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## Science in technology: technology in science

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## SCIENCE IN TECHNOLOGY: TECHNOLOGY IN SCIENCE

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### Introduction

Two contrasting ideas have been consistently present in the statements published and words spoken as the national curriculum design and technology profile component (D & T) has been fashioned and launched. The first is that D & T is a new subject in the curriculum and the second is that many appropriate teaching methods and materials will build on existing practice. They are both found, for example, in paragraph 1.1 of the non-statutory guidance for design and technology capability (NCC 1990) and were clearly evident in the words spoken by Professor Paul Black and Richard Dorrance at the Bristol "Technology Roadshow" that I attended. These two ideas set up a very clear tension of the "new wine in old wineskins" kind but we need to believe that this tension will turn out to be creative rather than destructive.

The process of creating a new subject requires that the content and approaches comprising the subject as experienced by pupils be defined, but it is precisely that process of definition that can lead to territorial conflicts with other subjects. Quite apart from the need to establish what elements of the identified contributors to D & T shall actually be drawn on within the new subject, it has to be remembered that much useful D & T already goes on in existing science courses: and I mean more than just knowledge acquisition. I need hardly remind people of the flourishing SATIS programme (ASE 1986), or BIOTECH (ASE 1987), both from the science area, and both opening up areas of D & T capability that many CDT teachers never contemplated. The science non-statutory guidance (NCC 1989 section 5) emphasises the essential constructive inter-relation between science and D & T and the D & T literature has all along emphasised the "special relationship" with science.

Skirmishing over the borders of a subject is not conducive to curriculum development. When McCulloch, Jenkins and Layton (1985) published "Technological Revolution?" there must have been many practitioners who recognized the political in-fighting described in that book. Unfortunately, existing power structures in all but the most enlightened schools and local education authorities tend to support power struggles rather than encourage constructive co-operation and it cannot be denied that much fighting of corners (with new and lively as well as old and jaded participants) has been a characteristic of the D & T debate over the last couple of years. Nevertheless, science and technology do interact in the world, and this interaction must be brought into play to the benefit of pupils studying and teachers teaching both subjects in a curriculum that still looks dangerously overcrowded.

I want now to develop some ideas about the relationship between science and D & T through reflecting both on material gathered for the Open University's Advanced Diploma in Technology in Schools, and also on discussions at the recent PATT (Pupils Attitudes Towards Technology) conference in Poland. To all those practitioners whose ideas and activities have contributed to my thinking I offer thanks and acknowledgement.

### The nature of knowledge and learning

I recently assembled a new set of case studies in order to update the "actuality" in the course material of the Advanced Diploma. One study described a junior school project based on commercial bread production (Deans 1990). I interviewed some of the pupils who had been involved in the project: they have now moved on to secondary school. Their comments were quite revealing: "[in secondary school] we don't do projects - we just do work". Projects are better because you can "learn a lot more" and they are "more fun". At secondary school you "just get into your work and the bell goes and you have to move on to something else - that's annoying!".



I find myself with an increasing feeling that any division of knowledge (in the broadest sense of knowledge), however necessary, is somewhat arbitrary and potentially distracting and I have to admit to preferring a "seamless robe" concept of knowledge to a "patchwork quilt" one. Perhaps it is partly as a reaction to hearing pupils dismissing particular information because it happens to be classified as belonging to a particular subject, and partly because I hear claims made for the way in which, say, scientists and designers operate which sound remarkably similar. Sadly, it can be in attempts to rationalize the curriculum, to ensure that pupils get something that is "broad", that divisions can be reinforced. The problem then becomes how to make the seams in the patchwork curriculum invisible enough for pupils to perceive a seamless coat of many colours (perhaps we should ask the HE department?!) in a way that enables them to build consistent and coherent frameworks of knowledge. Colin Deans tackled the problem in the way that I imagine is used by most primary teachers: by analysing what could be got out of the bread project beforehand (a pre-audit to set up a specification [D & T AT2]) and then analysing afterwards (a post-audit for evaluation [D & T AT4]). Thus the project could be evaluated and information stored for future reference and development but the pupils could get on with enjoying their learning without being distracted. Incidentally, Colin Deans found science, mathematics, problem solving, English, information technology, geography, history, R.E., P.E., art and craft and safety in his pre-audit of the project, and that was before his post-audit discovered how much D & T had actually taken place (D & T as such for junior children was only a gleam in Lady Parkes' eye when the project was planned).

The premature loss of significant numbers of pupils from the study of science and technology was one of the underlying factors that has brought about a national curriculum containing science and D & T for all (DES/WO 1987 para 8(i)). Will pupils now all enjoy these compulsory subjects and therefore find them to be genuine learning experiences? At the PATT conference there was debate about using technological contexts for the teaching of physics to make physics more approachable. Professor Henryk Szydłowski proposed a fundamental aim for physics in the curriculum as being to "arouse curiosity". I struggle somewhat with such aims because children are naturally curious - as was pointed out so long ago in the rationale for the Control Technology course (Schools Council 1975 p.1). Primary school teachers seem to respond to such curiosity and build on it. When secondary teachers look for it in fourteen- and fifteen-year olds it seems so often to have vanished. Is the structuring of courses in lower secondary partly to blame, because we expect pupils all to be interested in the same thing at the same time in disjointed little offerings?

But we are faced with the implementation of a new subject, so its nature must be established if only so that teachers can know when they're teaching it. It is some years ago that Sid Hargraves (Devon Primary Advisor) made the point to me that he wants his primary teachers to know the difference between science and design and technology whilst being less concerned about formalizing the knowledge with pupils and I think that remains significant. In my paper to the 1988 conference, I used a table that highlighted distinctions between scientific and technological activities and I want now to look in more detail at some aspects of these distinctions and explore how they arise and may be responded to in teaching situations.

## **Science (and a lot else) in technology**

I am currently tracking in detail the progress of one pupil who has just embarked (June 1990) on her major GCSE project in CDT: technology for submission in summer 1991. She has developed an interest, partly through humanities projects already completed, in things environmental. So she wants to monitor the weather and, in particular, to build an anemometer. This has led, amongst other things, to a visit to a local airfield frequented by a parachuting club, because she was told that there she would find an anemometer. She did. But she also found a group of parachutists who showed her not only the pole-mounted pitot-static anemometer, but also a hand-held one, but who then went on to introduce her to all sorts of interesting things about the practicalities of parachuting: "widdies", "ditters" and the like (ask a parachutist!). The result was a growth of knowledge and understanding through social interaction in the context of common interest and, for the pupil, an increased fascination with the whole area. The next stage has been investigation of articles in the "Meteorological Magazine" that have already linked with her personal memories of a storm and of a climb up Cairngorm. The result is remarkable links between schoolwork and real life.



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But these general background activities are going on alongside practical testing. She saw a three-cup anemometer and was encouraged to experiment with three plastic flower pots, some paper, sellotape and Meccano. The result was a transducer that worked, but poorly. Three problems were apparent: it was mounted too near the ground; the adapted flower pots were insufficiently aerodynamic; the Meccano bearing system introduced too much friction. What happens now? It has to be D & T AT4, doesn't it? Evaluate this modelled sub-system, redesign, test again, evaluate...she's a long way yet from the artefact that will comprise the actual transducer. But that very word "test" moves the exercise directly into the science area. When an "improved" transducer is assembled (the present intention is to replace the plant pots with cups formed from pop-bottle necks and to fashion some sort of point bearing) how will any improvement be detected, other than by gross speculation and what comprises improvement anyway? The anticipated improved aerodynamics of pop-bottle necks is, for this pupil, a scientific hypothesis (which is the name that graces most such hunches), as is the reduced friction in a point bearing. But how will the hypotheses be tested? A scientific experiment needs designing, carrying out and reporting. In other words, many aspects of science AT1 must be completed. Now will that be counted in her school's science reckoning? Will she know she's satisfying science AT1 and will her science and D & T teachers? I would also confidently predict that aspects of science AT5, AT6, AT7, AT9 (did whoever wrote that one actually realise the complexities behind the glib "be able to measure...wind speed" in AT9 level 4?), AT10, AT11, AT12, AT13 and AT17 will all be satisfied in the context of this one project, but I'll report on that to next year's conference. The point is that identifiable and creditable science does and will take place within D & T. Can our pupils afford to wait for the hurdle of integrating bits of the famous five subjects into D & T to be overcome for teachers then to have time to realise that the tweaking of an activity may well serve an attainment target in science and D & T?

## Technology in science

I used to teach second-year Nuffield physics including batteries and bulbs and copper connectors on Worcester circuit boards. One battery connected to one bulb - normal brightness; two batteries in series with two bulbs - normal brightness; one battery with two bulbs in series - less than normal but equal brightness (because the current's the same, isn't it?). Yes, but not in practice because the bulbs would be different. It was, of course, possible to explain it, but one rather tended to lose the impact of the experiment.

But why are these light bulbs as they are? Basically because they're a product of a technological manufacturing system that doesn't see the production of little light bulbs to a tight tolerance as being necessary or cost-effective. The distribution about a mean of their resistances is an illustration of an essential feature of any mass-produced product (as is outlined in Sparkes, 1988) which is a useful teaching point in its own right because here one is evaluating someone else's products and starting for a change at AT4 as suggested in non-statutory guidance. I wonder how many physics teachers will recognize the potential for satisfying aspects of D & T AT4 in this sort of context? I was interested by a note made by Ray Page during the PATT conference when such issues were being discussed which asked "...is a pupil doing an experiment in science a technologist?". I suppose the answer often has to be yes (unless the experiment is a thought experiment), in which case a pupil doing a scientific experiment is probably going some way towards satisfying at least one attainment target within D & T at some level. The question then is, could this be identified, extracted from its context, and credited towards the pupil's D & T profile? Here we have the complement to what was going on in the anemometer D & T project. The technologist also has something useful to contribute to the on-going debate about the usefulness (or otherwise) of attempting experiments that "prove" things in science using school equipment in school laboratories with inexperienced users.

## Implications for teachers

A further point emerges from a study of Colin Deans' bread-production case study: that the teacher himself was learning and was happy to admit it. That characteristic also emerged from an earlier primary school case study in the Advanced Diploma material (Bunce, 1988). Two other case studies focused on older students engaged in two- or three-day activities: one at the Bodellwyddan Centre in Clwyd and one at Islington Sixth Form Centre. In both those cases the staff from various subject areas worked together on cross-curricular projects being a resource for the students and also learning from



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each other and seeking information from elsewhere if necessary. If project work is going to be all that it is supposed to be, teachers cannot be the fount of all knowledge: secondary school teachers have to assume more often the primary school role of "lets find out together". I say "together" deliberately, because unless resource-based learning has been a carefully-taught set of skills from an early age, we just cannot expect pupils to locate and use learning resources. But in the secondary sector there seems so much more vulnerability on the part of teachers who find themselves outside their immediate area of confidence.

Researchers into curriculum change have identified the stress of change as teachers move into less-familiar territory, as Peter Toft (1989) reported in section 2.3.1 of "Managing Change in the CDT Department". It's a good thing to identify it because it can be addressed and that puts a responsibility on trainers and all others who support teachers. It gives the lie to the already-suspect "cascade" mechanism so beloved in the introduction of GCSE and implicit in the "Roadshow" system because it assumes that curriculum change is unproblematic for the teacher, who is at the receiving end but who also confronts the pupils.

I believe that there is much to be gained from a curriculum development that requires a fundamental review of the nature of and relationships between subjects. There are already outcomes such as the Suffolk scheme where interactions are acknowledged and made use of in a co-ordinated approach between science and technology. But planning and implementing such schemes at school level or even analysing existing curricular provision is costly in terms of teacher time, which seems to be the essential element of curriculum change omitted from governmental intentions.

## References

Association for Science Education (1986) Science and Technology in Society, Hatfield, A.S.E.

Association for Science Education (1987) Biotech, Hatfield, A.S.E.

Bunce, R. (1988) "Design technology through project based activities" in Harrison, M.E.

Technology in Schools: case studies in Module 4 of ET887/897 Teaching and Learning Technology in Schools, Milton Keynes, Open University Press

Deans, C. (1990) "Our Daily Bread" in Harrison, M.E. Supplementary Case Studies in Module 4 of ET887/897 Teaching and Learning Technology in Schools, Milton Keynes, Open University Press

Department of Education and Science/Welsh Office (1987) The National Curriculum 5 - 16: a consultation document. London. H.M.S.O.

McCulloch, G., Jenkins, E. and Layton, D. (1985) Technological Revolution? The Politics of School Science and Technology in England and Wales Since 1945. London. The Falmer Press.

National Curriculum Council (1989) Science Non-Statutory Guidance, York, N.C.C.

National Curriculum Council (1990) Non-Statutory Guidance > Design and Technology Capability, York, N.C.C.

Schools Council (1975) Control Technology teachers' handbook, Hodder and Stoughton Educational

Sparkes, J. (1988) "Statistics and Quality Assurance", Unit 4 of Module 3 of ET887/897 Teaching and Learning Technology in Schools, Milton Keynes, Open University Press

Toft, P. (1989) Managing Change in the CDT Department, Stoke-on-Trent, Trentham Book