups

The initial target audience is all HEI Mathematics and Engineering departments (as specified by the two LTSNs). This will be refined subsequently to eliminate those for which there is no prospect of future interest.

6.4.2 Transferability

We will pilot in a variety of situations to test accessibility (for academic ability levels, gender, cultural background and different disabilities). We will capture relevant success factors and disseminate guidance on these processes alongside the products themselves. Dissemination of concepts and not just outputs will be important. We will work closely with the LTSN MSOR and LTSN Engineering to achieve these ends.

Loughborough has considerable experience of transferability through its involvement with many externally funded development projects, including FDTL. Staff involved with such projects will contribute to developing this project's dissemination strategy. In view of its importance, a specific post of Dissemination Manager has been created (FTE 0.2), supported by an administrator/senior secretary (to spend about 0.5 FTE on this activity).

6.4.3 Dissemination for awareness

Our target is that 100% of institutions will be made aware of the project by:

- information brochures sent to all relevant departments (Spring 2003, 04, 05)
- articles in LTSN MSOR Connections and LTSN Engineering newsletters
- presentations at HoDoMS (annual) (project members are on the committee)
- presentations at Engineering Professors Congress (annual)
- presentation at IMA Mathematical Education of Engineers Conference (April 2003) (project members are on the organisation committee)
- activities at UMTC conferences (a project member is on the committee). [In 2002 the UMTC committee unanimously agreed to act as a conduit for any FDTL4 project wishing to use its facilities. These include the opportunity to present to the conference and to include briefs to be worked on by conference delegates.]
- LTSN Engineering national events (through representative on Steering Group)
- LTSN MSOR national events (through representative on Steering Group)
- LTSN MathsTEAM Workshops (through liaison with LTSNs).

6.4.4 Dissemination for understanding

By the end of Year 1 all consortium members and trialling partners will have a clear understanding of how they may implement the project in their own institutions. To aid uptake, the CAA aspects will be supported by visits by a technical expert from the lead institution as necessary.

We will organise one central workshop for the consortium and partners by December 2002 to ensure the project is running well.

With the assistance of the LTSNs as appropriate, two regional workshops (open to interested HEIs) will be run Summer 2003 when the participating HEIs can show their achievements and report on evaluation. From those attending, five more HEIs will go forward to participate in Year 2. This pattern of dissemination and recruitment will be repeated in Summer 2004 and, with some variation, in Summer 2005. Visits to other HEIs to make presentations at in-house L&T events will be arranged where possible.

6.4.5 Dissemination for action

The aim is for fifteen departments to use the materials at the end of the project. Strategies to achieve the embedding of the project products in the wider community and their continuing availability and maintenance will include:

- website with information for potential users/partners and links to sample OLP pages
- materials in electronic format available from Loughborough
- Guidebook (informed by outcomes of trials and evaluation)
- network of consultants (consortium members) available for site visits
- regional workshops
- liaison with the LTSN *MathsTEAM* project
- liaison with the EBS Trust (responsible for *Maths for Engineers WebDisk* project)

6.5 Continuation

Loughborough's *Mathematics Education Centre* will take responsibility for distribution of the OLP materials when the project finishes, to enable effective continuation.

Continuation for at least three years beyond the end of the project will comprise:

- the website will be maintained by Loughborough
- consortium members will update the materials as a normal component of maintenance in response to changing circumstances
- the electronic version of the written materials will be maintained by Loughborough
- the CAA Question Bank will be held in electronic form by Loughborough
- consultants from the consortium will provide ongoing support (at cost).

7 References

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- [3] Engineering Council (2000) *Measuring the Mathematics Problem*, Engineering Council, London.
- [4] Lawson, D. (1997) *What can we expect of A level mathematics students?* Teaching Mathematics and its Applications, Vol. 16, pp151-156.
- [5] Gareth Roberts (2002) *SET for success*, HMSO.
http://www.hm-treasury.gov.uk/Documents/Enterprise_and_Productivity/Research_and_Enterprise/ent_res_roberts.cfm
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- [7] <http://www.ltsneng.ac.uk/nef/news/archive/national/mathsprob.asp>
- [8] Croft, A.C., Danson, M., Dawson, B.R. and Ward, J.P. (2001) *Experiences of using computer assisted assessment in engineering mathematics*. Computers & Education, Vol 37, No 1, pp 53-66.

Appendix 1 – Project Team and Steering Group Biographies

Project team

Prof Keith Attenborough is Research Professor in Engineering at the University of Hull and was Head of Department 1999 – 2002. He has been involved with the development of a number of Open University courses and texts of relevance:

TM281 Modelling by Mathematics, 1979

TM282 Modelling with Mathematics: An Introduction (remake of TM281), 1985.

MST121 Using Mathematics, 1997.

MST207 Mathematical Models and Methods 1997/8.

Dr Peter Chamberlain, who is in the Mathematics Dept at the University of Reading, has eight years experience as a lecturer, including adviser to individual students and as part of the management team for teaching Mathematics to non-specialists. He is the departmental special needs coordinator and has experience in obtaining and negotiating the implementation of student evaluation of taught courses.

Gavin Cutler was originally educated as a physicist and spent eight years in a wide variety of industrial companies. After further postgraduate work in Management he joined the University of Hull in 1995 as a curriculum developer, and more recently has been involved in teaching and learning development projects, currently being the project manager of the PROGRESS FDTL3 Project initiative to enhance the achievement of Engineering undergraduates.

Ms Lesley Davis is a lecturer in the School of Mechanical and Manufacturing Engineering at Loughborough University. She is the Director of the FDTL3 Balance Project and has many years of experience supporting students within her department. In particular she has acted as the department's link to the Department of Mathematical Sciences with regard to the service teaching provided.

Dr David Green is Reader in Mathematical and Statistical Education in the Department of Mathematical Sciences at Loughborough University, and since 1998 has also been Associate Dean (Teaching) for the Faculty of Science, responsible for quality assurance for teaching, learning and assessment across the seven departments in the Science Faculty. He was instrumental in establishing the Mathematics Learning Support Centre at Loughborough. He has helped evaluate some of the Open Learning Project material. He has published widely on mathematical and statistical education and has been a member of various national committees and is currently a member of the Executive Committee of the Joint Mathematical Council of the United Kingdom. He has experience of managing externally funded projects: (a) investigating school pupils probability concepts (testing 4000 subjects) (b) developing educational software.

Dr Martin Harrison is Senior Lecturer in the Department of Mathematical Sciences at Loughborough University. He has considerable academic expertise and past experience of developing and publishing teaching software. He has been editor of the International

Journal of Mathematical Education in Science and Technology since 1997. His promotion to Senior Lecturer was on the basis of his excellence in teaching.

Mr Walter Middleton is in the School of Computing and Technology at the University of Sunderland. He is Reader in Mathematics Learning Systems and acts as School Learning, Teaching and Assessment Co-ordinator and also as Mathematics Team Leader.

Dr Leslie Mustoe is Senior Lecturer in the Department of Mathematical Sciences at Loughborough University. He has helped write some of the Open Learning Project material. He is chairman of the SEFI Mathematics Working Group and on the IMA Council and on its Membership Committee. He has written several textbooks on mathematics for engineering undergraduates. In 2000 he received the International Award from the Engineering Mathematics Group of ANZIAM (Australian and New Zealand Industrial and Applied Mathematics).

Dr Susan Pulko is Senior Lecturer in the Department of Engineering at the University of Hull. She will provide a valuable link with the FDTL3 project entitled *Improving Student Progression and Achievement in Electronic Engineering - Progress* of which she is project director.

Dr Colin Steele is Director of Service Teaching in the Department of Mathematics at UMIST and is responsible for overseeing the mathematics courses taught to 1000 students in different departments. Responsibilities include updating of syllabuses, development of resources (CAA etc), administering the streamed mathematics course for engineering students, as well as being lecturer for several of the courses. He has presented talks and published papers on such matters e.g. at the IMA conferences on Mathematics Education of Engineers.

Dr David Stirling is Head of Mathematics Department at the University of Reading. His Departments teaches students in Physics and Meteorology while the teaching of mathematics to engineers is largely the responsibility of Engineering. The Engineering courses use computer-based material extensively.

Dr Joe Ward is Senior Lecturer in the Department of Mathematical Sciences at Loughborough University. He has taken the lead in developing the Open Learning Project material and has considerable academic and technical expertise. His promotion to Senior Lecturer was on the basis of his excellence in teaching.

Dr Andy Wilson, Director of the Staff Development unit at Loughborough University will advise the project on all aspects of evaluation and dissemination. He has considerable expertise in running workshops locally, nationally and internationally on such topics as: creating web pages, project management, writing training materials, etc. He has been a member of Project Management Groups for: Distance Learning Project; Online Teaching and Learning Project; FDTL Projects on (i) Students and Quality Systems and (ii) Student Placements, (iii) Balance of Women in Manufacturing Engineering, and (iv) RAPID 2000; DfEE Higher Education and Employment Development Programme on Recording Achievement; and TLTP CALVisual project. His regional and national appointments have included: Members' Advisory Group of

UCoSDA; Advisory Group on the HEQC DQE (Higher Education Quality Council, Division of Quality Enhancement) Project: Managing for Quality; CVCP/UCoSDA groups on Student Feedback Systems, and Students with Special Needs; Project Leader, LTSN Project on Working with Students with Disabilities.

The following team members have acted as QAA ESR MSOR assessors:

Dr David Green, Dr Martin Harrison, Dr David Stirling

Steering Group

Dr Adam Crawford is the Manager of the Faculty of Engineering Teaching and Learning Support Centre (Eng TLSC) at Loughborough University and has been involved in a number of e-learning related projects developing electronic resources for use in the UK and overseas. Eng TLSC supports staff in ensuring good practice and innovation is adopted in learning and teaching throughout the curriculum. The centre also has a wide range of experience in managing national and international projects from a range of funding sources, including TLTP, FDTL, DfEE, and ADAPT. The centre has developed a wide range of learning technology based teaching and administrative support materials.

Dr. Tony Croft is Manager of the Mathematics Learning Support Centre at Loughborough University which he established and has developed since 1996. Tony has written extensively about the work of the Centre, and reported upon its development at conferences both in the UK and overseas. He is a well-established author of several very successful undergraduate textbooks. He is the LTSN Maths, Stats & OR Network service teaching consultant. Loughborough has experience of rolling out materials developed in-house; for example the *Algebra Refresher Booklet*, has recently been distributed in quantity by LTSN MSOR to seven HEIs, with more requests expected.

Dr Croft, will provide a valuable link with the FDTL4 Leeds project *National Mathematics Support at the Transition to University* (if successful) to aid complementarity.

Mr Myles Danson is the CAA Manager at Loughborough. Previously he was the Teaching Support Officer in Loughborough's Chemistry Dept where he acted as Departmental I.T. Co-ordinator and designed and managed the departmental website.

In his current post he has implemented the central web-based CAA System to allow test delivery on and off campus using Question Mark Perception, and has implemented the central Optical Mark Reader CAA System. He undertakes regular liaison with support services including Examinations Office, Computing Services, Staff Development, Corporate Information Services. He is organiser of the Annual International CAA Conference, now in its 6th year.

He has co-authored various funding bids including TQEF, JISC 7/99, JISC 1/01, JISC X4L, HEFCE, FDTL, LTSN.

Professor Christopher Haines is Dean of Students at City University and Professor of Mathematics Education (Higher Education) within the Department of Continuing

Education. He was previously Pro Vice Chancellor (1994-2000) with responsibilities for Teaching and Learning, during which period he was director of the HEFCE Effective Teaching and Assessment project *Mathematics Learning and Assessment: Sharing Innovative Practices*, leading a consortium of 15 universities (1993-1996).

He has almost 30 years experience teaching mathematics to engineers and to honours mathematicians. His published research includes conceptual (mis)understandings of first year engineering undergraduates, implications for mathematics of key skills within business and commerce and attitudes to mathematics, computing and their interaction; this latter area being of particular importance with embedding of ICT in the curriculum.

Chris is a panel member of the NTFS (2000-2002) and a former QAA reviewer for mathematics. He is secretary to ICTMA and will chair ICTMA12 at City University in 2005.

Dr Stephen Hibberd

Stephen Hibberd is a Senior Lecturer and Director of Service Teaching within Mathematical Sciences at Nottingham University. Having spent 5 years seconded part-time as a Teaching Enhancement Adviser, he was given a 'Lord Dearing Award for Teaching and Learning' for his outstanding contribution. He was a Subject Reviewer for QAA and maintains a strong collaboration with the University's Centre for Teaching Enhancement and the LTSN Centre for MSOR. Stephen has been involved with a number of HEFCE initiatives including an Executive Steering Group member of *Mathwise*. Areas of active research are within fluid mechanics and mathematical modelling within engineering and industrial contexts. Collaborative projects are ongoing in Pharmaceutical Sciences, Chemical and Civil Engineering and the University Technology Centre with Rolls Royce plc.

Dr Hibberd has a particular interest in the mathematical education of university engineering and science students. He has been joint-organiser of three IMA conferences on the *Mathematical Education of Engineers* and a contributor to several reports on the 'mathematics problem' concerning the School/College/University interface. He is a member of the ILTHE.

Prof David Malvern is currently Dean of the Faculty of Education and Community Studies at Reading. His research field is education and development in the sciences, technologies and mathematics, and he advises the University of Reading about assessment matters.

Dr Joseph Kyle

Dr Joseph Kyle is a Senior Lecturer and Director of Learning and Teaching in the School of Mathematics and Statistics at Birmingham University. He is Mathematics co-ordinator for the LTSN MSOR. Joe is an editor for the journal *Teaching Mathematics and its Applications*, and a collaborator in the *Active Learning in a Computer Environment Project* in Belgium and is also co-editor of the forthcoming *Effective Learning and Teaching in Mathematics and its applications* one of a series sponsored by the ILT.

Joe is a very experienced teacher at all levels of the undergraduate and postgraduate curriculum and has an active interest in increasing participation at university. He has gained several grants for teaching and learning projects and has been responsible for the creation of a successful staff development programme which operates for the LTSN MSOR community.

Dr Sarah Williamson is Academic Co-ordinator with LTSN Engineering where she is responsible for publicity materials and dissemination activities.

Appendix 2 – Letters of support

- Letter of support from LTSN MSOR
- Letter of support from LTSN Engineering
- Letters of support from consortium members:
 - University of Hull
 - University of Reading
 - University of Sunderland
 - UMIST
- Letters of support from trial partners:
 - Aston University
 - City University
 - Coventry University
 - Northumbria University
 - Southampton University
- Letter of support from CAA Question Bank development partner:
 - Brunel University

Detailed Budget – charges against project

FTE figures indicate the amount of time that will be committed to the project.
Subsidised means that the institution bears a substantial proportion the cost.

	Year 1	Year 2	Year 3	Total
Project Staff				
Project Manager (LU) 0.3FTE (subsidised)	4500	4500	4500	13500
Technical Manager & Author (LU) 0.6FTE (subsidised)	9000	9000	9000	27000
Dissemination Manager (LU) 0.2FTE (subsidised)	3000	3000	3000	9000
Student Evaluation Manager (LU) 0.15FTE (subsidised)	2250	2250	2250	6750
Technical Author (LU) 0.8FTE (subsidised)	14000	14500	15000	43500
Project Administrator / Sec (LU) 1.0FTE (subsidised)	-	-	-	-
Hull - Case Study Author (0.15FTE per annum); Project Officer (Gavin Cutler) (0.4FTE in Year 2). Prof Attenborough and Dr Pulko (subsidised)	4500	21000	4500	30000
Reading – Dr Stirling & Dr Chamberlain (subsidised)	5000	5000	3000	13000
Sunderland – Mr Middleton and Dr Farrow (subsidised)	5000	5000	3000	13000
UMIST – Dr Steele and others (subsidised)	7000	6000	3000	16000
Payments to trialling partners				
Partners (units of £250 or £500)	2500	2500	3000	8000
Technical				
Equipment	2100	-	-	2100
CAA support and Staff Training	3000	2500	1500	7000
Travel and subsistence				
FDTL conferences and seminars	1000	1000	1000	3000
Management Team meetings	700	700	700	2100
Steering Group meetings	1250	1250	1250	3750
Support visits to partner and consortium HEIs	1000	1000	1000	3000
Dissemination				
Publicity	1500	1500	1500	4500
Materials for trials	4000	4000	4000	12000
Workshops/conferences (about 20 participants each)	3000	2500	2500	8000
Visits to other HEIs to publicise project / Visitors to project	500	600	700	1800
Evaluation				
Internal Evaluator	2500	2000	2000	6500
Software evaluation using EASEIT methodology	1000	1000	-	2000
External Evaluation	2000	2000	2500	6500
Other				
Advertising posts at LU	500	-	-	500
Consumables at LU	1500	1500	1500	4500
Contingency	1000	1000	1000	3000
TOTAL	83300	95300	71400	250000