

Marconi ECT Project: phase 1 evaluation

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Abstract

Imagine a world without the use and application of electronics, and then consider a compulsory education system that does not offer courses in more than 18 percent of our secondary schools. This major shortfall in our education systems lies at the heart of much of the work carried out over the past four years related to finding training models for teachers in this very demanding area of work. This paper reflects the work carried out in the academic year 2000/2001 in piloting a revised training model from the original 'Marconi Days' training programme. The original two-year trial programme used a 10-day training model. Sadly, this was considered too expensive, so this evaluation focused on two models, a 2-day course and a 4-day course, with support from a comprehensive web site and advisory support in school on the 2-day model. As the pilot has been established, much work has taken place to create principles for the programme and for teaching electronics. The term 'electronics and communications technology' (ECT) has been used as we consider it better reflects the work in this digital era where communications are a crucial part of electronic communications.

Context for Phase 1 of the Marconi ECT Project

In the period 1997 to 1999, GEC, later focused and named Marconi Plc, provided funding to the Institution of Electrical Engineers (IEE) to improve the teaching of electronics in schools. A sum of £200,000 in

total was provided and under the direction of Dr Peter Branson, a series of trials were held in Stafford, Salford, Coventry and North Wales. The aim of these trials was to see if a successful model for training non-specialist teachers, with an interest in electronics, into competent teachers able to teach GCSE courses in the subject could be established. The conclusion to the exercise was that the model worked. When the funding came to an end, the IEE asked DATA to see if the work could be taken forward. Marconi Plc felt it had made a sound contribution and that it was now time for the Government to contribute. DATA produced a series of bids to bodies such as New Opportunities Fund (NOF) and the DfEE as well as trying to engage other electronics companies. In May 2000, Paul Watts (Education Director, Marconi Plc), Andy Breckon (Chief Executive, DATA) and Ian Berry (Head of Curriculum Division, DfEE) held a meeting, where it was agreed in principle that the DfEE would support the initiative, although it was recognised that in the current financial year (2000/1) there would be difficulties in finding funding, but that it would be planned into future years. On the basis of the agreement that the Government would provide some funding, Marconi committed a further £100,000 to a new pilot phase. After much discussion, in September 2000, the DTI agreed to contribute £100,000 to the programme and the short fall of £75,000 was provided by DATA Trustees.

The original Marconi Days had a number of principles which included fully funded face-to-face training, curriculum support in the classroom, resources and contracts with the schools regarding progression. However, the costs per teacher were very high with 10 days face-to-face training. The DfEE agreed the new principles but wanted the original costs reduced using 2-day and 4-day training models. DATA recommended developing web-based support for teachers and students and following the successful model used for the CAD/CAM in Schools Initiative, which DATA introduced with the support of the IEE, the concept of accrediting teachers for their work. The aim of the pilot phase was to allow time to develop alternative models and materials to test further the viability of a cost effective scheme.

One key question that is frequently asked is, 'Why do we need the Marconi ECT Project?' First, less than 18 percent of secondary schools offer a GCSE course in electronics or one which contains a significant element of electronics, in other words more than 80 percent of children have no opportunity to learn about one of the key technologies of the 21st Century. Evidence shows where the



subject is taught well, the level of interest in and desire for further study is high as children find the work stimulating and interesting. The *Skills for the Information Age – Final Report* from the Information Technology and Communications and Electronics (ITCE) Skills Strategy Group states, 'this is one of the most dynamic sectors of the UK economy', it also notes that people are the key to the sector's prosperity. The report states that there are significant staff shortages with appropriate skills and points out that in electronics the output from the education system has risen by much less than other areas, despite the demand.

Principles established in the early phase of the project that we have endeavoured to work towards

The pilot phase has been very challenging with a vast number of issues to be addressed. To resolve these, a number of seminars, presentations, exhibitions and discussions have been held in order to ensure a sound basis for our work. Some of the key decisions are set out as follows:

- a) The educational and ECT principles are as follows:
 - a systems approach to teaching electronics will be adopted, which develops systems thinking
 - electrical and electronic theory must be taught as a fundamental building block
 - teaching strategies will focus on using stimulating activities to generate motivation and interest
 - teaching will involve the pupils in the application of ECT in design and making situations
 - development of systematic fault-finding and evaluative skills will be built into the activities
 - a range of contexts will show how electronic systems permeate many aspects of our society
 - case studies will illustrate current industrial practice through case studies
 - a policy of inclusion towards the use of materials on the web site will be adopted, subject to format and quality.
- b) Knowledge, skills and understanding required for electronics and communications technology
 - electronics and communications technology in society
 - electronic building blocks
 - electronic theory



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- standard components and materials
- smart components and materials
- ECT systems and their control
- programmable functionality
- communications concepts
- modelling, measuring, testing and evaluating
- manufacturing ECT systems
- health and safety

(c) Web site development

The web site will be the main point of reference for all teachers and students working in ECT. Initially, the web site will be for teachers, but significant parts of the web site will be opened up for student use once it is fully operational. The web site address is www.marconiect.org we expect this to be live to the general public in September; it is currently being populated as authors produce the work and it is evaluated. The web site has a number of features:

- database driven to allow significant cross-referencing
- some open access material such as ECT in society, taster activities and company support materials
- restrictive access to Marconi ECT accredited teachers through the teachers CPD pathway
- teaching activities for students pathway, only available to Marconi ECT schools that join the scheme
- ECT datafile with an associated ECT index



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- ECT datafile will link across into almost every module and activity.
- resources will include case studies that illustrate ECT at work in a range of contexts
- continuing professional development activities and assignments for teachers
- handout guidance materials and student activities and assignments
- discussion forums.

d) The training programme
Two models were piloted: Model 1 consists of 12 hours (over 2 days) training and Model 2 is 24 hours (over 4 days) training which is broken into 2 days with another 2 days approximately 10 weeks later. In this phase we endeavoured to use different interfaces with schools for the training, for example we intended to use LEAs, SETPOINTS and companies.

The Marconi ECT pilot programme provided the following:

- supply cover for the teachers training programme

- travel and any subsistence/accommodation costs
- free training
- free tutor support
- the project will give a grant of £400 to be spent on ECT resources related to activities that help teaching and learning, this must have a sum of £600 allocated from school resources to access this grant
- full access to the Marconi ECT web site for its teacher and students.

A school contract will include:

- ensuring it makes every reasonable effort to support the designated Marconi ECT teacher during their training
- ensuring the teacher completes set assignments
- making every effort to offer a GCSE Electronics or equivalent course within 12 months of completion of training
- making a contribution of £600 towards electronics equipment in order to release the Marconi ECT grant of £400
- contributing to evaluation activities and data collection required by the programme.

Pre-course activity for both models:

- letter to head of school outlining the scheme and the commitment expected by the school to the scheme, at a minimum level that will be a GCSE course in electronics
- identify specific teacher that is required for training
- course package with teacher registration and web access
- needs identification activity
- send some pre-reading tasks.

Model 1 – The 12-hour's face-to-face training

- Day 1
 - Introduction to scheme.
 - Reflection on school situation.
 - Needs analysis.
 - Personal action plan.
 - Support system for teacher.
 - Outline of assignments and accreditation routes.
 - Taster modules.
- Day 2
 - Practical activities including use of electronics designing software.

- Practical activities on PICs.
- Using the web site.
- Action Plan agreement and signature from head teacher 21 days after the course.
- Follow-up tutor support programme.
 - On-line tutor.
 - Possible programmed tutor visit.
 - Emergency tutor visit.
 - Local cluster support programmes.

• Assignments.

There will be three types of assignments:

1. assignments related to specific knowledge and skills
2. assignments related to pedagogic issues
3. assignments which are integrative in nature and allow teachers to demonstrate a wide range of skills and techniques
 - Five assignments will be required with the need to undertake at least one type from each category, as part of the personal/school action plan
 - Each assignment will be designed to cover a range of competences which the teacher will be working towards

• Accreditation

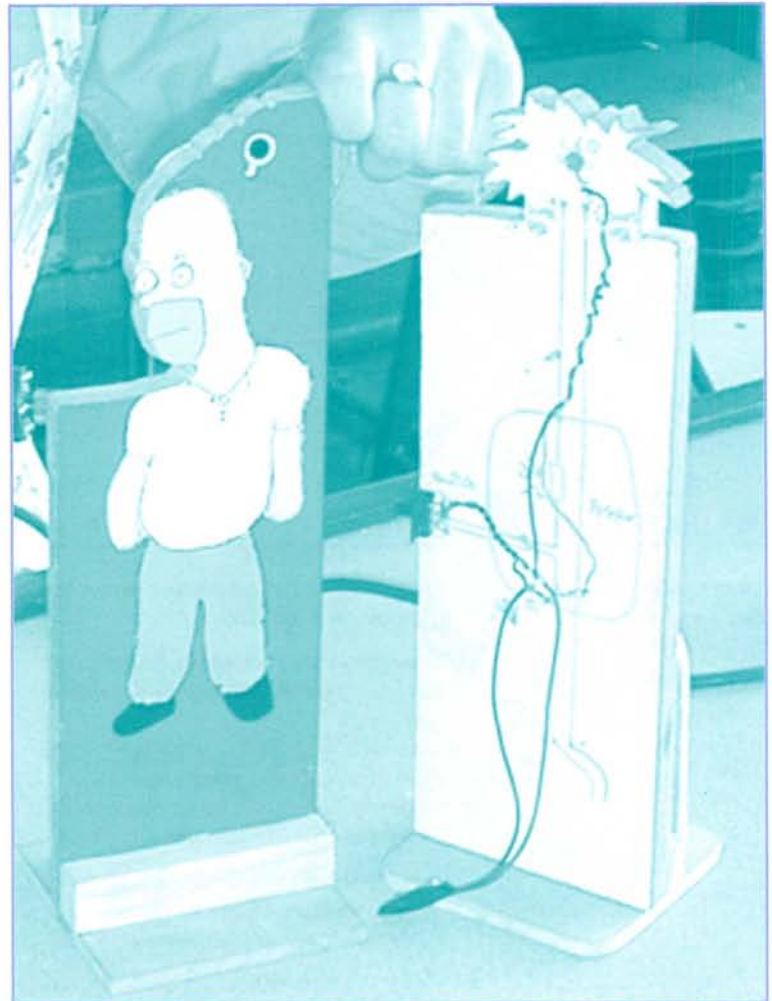
- This will take place approximately 3 months after the initial training and the completion of the assignments, which will bank a number of competences leading to the award.
- There will be two levels of awards, the first will be the Marconi ECT teacher award and the main thrust of the programme will be aimed at this award. However it is intended to have a second award which is for advanced teachers and those who can act as trainers.
- On completion of the competences the IEE with DATA will make the award, which will carry the DTI and DfEE endorsements.

Model 2 – The 24 hours face-to-face training

- The second group will have the same as above for the first 12 hours.
- Plus a 12-hour practical course which will include an assignment to be done prior to the course and two practical assignments during the course.

e) Teacher accreditation

The development of an accreditation scheme for teachers as a means of rewarding them professionally is seen as a key priority of the scheme. The accreditation of teachers is based



on teachers demonstrating to their tutor that they can meet the defined competences. These will be refined during the pilot phase of the programme. The award will be a DATA/IEE award, which will be supported by the DfEE and DTI.

The following summaries the competences that teachers will be expected to demonstrate:

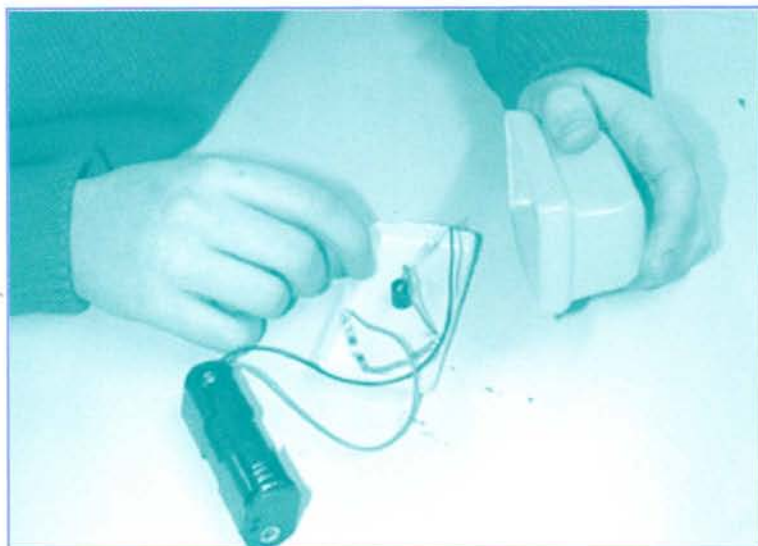
Competency area 1 – ECT in society – *teachers are able to demonstrate a capability to:*

- different contexts where ECT is used
- a range of ECT applications in society.

Competency area 2 – Basic Theory – *teachers are able to demonstrate a capability to:*

- electronic building blocks, including sensing and input devices, comparing, counting, logic, output device drivers, actuators and output devices
- electronic theory, including current, voltage and potential difference, Ohm's law and resistance in series and parallel, impedance matching, Kirchoff's laws,

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electrical power and power supplies and the potential divider.

Competency area 3 – Components and materials – *teachers are able to demonstrate a capability to:*

- discrete components including resistors, capacitors, diodes, potentiometers, optoelectronics and indicators, sensors and transducers, transistors and filters
- integrated circuits including latches, logic gates, counters, amplifiers, micro-processors and micro-controllers
- smart components and materials including operating characteristics and applications.

Competency area 4 – ECT systems and their control – *teachers are able to demonstrate a capability to:*

- concepts including analogue and digital signals and their processing, analogue and digital systems and ADC and DAC
- designing systems
- programmable functionality including text and graphic based systems and PICs.

Competency area 5 – Communications concepts – *teachers are able to demonstrate a capability to:*

- media including: telephone, radio, television, email, internet
- transmission channels including: radio, wire, fibre optics
- modulation
- transmission protocol and encryption/security systems
- awareness of electromagnetic compatibility (EMC).

Competency area 6 – Creating products that use ECT – *teachers are able to demonstrate a capability to:*

- analyse existing electronic products to determine their functionality
- analyse the requirements of an electronic system in terms of input, processes, outputs, etc.
- use a systems approach in designing and modelling electronic systems
- use software, including CAD/CAM to test and model circuits and systems
- apply fault finding principles and techniques and use measuring instruments
- manufacture ECT systems and PCBs.

Competency area 7 – Teaching and learning – *teachers are able to demonstrate a capability to:*

- apply health and safety regulations, codes of practice, and carryout risk assessments within a safe working environment
- create a good teaching environment for ECT, deploying available resources soundly
- use the Internet as a key tool for enhancing teaching and learning
- plan individual units of work in ECT
- plan a scheme of work for ECT and related activities which shows continuity and progression
- develop the subject beyond the school environment.

Report on Pilot Training Programme – related to all courses

a) Recruitment of teachers to scheme
In all four pilot areas a similar procedure was adopted to recruit teachers onto the programme. A letter outlining the nature of the project, together with the Marconi ECT Working Paper and an application form was sent to the head teacher of every school within each area. In two of the areas – Durham and Sheffield – there had also been an earlier groundswell of interest generated by local LEA inspectors and/or advisers. These LEA's produced the greater numbers of recruits and already show the benefit of local contacts understanding their schools. In the two other areas – Essex and Liverpool – the recruitment problems were significant. In Liverpool the SATRO took the lead in recruiting schools and they had limited success, this may be a result of lack of local knowledge of teachers, or because there was less preparation of teachers in this area. In Essex, changes of LEA staff and again lack of local knowledge

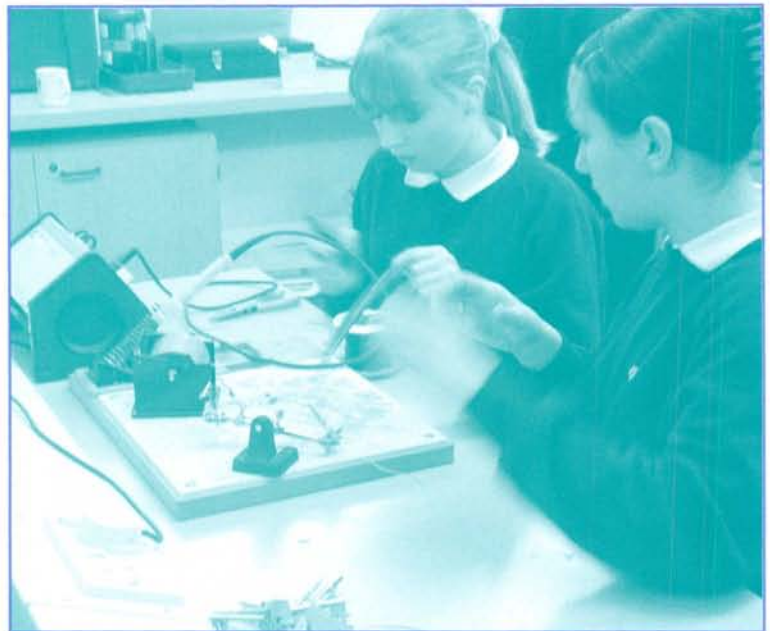
to target schools proved very difficult to overcome. The LEA advisor only became involved at the last minute – he is new to the post. This clearly indicates more preparation is required to engage schools and teachers at a local level.

b) Needs identification materials

The needs identification booklet has proved to be a key document in the way the teachers' own CPD has evolved. Course members gave themselves a numerical 'confidence level' rating (0-4) against the competency areas and this information will be of value in setting baseline data from which progress/value added can be measured. By reflecting upon the range of competencies to be met prior to attending the course, participants were able to be more focused in the way they engaged with the materials and approaches when on the course. Where participants felt they lacked expertise in particular areas they were able to develop their skills, knowledge and understanding as the course progressed. The main use of the needs analysis proforma from the point of view of the course participant is in relation to the assignments they set themselves for completion during their time with the project. Their needs analysis is used to identify the particular routes to be followed and the specific assignments to be completed in order to fulfil the requirements of meeting the set of competencies. The needs analysis proforma also included a section where course participants were able to reflect on the current position of their D&T department and in due course this information can be used to monitor progress in terms of departmental target setting. This part of the needs analysis proforma also relates to course members performance management and can be used to record their own personal development targets.

c) Course materials

A decision was made on earlier 'Marconi Days' pilots to use, as course materials, both teacher and pupil materials which were already commercially available or which had already been written to accompany and support the hardware and software used on the course. This procedure was also adopted for this set of pilots. A wide range of articles taken from publications of an educational and general nature were reproduced and presented as a pack of background reading materials. These articles related to – pedagogic issues, career opportunities, comments from examination board moderators and a number taken from the scientific and technical literature which were relevant to particular products, processes and materials. Some manufacturers and suppliers information was also presented where it related to hardware



and software which may be purchased as a result of the course. Teachers were also introduced to the new material available on the web site (although that was still under development).

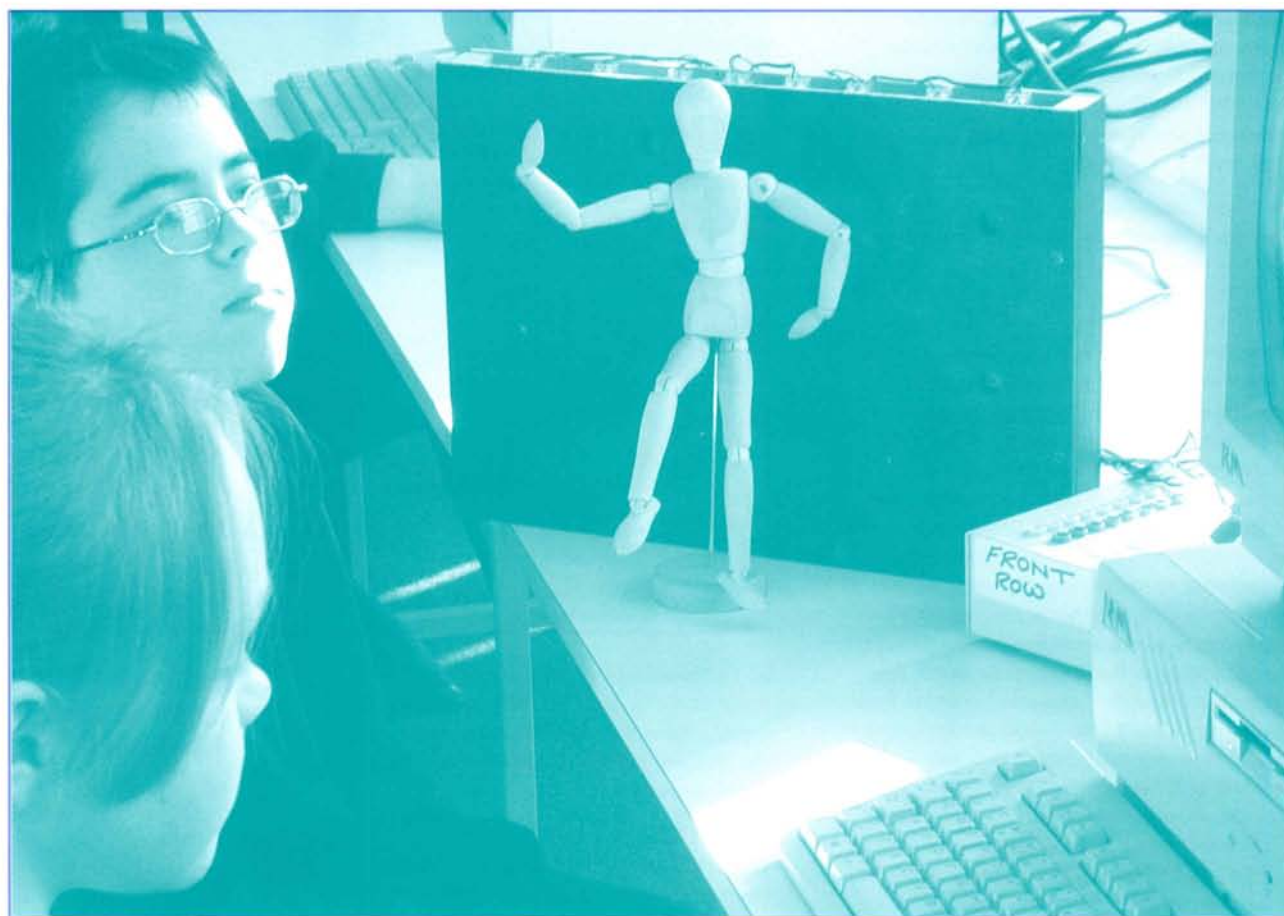
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d) Input from external speakers

On several occasions throughout the pilot courses a number of outside speakers were invited to talk about and comment on some of the more recent ECT hardware and software developments. Course members found this to be of immense value as it gave them an up-to-date view of and presenters also were able to gain feedback from the teachers as to the usefulness and appropriateness of these developments. At one of the training venues a tour of the company distribution depot was of immense value in seeing ECT systems in operation and being able to relate pupil activities to real-life situations. At some of the training sessions, the course members themselves were able to contribute further by sharing their expertise from their work in other areas of ECT developments notably examination setting and moderation activities for the various examination boards. Several course members also brought actual pupil project work to illustrate a number of ECT applications and approaches.

e) Nature and range of resources used

Neither the 12-hour nor the 24-hour model could cover all of the hardware and software that is currently available to schools and whilst a wide range of materials was displayed for information and evaluation purposes, only a representative and select sample of this was used as the basis of the training programme. However, the hardware and software selected to be used in the training represented



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examples of up-to-date ECT designing, modelling, testing and manufacturing materials. Even using this limited range of resources course members had full access to the range of ECT functions and processes to enable them to develop their confidence and meet a range of competencies. Also the materials and resources used enabled them to design and develop ECT activities for their pupils and to gain an appreciation of what is possible in terms of a wide range of classroom activities. As part of our inclusive policy contacts for other resources were made available to teachers.

f) Teachers as learners

Generally on all of the courses delivered so far the teachers have been enthusiastic and committed participants. The majority of the teachers have recognised that progress needs to be made in ECT within the curriculum. The teachers were quick to appreciate the appropriateness and value of much of the software, hardware and curriculum materials covered and the access to an expert in the field of ECT.

The varied experiences of teachers on the courses in teaching electronics in schools meant that there was a considerable amount of peer group learning and all colleagues have

benefited from the wide 'experience spectrum' of the groups taking part so far. Those teachers on the course who had already some degree of expertise used much of the time to consolidate their knowledge whilst those new to this area of the design and technology curriculum were able to explore new materials and approaches.

Many course members commented on the very positive atmosphere created within the groups during the training sessions. The non-threatening environment meant that colleagues could discuss and share ideas openly and gain from the group interactions. Efforts were made to help create user groups to provide local support networks.

g) Effectiveness of evaluation

An evaluation sheet was issued to all course participants shortly after the first two days to gain an interim view of the effectiveness of the training. The evaluation sheets asked course participants to comment on the various aspects of the two days under the headings – presentation, content and value for use in schools. Other information was requested on the format, timing and structure of the days, the overall benefits for the department and (in the case of the 24 hour model) suggestions to enhance the content covered in the second



block of 2 days. The comments returned so far have shown that the course in general has met participants expectations and there was an almost universal welcome both for the course and the areas of the curriculum covered but they have highlighted a number of issues to reflect on and review for subsequent courses – timing and order of the different aspects of the course, structure of focused tasks for participants and some suggestions for the content for the second block of two days.

The structure of the evaluation proforma will be altered to ask wider questions related to schools involvement and support in school for the teachers.

h) Assessment Structure

The assessment structure has been carefully planned so that course participants, through their choice of assignments, are able to fulfil the set of competencies identified. The five assignments to be undertaken, taken from the three areas – skills, knowledge and understanding – pedagogic issues – reflection on classroom practice – are all designed to be of maximum use to the course participants. Course members have almost universally been happy about the nature of the assignments and their direct relevance to work being undertaken in schools. The timescale, over

which the assignments were to be completed, was outlined with all course participants completing the work by the end of 2001 (December). However, it is recognised that the pressures and demands upon colleagues in schools since the course has already meant that these timescales are slipping. Several colleagues have already sent in a number of assignments targeted at a number of competencies and these have been commented upon and returned to course members.

Specific training related to 12-hour training programme

Clearly, from the training perspective and the course participant's perspective the time needed to cover the material (hardware and software) in any rigorous way was woefully inadequate. Many course members welcomed the opportunity to review much of what was available to schools but there was insufficient time to come to grips with curriculum issues associated with using much of the new materials. More time on the second day had to be devoted to ensuring that the after-course assignments and support structures were covered and well understood. This took time away from the hands-on aspects of the course and time to explore some of the curriculum issues.

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Within this training model there was no time set aside to look at manufacturing ECT systems, let alone actually making printed circuit boards and the associated classroom and resource management issues. This model would be adequate if it was an updating course only, but clearly unsuitable for those with limited experience. One teacher indicated that 'it was a waste of time because of its superficial nature'.

Specific training related to 24-hour training programme

Similar comments came from the course members during the 24 hour training model related to the lack of time. However, course members were able to explore a number of manufacturing techniques and were able to produce a variety of printed circuit boards and PIC micro-controller boards. Using the software applications available, course members were able to successfully manufacture a number of printed circuit boards and return to their schools with these examples. The 24 hour model also allows course participants to peer review any assignments that have been undertaken in the interim and to offer constructive advice on moving forward. This four-day model, although far superior to the 12-hour (two day) course, remains marginal for those with very little knowledge and skills.

Supporting teachers outside the training days

All teachers on the current round of pilot areas have the opportunity to make use of both the central support system and local support in one form or another e.g. local LEA/SATRO advice. No local support was built into the two 24-hour courses (Sheffield and Essex). Interestingly the Essex teachers plan to maintain contacts with each other and the representative of one of the schools suppliers also continues to make contact with the schools in this area. The Sheffield teachers have established a strong network enabled by the LEA adviser who has organised follow-up sessions visits to local industry and organises links with Sheffield Hallam University. The Durham group is reliant upon local LEA inspectorate support to maintain contacts and undertake any follow-up visits.

Since the completion of the courses a number of teachers from different pilot areas have contacted the central support seeking further advice and guidance. The web site contains a 'forum' wherein teachers may also make contact with each other to share ideas and seek advice from each other. This is being used but any developments are still in their

early stages. There needs to be a critical mass of people taking part in the discussions to attract ideas and keep the momentum going.

Web site evaluation

Comments from the course members and others who have been given access to the Marconi ECT Website, have been encouraging. Respondents have highlighted the usefulness of the content on the site not only for their own use but also to direct student to. Much of the material that had been written prior to starting the pilot training was loaded onto the web site in an un-edited and unformatted state. This was done so that materials would be available for course members and it would give them an impression of the overall structure and inter-relatedness of the web site modules and content. A review of the current content is now underway with re-editing and formatting a priority. Also new materials are being edited prior to loading onto the web site.

As part of the web site design various 'metrics' can be established to determine the 'who, when and what' of web site use.

There have been some difficulties encountered from some authors of materials for the site. Timescales have slipped despite reminders to meet deadlines. However, materials continue to be developed and loaded onto the site. A number of individuals have also offered to write new materials for the site and new authors are being commissioned as and when interesting ideas or projects are encountered. The web site has the following functions areas:

The five areas of study for teachers to work in: ECT in Society; Designing, developing and manufacturing ECT systems; Modelling with software, kits and systems; Using Technologies in ECT systems; and Pedagogic issues. There are three non-study areas, which provide information: ECT Activities; Datafile; Glossary/Index as well as Teacher CPD routes, which provide information about possible routes to professional development.

See Marconiect.org web site for details.

Other points

- With regard to the recruitment of teachers onto the courses, there is a need to work more closely, and earlier, with key personnel in the LEA or local area. LEA inspectors and advisers have a pivotal role in generating interest about taking part in the project. As the Marconi ECT project develops, this role will be taken on by the 'local' accredited trainer in the next phase. Any letters sent to schools and colleges will need to be addressed not only to head

teachers but a covering letter sent to heads of design and technology departments.

- The current needs analysis documentation works well in identifying colleagues strengths and areas for development within ECT. The needs analysis documentation forms one of the cornerstones of the philosophy behind the training programme. There may be a need for some clarification in terms of the responses needed when scoring on the 0-4 range and in terms of the quality of the free written response section.
- The Marconi ECT project maintains contact with all the major developers and suppliers of ECT resources in schools. The content of the course in terms of resources and materials used is under constant review and new materials, processes and resources can easily be accommodated within the training programme.
- The development of local self-help groups needs to be strengthened and given a higher profile. In relation to this, as the project moves over to a wholly electronic means of communication, course members will be encouraged to use the Marconi ECT Website as the means of maintaining contacts. One idea is that comments or notes or ideas, which need responding to, could be posted on the forum at regular intervals
- Greater use is planned of the forum and there is a move to transfer to fully electronic means of communications within the project.
- Many of the teachers in their evaluation returns, and through comments, have said that the course has moved the department forward significantly. Several course members have already bought equipment and are implementing ECT activities within their classrooms.
- The assessment structure will be better outlined and in more depth on later courses with practical examples taken from earlier courses.
- Web site development is continuing with almost every module on the site being populated to some extent. The content to be loaded onto the site continues to be commissioned and the interactive nature of the web site continues to be developed. The web site will continue to be reviewed and modified as new materials and applications become available.

Conclusions and recommendations

- The overall structure of the Marconi ECT project was sound and a workable model.
- The recruitment of teachers to the courses was a major challenge and requires significant incentives.
- Four days face-to-face training is the minimum time allocation to have any worthwhile impact.
- The needs analysis tools were essential, and proved effective.
- The teacher competencies were difficult to fully complete in 4 days, teachers found the assignments demanding, worthwhile but time consuming.
- Teachers continued to require personal support during the training period and for a period after completion of the course.
- The Marconi ECT Website was a major resource and once fully populated should be a major asset, however it will require expert advice forum for teachers and pupils.
- There is a need for local support for teachers, with the development of self-support groups.
- The educational and ECT principles have proved robust and workable.
- Accreditation and certification was considered essential.