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The Technology Enhancement Programme (TEP) millennium research - a positive intervention to change the D&T curriculum

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Abstract
OfSTED reports published at the start of the millennium indicated significant weaknesses in the Key Stage 3 design and technology (D&T) curriculum. In 2002 HMI said:

> *'- - the choice of project, with contexts that are pertinent to pupils' experience, is crucial to successful learning in design and technology. Far too many projects are based on contexts that are seen as irrelevant or boring by pupils. Tasks need to encourage creative and innovative responses.'*
> *(OfSTED 2002b 7)*

The previous year's report highlighted possible reasons for this weakness. HMI said:

> *' - - many teachers are failing to keep up with new developments in the subject because there are few opportunities for appropriate INSET - - .'*
> *(OfSTED 2001c 5)*

The Technology Enhancement Programme (TEP) has a remit to develop the D&T curriculum therefore it was appropriate they instigated a development programme to facilitate change in the Key Stage 3 curriculum. This became known as the TEP Millennium Project.

By the year 2000 TEP had developed a range of new products and materials for use in the D&T curriculum and the initial focus of the Millennium Project was to develop a range of projects teachers could use to modernise their curriculum. To implement these in a number of schools TEP and Sheffield Hallam University devised a programme of development, targeted support and INSET. Financial support to participating schools gave D&T departments access to TEP products. This paper reports on the research outcomes of this project.

The research was to:

- *monitor the progress of D&T change in the schools;*
- *assess the impact of change on teachers and pupils;*
- *assess the longer term effects of the intervention on the D&T curriculum in the schools.*

The research team used in-depth case studies compiled from observation and teacher interviews, followed by questionnaires.

The conclusion discusses the features that this intervention found to be effective in bringing about curriculum change.

Keywords: *design and technology, D&T, intervention, millennium research, Technology Enhancement Programme, TEP*

Why Intervene?
The UK introduced its D&T National Curriculum in 1990 and this proved to be difficult to implement in schools. Only two years after its introduction Smithers and Robinson concluded that:

> 'Technology in the national curriculum is a mess. What has emerged seems to be very different from what was intended. Her Majesty's Inspectors are reporting that the standard of work in secondary schools, where national curriculum technology has been running for five terms, is actually declining (in contrast to the other subject areas where improvements have been noted).'
> (1992 5)

As recorded by Eggleston (2001b 38-49) in his review of the D&T National Curriculum, subsequent revisions improved the situation considerably, however six years after its introduction Kimbell found it necessary to express the view that:



> ' - the centralising influence of the national curriculum runs the risk of placing a dead weight on innovation - discouraging imaginative teachers and schools from developing their curricular.'
> (1996b 99)

By 2005 Norman was expressing a similar view using the forceful statement:

> 'The introduction of the UK national Curriculum in 1990 effectively froze the subject's conception within the most influential ideas of the late 1980s, and these were not a secure enough specification to freeze.'
> (2005 12)

Uncertainty about both the content and how to teach D&T in the National Curriculum resulted in the subject, particularly at Key Stage 3, lacking innovation as many teachers struggled to deliver the programmes of study. Banks supported this with the pragmatic statement that:

> 'If learning in Design and Technology is to be meaningful, the work done must:
>
> • be relevant to pupils - pupils must see the point of the project - - '
> (2002a 86)

Kimbell (2000) blamed what he referred to as a list of 'accountability initiatives streaming out the DfEE' for teachers resorting to a safe D&T curriculum. He encapsulated teachers' attitudes by saying:

> 'We should not be surprised if teachers play it safe rather than take creative risks. It is sensible for them to do so.'
> (2000 209)

It is not surprising therefore that OfSTED commented on the choice of projects in D&T needed to be ' - - pertinent to pupils' experience' and must ' - - encourage creative and innovative responses.' (2001c 7).

On the issue of in-service education and training (INSET) for D&T teachers the Design and Technology Association (DATA) in Research paper No. 6 (1996) reported that:

> 'The INSET needs of secondary school design and technology teachers are many and varied. The concept of planned, coherent continuing professional development is not established well in schools.'
> (1996a 3)

When discussing teacher education Eggleston had the view that INSET was particularly important in D&T as the very nature of the subject involved keeping abreast of new knowledge, technologies, materials, processes and skills as they become available. He summarised his view by saying:

> 'There can be scarcely be a school where this is not a management task for senior Design and Technology staff.'
> (2001b 83)

Evidence from both researchers and OfSTED indicate that by the year 2000 education policy, the National Curriculum and a lack of INSET opportunities had been major contributors to ossification of the D&T curriculum. This curriculum development project and research (referred to as the Millennium research in this paper) was a deliberate intervention to reverse stagnation which seemed to be developing in the D&T curriculum and measure the effectiveness of the process.

Introduction to the curriculum intervention

The Technology Enhancement Programme (TEP) is funded by Gatsby Technical Education Projects (GTEP) with a remit to develop, and provide support for, technological education in schools. Schools become members of TEP by application which must include evidence they have made progress in developing their technological curriculum. Currently there are at least 1,750 schools affiliated to TEP. Initially TEP focused on developing a range of hardware suitable for use in projects plus supporting teaching resources. During 1998 an unpublished pilot study was undertaken to assess the effect these resources had on the technological education in a small number of schools. The Millennium research developed from this to become a significant intervention in the D&T curriculum with a remit to:

- address the issue of re-invigorating the Key Stage 3 D&T curriculum;
- stimulate further change in the D&T curriculum;
- support teachers to enable them to manage change in their schools;
- assess the impact of the intervention.

The research was facilitated by a steering group consisting of staff from the Centre for Design and Technology Education at Sheffield Hallam



University and TEP. The strategy adopted was:

- generation of new teaching and learning materials;
- collection of data as the project progressed;
- an end of project assessment of teachers' views of the intervention;
- an assessment of the impact on the schools.

The intervention engaged a mix of inner city, urban and rural schools in South Yorkshire and the West Midlands regions and involved some 40 teachers and at least 5,000 pupils in eleven schools. At the start of the research none were affiliated to TEP. Each pilot school entered into an agreement with TEP which involved ceasing to use their usual Key Stage 3 (11-14) resistant materials and systems and control projects and replacing them with new projects developed by the team at SHU. Schools selected any of the ten projects available. TEP provided schools with resources supplied from Technology Resources at Middlesex University.

As the Millennium project evolved the key features were:

- the development of a range of innovative projects for the Key Stage 3 D&T curriculum (which in this paper are referred to as the Millennium projects);
- the trialling of these projects in schools and modifying by the SHU team as required;
- the presentation of the finalised projects in a published form to enable teachers to engage with them readily;
- giving financial support to schools engaged in the research by providing materials and resources required to implement the projects free of charge;
- providing INSET and on-going support for teachers engaged in implementing the projects;
- assessing the reaction of teachers to the projects;
- monitoring the progress teachers made when implementing the projects;
- collecting data for case studies
- assessing the impact of the projects on the schools involved.

Throughout the implementation stage data was collected by participant evaluation during the INSET courses and, in the final year, regular visits to schools by members of the research team to collect further data using teacher interviews and lesson observations. This provided evidence for case studies. A post-implementation phase questionnaire was used to assess teachers' experiences of implementing the projects, attitudes to change and impact on their school. Elements of the post-implementation phase questionnaire provided triangulation of data collected for the case studies. An important aspect of the questionnaire was assessing the extent of teacher modification of the Millennium projects and retention of the projects within the D&T curriculum.

Academic year	2000/01			2001/02			2002/03			2003/04			2004/05		
Project development at SHU	■	■	■	■	■	■	■	■	■						
INSET			■			■			■						
Implementation in schools				■	■	■	■	■	■	■	■	■			
TEP and SHU support				■	■	■	■	■	■	■	■	■			
Collection of case study data										■	■	■	■		
Impact questionnaire														■	
Analysis of data														■	■
Report findings															■
Term	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3

Timescale of the Millennium Research



Developing the Millennium projects
The concept of the Millennium projects was to provide teachers with well researched and developed projects which could be integrated into the Key Stage 3 curriculum and, if necessary, be modified to meet the particular requirements of the D&T department. Teacher modification was seen as a significant feature as it recognised the necessity for teachers to decide on the level a particular project could be implemented in their school. The objective was to provide teachers with opportunities to explore methods of engaging pupils in exploring creative opportunities provided by the project framework.

The projects were designed to:

- motivate pupils;
- introduce pupils to new technologies in ways which facilitated successful outcomes;
- facilitate pupils developing their designing capability within a structure of a design and make assignment;
- enable pupils to develop aesthetic capability;
- provide opportunities for pupils to work with new materials and use processes which could be linked to those used in industry;
- provide opportunities for differentiated learning.

Developing cost-effective projects was initially seen as a significant factor to ensure schools would be able to continue using the projects when they reverted to their usual levels of capitation. Members of the steering group had differing views on this as cost constraints could restrain development of the technological curriculum to such an extent that schools could not take advantage of emerging technologies. At the start of the research the average capitation per pupil per year in UK state schools was £6.42 (Breckon 2001a 6) with most pupils doing at least three projects per year in D&T.

The range of projects developed complied with the 'Breadth of study' outlined in the Key Stage 3 D&T National Curriculum, particularly:

b focused practical tasks that develop range of techniques, skills, processes and knowledge;

c design and make assignments in different contexts. The assignments should include control systems, and work using a range of contrasting materials - - - '

(1999b 22)

During the project development phase the research team developed, tested and published outline schemes of work and supporting material for ten projects. These were:

Personal Organiser - a project using anodised aluminium, neoprene, injection moulded components and simple bench mounted jigs and tooling;

Flat Flash - a graphics/technology project making extensive use of graphics software, miniature light bulbs and Polaroid batteries;

Flat Battery Tester - a graphics/technology project using card, copper circuit tape, wire and thermo colour film to produce a simple circuit;

CNC Torch - a computer aided design and manufacture project with a graphics element to produce a key ring torch;

Jitterbug - a systems and control project to introduce peripheral interface controller (PIC) programming with opportunities to control motors, sound and light emitting diodes (LEDs);

The Phone Pod - a press forming manufacturing project using foamex, plastazote and a range of flexible plastic fittings;

Message in a Box - a project using printed circuit board construction techniques, PIC programming with a mathematical element all packaged in a polypropylene enclosure;

Aroma Therapy Fan - a project bringing together considerable design opportunities, manufacturing skills and electronics;

Mousemate - an individualised mouse mat developed using graphics software; fabric printing and manufactured in plastazote;

Bubble Blower - a project using motors, speed control, vacuum forming, graphics and construction techniques.

Each project publication contained an outline scheme of work, references to the D&T National Curriculum (1999b) and teachers' notes on design and manufacturing techniques.



Projects were developed and trialled by initial teacher education students and in schools before presentation to pilot school teachers during INSET sessions. During these sessions teachers worked through each project exploring both new knowledge and formulating ideas about how they could use each project in their school. INSET courses were well attended with each school usually sending more than one teacher to each course.

The Case Studies
Evaluative case studies undertaken in the fourth year of the research were considered to be an appropriate method of describing the implementation of the Millennium projects in three schools. Bassey (1999a) describes case studies as 'enquiries into educational programmes, systems, projects or events to determine their worthwhileness, as judged by analysis by researchers, and to convey this to interested audiences.' The case studies were conducted in such a way that sufficient data was collected to be able to: '(a) explore significant features of the case, (b) create a plausible interpretation of what was found, (c) construct a worth while story, and (d) convey convincingly to an audience the argument or story' (Bassey 1999a). Data collection included interviews with teachers, observation of lessons, and photographic evidence of project outcomes. Additional data was collected during progress visits to a further eight pilot schools. This data was used to assemble progress studies.

The post-implementation phase questionnaire
The purpose of this questionnaire was to establish the impact of projects on the D&T curriculum in the pilot schools. This influenced the questionnaire design as the researchers considered it was important to:

- ensure the best possible response from the 11 pilot schools so producing credible data;
- obtain accurate factual data;
- obtain teachers' views about the projects, based on their experiences during the implementation phase.

The questionnaire consisted of numerical data collection about projects used, and closed multiple choice response questions for teachers to indicate their attitudes and views concerning the projects. Bryman (2004) states that closed questions have the advantage of being easy for respondents to answer and a reliable way of collecting data. However, he recommends that in certain closed question situations some respondents find 'forced-choice' answers can produce a variation amongst respondents in their interpretation of the possible answers presented. He goes as far as saying that some closed questions 'may be irritating to respondents' and recommends including, where practical 'other' as a possible answer as this usually elicits a wealth of useful information from respondents. This opportunity was included in three of the ten questions.

Questions were divided into the following sections:

- project popularity and reasons for choice;
- projects still in use with reasons for retention;
- financial factors;
- teacher and pupil reaction to projects;
- modification of projects;
- influence of Millennium projects on the profile of D&T within the school.

Results: Case Studies
In-depth case studies of three schools with progress studies of eight produced data which describes the successes, difficulties and failures of the Millennium research. Impact on learning was the major feature with lesson observations and teacher interviews the main data collection procedures.

School A
In this school pupil motivation was high when working on the projects and teachers considered there had been a significant impact on learning. The head of department considered the projects were simple but provided opportunity for extension and application of ingenuity. Teachers had 'adopted' and 'adapted' the projects to fit their circumstances. Both the head of department and teachers considered that D&T should be fun and they considered the Millennium projects had contributed to an 'enjoyment factor'. Take home rates were considered a positive indicator of the success. While systems and control was established in the school teachers considered they were now more confident in the possibilities of this aspect of D&T. Interesting pupil comments about the Jitterbug included:

> 'We have never done anything like this before. We like it because it moves about and has working parts.'



Spin off from the project included the technician being particularly innovative in producing jigs and moulds to assist pupils; and Key Stage 4 pupils experimenting with the newly introduced materials and processes with noticeable improvements in their examination work.

School B
A feature of this well resourced, managed and staffed D&T department's approach to the Millennium research was to 'redesign and develop' the projects. The head of department said that:

> 'Staff and students have had so much fun exploring the many possibilities embedded in these activities.'

Teachers in the department decided to run each project in the prescribed format to enable them to evaluate opportunities and then focus their attention on specific aspects of learning they wanted to develop, particularly how the project could be adapted to meet individual circumstances. Two examples of this process were evident. The first was a much modified jitterbug with a switch to activate the 'bug' when it was placed on a surface. The second incorporating a ball bearing puzzle into the CNC torch project to provide greater opportunities for differentiated learning. The head of department reported the following:

> 'There had been a massive increase in the number of projects completed and taken home.'

> 'Year 10 through to Year 13 students have asked why they couldn't do these projects when they were in Year 7?'

School C
The department in this school used the Millennium research as a staff development exercise to act as a catalyst to enable the department to move forward in providing a quality D&T experience for pupils. All projects were attempted with the systems and control projects proving to be popular with both staff and pupils. Teachers in this school found Message in a Box interesting as it enabled them to embrace new approaches to systems and control teaching. By engaging with projects which included significant electronic control content they were able to build up departmental expertise. The head of department considered that during the project the department became more reflective about how and what they teach in D&T. As a result teachers were making use of modelling as a design methodology; this was having beneficial effects on 'fostering creative thinking at Key Stage 4.'

Progress studies
The progress studies reveal similar results in a further six schools, however the following key issues emerged:

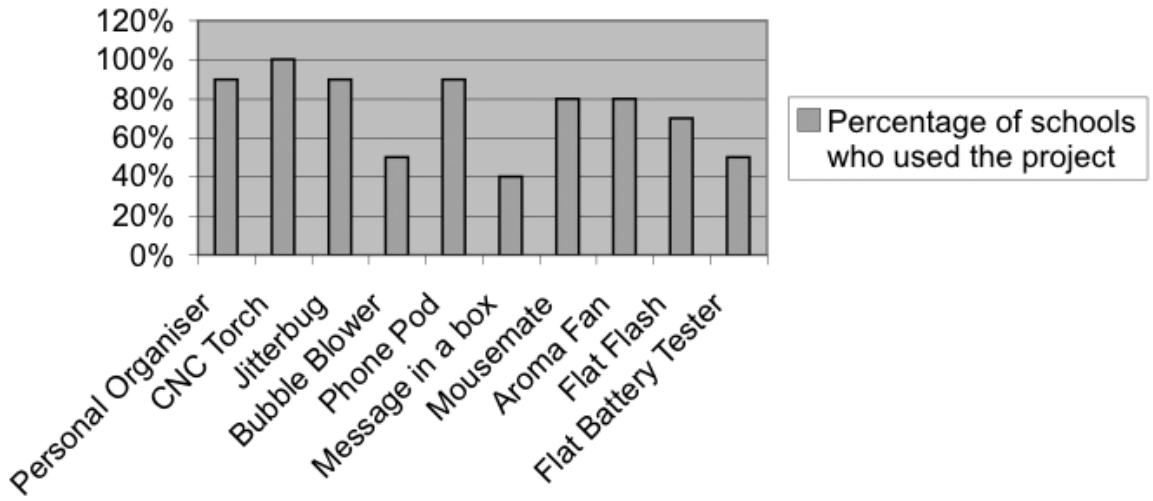
- Departments in poor D&T environments took the opportunity to use the highly visual qualities of the Millennium research projects to improve their circumstances.
- Departments in well equipped facilities can be reluctant to develop their curriculum.
- Enthusiastic management of a teaching team is an essential element of curriculum development.

Exceptionally, two schools in the progress studies were reluctant to leave behind their existing practice. In one school this was exemplified by the statement 'wood is a main material and cabinets the project choice at GCSE'. Progress with the Millennium projects in these schools was limited as it seemed the departments and individual teachers were doubtful about implementing them.

Results: post-implementation phase questionnaire
Ten of the eleven schools responded, the eleventh being unable to participate due to changes in the school's circumstances. Questionnaires were completed by heads of department or, where personnel had changed, by a member of staff who had participated in the research.



Percentage of schools who used projects during the research

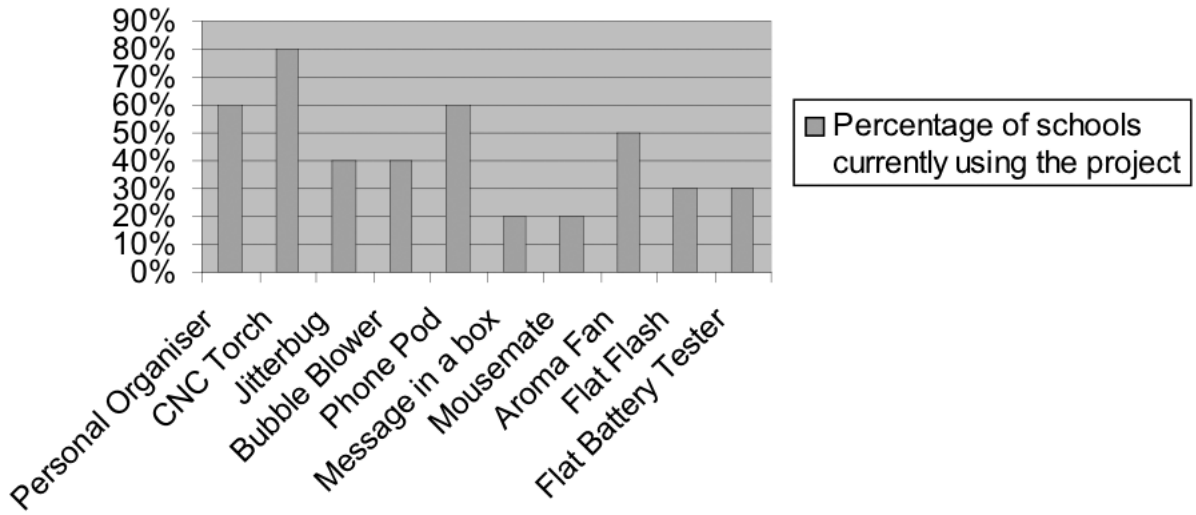


A factor which may have affected the popularity of projects is that some were not ready for delivery at the start of the Millennium research. For example the Bubble Blower was the last project developed and this is likely to have affected opportunities for teachers to engage with it. The CNC Ttorch proved to be the most popular project with the Jitterbug, Personal Organiser and Phone Pod being popular choices.

When asked why they chose particular projects nine out of ten schools considered that the project would result in a functioning product with eight out of ten indicating they would appeal to pupils, and they would represent a major step forward in their D&T curriculum. Interestingly, only five out of ten schools considered it was important for the project to appeal to teachers. However, one head of department reported that 'they suited the skills of most of the members of the department'. Additional supportive responses included:

> 'All the projects were of a higher quality than we were offering at the time'.
>
> 'Innovative, different, modern, better use of materials, greater learning'.
>
> 'Allowed us to introduce electronics across the traditional subject areas, which have now been broken down'.

Percentage of schools currently using the projects (2005)





All projects are still in use in the schools with the CNC Torch being the most popular, followed by the Personal Organiser and Phone Pod. The Aroma Therapy Fan remains popular in half the schools but significantly the Jitterbug (with 90% popularity during the implementation phase) has declined as have projects such as the Mouse Mate and Flat Flash. Two thirds of schools said they continued with projects because they 'appealed to pupils' and they were 'unproblematic to implement' with seven out of nine schools saying they 'continued using projects because they have proven to result in functioning products'. Interestingly one school reported that:

> 'We found these projects to be cost effective within the 'strict' limitations of our capitation. Also we found that these projects enabled our students to take a quality project home.'

This view was confirmed by this statement from another school:

> '100% take home rate. Helped deliver the national curriculum'.

When considering the cost of projects schools were asked to rate each project using the scale 'affordable', 'moderate', 'expensive' or 'no opinion'. All schools considered the Jitterbug expensive with the Message in a Box getting a similar result. Six schools stopped using the Jitterbug project and two schools the Message in a Box when TEP funding ended. The Bubble Blower was rated as expensive by half of the schools retaining the project and moderate by the remainder. On the other hand the Aroma Therapy Fan was seen as being, equally, affordable or moderate cost. The Personal Organiser, retained by six out of ten schools, considered this to be of moderate cost while the Phone Pod was judged to be expensive by three schools and affordable by five. The cheaper projects to implement - Flat Flash, Mouse Mate and Flat Battery Tester were considered to be affordable by the majority of schools. The popular CNC Torch was rated as affordable by six schools and moderate by three.

Two questions concerned the reaction of teachers and pupils to the projects. Teachers' reaction produced a confusing result with several schools making a multiple response to the question. It is possible that this reflects a variation in teachers' attitude within a department. However, seven schools reported that teachers were enthusiastic and highly motivated with three recording teachers were moderately enthusiastic. One school reported that teachers' motivation and application remained the same as when working on their usual D&T curriculum. Two schools considered that teachers were 'in two minds about the value of the projects'. Eight out of the ten schools reported that pupils were 'enthusiastic and highly motivated', one school 'moderately enthusiastic' and another 'remained the same as when working on the usual D&T curriculum'. One school commented that they experienced problems with 'supply and a lack of basic resources'.

The question 'In the process of using the TEP projects, did you modify or customise any of them?' All schools responded that modifications had been made with six making significant changes and four minor modifications. Particularly interesting is the response to the question 'Has cost been a significant factor in making the projects work since 2003? Only two schools considered cost had not been an issue with six schools indicating that cost was an issue but 'the TEP projects had been a worth-while investment'. Two of these schools considered that 'the school cannot afford to continue using some of the projects'.

Finally, nine out of the ten responding schools said they were interested in using future TEP projects. When asked about the Millennium projects' influence on their department's profile within school five responded positively reporting the following successes:

> 'Capitation was increased from £800 to £1,500. Without TEP support (we) would be struggling. (D&T) became a leading department in the school. GCSE scores (went up) from 35% A-Cs to 87% A-C last year. 47% of pupils obtained A* or A. Became a Technology college in September 2004.'

> 'The profile of D&T within the school, (both) students and staff, has gone up. However, after talk of increasing capitation none was forthcoming. In the end we have had to move to a system of student contributions to fund part of the projects.'

> 'We have, and continue to receive high profile from these projects. (The projects were) good publicity and since the pilot I have done in-service training in two counties where the TEP message has been well received – in particular incorporating electronic



components. Parents and pupils are still highly motivated and give good feedback.'

'The modifications made have allowed greater use of CAD/CAM with a wider range of year groups – this has had a positive effect as students progress from KS3/KS4. TEP has provided an **excellent** source of inspiration for our own development!'

'I feel that the positive feedback from the students has helped raise the D&T (department's) profile.'

Two of the schools who had not enjoyed this success commented:

'Capitation is a serious issue. We have to deliver items which pupils will want to take home and pay for – this is essential'.

'Due to a range of problems, some of which were directly connected to our school, the TEP projects had a negative effect on the faculty. Staff never really got behind the projects and were not prepared to put extra work in to make them suitable for our situation.'

Discussion and conclusion

There is evidence that the D&T National Curriculum and political factors has resulted in teachers resorting to a D&T curriculum delivered through 'safe' projects and this can result in reduced pupil motivation. The Millennium projects were developed with the explicit intention to innovate by introducing new technology, materials and processes. Supporting the implementation in schools with INSET proved successful, all courses being well attended. For many teachers the electronics and systems and control were new. Similarly, the use of press forming in the Phone Pod was a process new to a majority of teachers. It is not surprising, bearing in mind the lack of INSET opportunities that the majority of the Millennium projects included using materials, tools and equipment which many teachers had not experienced previously. The Aroma Therapy Fan, Jitterbug, Message in a Box and CNC Torch have a considerable technological content which required many teachers to develop their technological capability. The success of these projects in schools indicates that, given the opportunity, teachers quickly embrace new technology and implement it in their schools. As the INSET courses progressed participants developed a camaraderie which produced beneficial effects in establishing ownership of the projects.

When selecting projects to implement in schools most teachers selected those they thought would enthuse pupils and not because they liked the project themselves. It seems their professional judgement was correct as there was strong evidence from teachers that pupils were enthusiastic about the projects. A positive outcome is that the majority of schools modified the projects to fit their circumstances indicating that D&T teachers are innovative when given the opportunity.

There is evidence that cost is a significant factor in project choice. The Jitterbug was the most popular project when the TEP funding was available but a significant number of schools could not afford to fund the project from their own capitation. This could be a limiting factor in developing the technological curriculum in the future. Interestingly, some teachers used their ingenuity to re-invent their own cheaper version so maintaining this project within their curriculum. Several schools continued with the expensive projects, in some cases struggling to resource them from their capitation or finding other means of finance. It cannot be assumed that cheap projects prove to be attractive. The cheap Flat Battery Tester was not popular as most teachers did not think it would be attractive to pupils.

There is no doubt that the Millennium research brought about significant curriculum change in seven of the pilot schools with a further two keen to continue working on TEP projects. The majority of pupils were enthusiastic about the projects and nine schools reported that there have been improvements in pupil performance. One school attributes its success in improving GCSE grades in D&T to engaging in the Millennium projects. Five schools experienced a significant improvement in their status within the school as a result of their introducing the Millennium projects into their D&T curriculum.



The conclusions can be summarised as:

- carefully developed interventions can be an effective way of re-invigorating the curriculum;
- when provided with the opportunity D&T teachers are able to embrace new technology and integrate it into their schemes of work;
- D&T teachers can be innovative in the way they adapt projects to suit their curriculum circumstances;
- D&T teachers consider pupil motivation to be an important factor in selecting projects for their schemes of work;
- INSET is essential to bring about significant curriculum change;
- using innovative projects developed to motivate pupils can benefit examination results and the status of a department within a school;
- cost is a significant factor in teachers' choice of project;
- financial constraints could be inhibiting development of the 'high tech' aspects of the D&T curriculum.

This Millennium research has shown that while the D&T curriculum may currently be restrained the many teachers engaged in this intervention were willing, and enthusiastic, to be innovative and use new technology when it is available to them.

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