Tasks in Technology: An analysis of their purposes and effects

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Introduction for the 2015 DATA Special Edition

This paper was written in 1993 and was published in *The International Journal of Technology and Design Education.* 1994 Springer 4(3): 241-256. The paper concerns the nature of the tasks that initiate and drive technological activity. It is set in the context of two research projects that we conducted in TERU; the *Assessment of Performance Unit* project in Design & Technology (1985 to 1991) and the Economic and Social Research Council project "*Understanding Technological Approaches*" (UTA) (1992-1994). The former was a large scale national survey of performance in schools - involving tests on 10,000 learners in 700 schools, and the latter is a small scale study (80 learners in 20 schools) examining in detail the processes that learners engage in as they tackle technological tasks. However, the wider context of this paper concerns the English and Welsh National Curriculum (NC) implementation programme that had been launched in 1990. It caused a huge storm both in the curriculum generally and in design & technology (d&t) in particular. In the wider curriculum the assessment arrangements surrounding the Standard Assessment Tasks had been so badly designed that in 1992 teachers and schools had boycotted the whole process. And in d&t, the 'Order' that defined what teachers should do in the classroom/studio/workshop appeared to make very different demands on teachers than had previously been the case. The Order defined d&t in four 'Attainment Targets', the first of which (AT1) was 'Identifying Needs and Opportunities'. This (at least) implied that learners themselves should be doing that 'identifying', and in 1990 that was far from common practice. At exactly this moment we undertook the ESRC: UTA project that enabled us to collect the data that would inform this issue. We followed in detail the tasks that teachers set or negotiated with learners and examined the consequences of these tasks on ' subsequent actions.

I shall focus on two aspects of tasks that are central to understanding how learners respond to them and what they learn in the process. The first of these concerns the end-user; to what extent and in what ways the concept of a client impacts on the tasks that learners pursue in schools? Whilst this client issue had recently been brought to prominence in the NC, the second issue is much more deep rooted in the traditions of design & technology teaching. It concerns the extent to which the teacher controls what goes on - setting the task and controlling events - as against the learner taking responsibility for these matters. How much autonomy do learners have in setting and running projects, and what are the consequences of these levels of autonomy?

Technology and 'clients'

Technology is a task-centred, goal-directed activity. It is a multi-faceted and somewhat amorphous activity rather than a distinct discipline[1]; quite different for example from science or philosophy which have distinct boundaries. Technology makes use of a wide range of bodies of knowledge and skill, but is not defined by them, for the raison d'etre of technology is to create purposeful change in the made world. Something did not exist before, but now - as a result of human design & development - it does exist. We have wheelbarrows, wallpaper, waistcoats and warships because someone (or group) decided (for one reason or another) that they would be good things to have. This is technology. But technology is not just about new things. I constantly try to make my latest model of wheelbarrow (or warship) better than yours. This too is technology. It is a highly focussed activity and it is intensely value laden as should be clear from the use of the word "better". I might mean cheaper, or stronger, or longer lasting, or shorter lasting, or less damaging to the environment, or more damaging. All these are perfectly proper objectives that might make my ...whatever... better than yours for the purposes I have in mind.

So technology is a very human activity and is arguably one of the major distinguishing features of humankind. As Bronowski put it....

> Among the multitude of animals which scamper, fly, burrow, and swim around us, man is the only one who is not locked into his environment. His imagination, his reason, his emotional subtlety and toughness, make it possible for him not to accept the environment but to change it. And that series of inventions, by which man from age to age has remade his environment... I call... *The Ascent of Man*.
>
> (Bronowski, 1973, p.19)

Technological activity is driven by human desires - for comfort, for power, for money, for convenience, for identity. Technology cannot be blamed or praised for anything, for in itself it is entirely neutral. Blame and praise can only be attached to those of us who identify the objectives and who do the designing and developing of new and ever 'better' things. The boundaries of technology are *not* set by

1. Peter Medway (1992) provides an illuminative analysis of the multidimensional nature of the activity.

our current practices and understandings in electronics or biochemistry or any other existing field. The boundaries are defined by our human desires. This is not to say that developments are always led by such desires, for there are many examples of manufacturers and marketing experts creating and massaging our desires. But the fact remains that any given technological outcome only exists when there is an identifiable client-based need for it. It matters not whether this need/desire is for Sidewinder missiles (very few clients but very wealthy ones - hence sufficient development and production money) or for cups and saucers (very many clients - hence a big market creating sufficient development and production money). In either case the fact remains that technology is client-driven.

What then of technology in schools? There is clearly a bit of a problem here as the people doing the technology are the learners and in the 'real' world they would be servicing the needs of their clients. But being in school means they are part of a teaching and learning programme that is controlled by the teacher. So who is in charge? Surely, either the *learner* is in charge of the activity, responding to the needs of a client, or the *teacher* is in charge, directing the learner into areas that s/he judges will be useful for the learner to experience.

It is clearly a much more complex issue to talk in terms of a client for learners' designing, and the notion was thrown into high relief by the publication in 1989 of the NC documents. Even from the very first of them in The Interim Report of the Design & Technology Working Group (DES/WO, 1988) it became clear that we were being encouraged to locate learners' project work in reality; or rather "in context". These contexts were many and various, the list in the document including the obvious ones of "home", "school", and "business & industry".

This was not in itself particularly far-reaching, for most technology teachers most of the time would expect to locate their learners' activities into some real or contextual framework. There is not only ample evidence that learner performance is far more effective when the tasks on which they are to engage are seen within a wider contextual framework (see e.g. Kimbell et al 1991), but also that learner performance can only really be understood in terms of that context (see e.g. Light & Perret-Clement, 1991). So the implied demand in NC technology for contextualised tasks was neither far-reaching nor particularly threatening for teachers. But far more significant - and infinitely more threatening - was the drafting of the 1st Attainment Target (AT); "Identifying Needs and Opportunities".

> ...learners should be able to identify and state clearly needs and opportunities for design and technological activities.
>
> (DES/WO, 1989)

Shock! Horror! Were learners really being expected to identify *their own* starting points for designing; identify *their own* client with an individual need that might be met? And if so what is the teacher supposed to do other than preside frenetically over the chaos (anarchy?) of a studio/workshop in which every learner is doing something different for their own clients? How, in this situation, would teachers ever manage to construct a teaching programme that showed any kind of progression? Surely structured teaching requires the *teacher* to be able to control the agenda; introducing certain things at certain times. If learners are busily setting *their own* agendas (in response to the imperative in AT1) - to what extent can teachers be said to be teaching?

The issue of whether or not a client is central to the activity has been supplanted by a different and more threatening issue. Who is in charge, the teacher or the learner?

Learner autonomy (learning to be self-directed)

One of the more obvious objects of schooling is to develop the ability of learners to manage themselves; to bring them to the point where they not only understand what it means to take responsibility for their actions, but moreover they have expertise in so doing. Developing learners' personal autonomy would rightly be claimed by any teacher as a central goal for education.

Some school activities lend themselves well to supporting this goal, and other less so. But it is not unusual to find school prospectuses identifying extra-curricular activities as a major area in which this goal of personal responsibility is brought home to learners and is thereby developed. The sporting ethic, the Duke of Edinburgh awards scheme, choirs and plays, neighbourhood support systems and the like all provide opportunities to underline and develop learners personal responsibility within a wider group framework. There is typically rather less emphasis on this in curricular activities - for there is simply less elbow room within which to do it.

But some curricular activities do lend themselves to it - and technology is one of them. In technology we do not need to feel entirely hamstrung (as are our science and maths colleagues) by vast lists of content to be taught, and for many years the basic mode of teaching and learning has been built around "the project". We operate in a

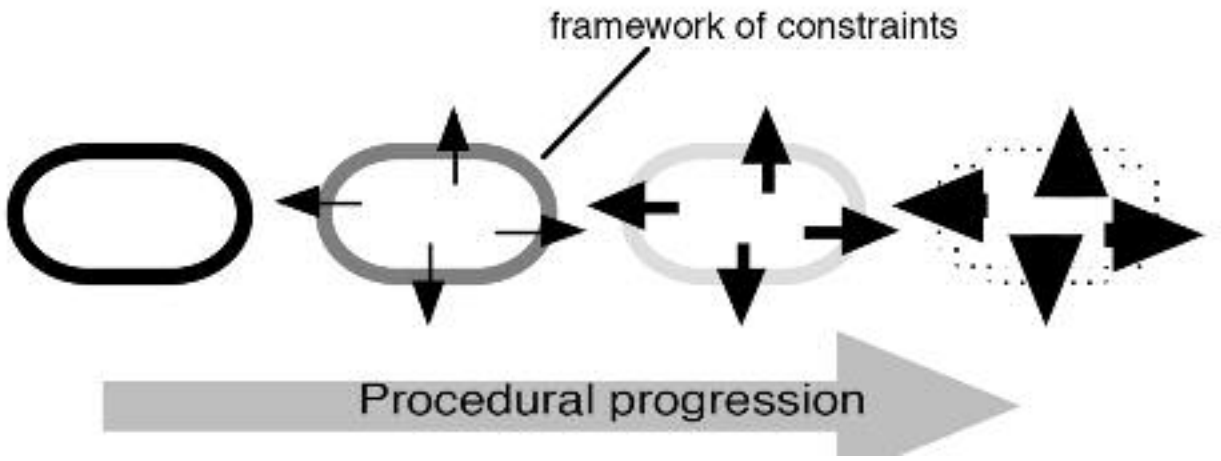

Fig 1. The teacher provides a progressively looser framework of constraints on project-work

studio-workshop environment on projects that typically run over an extended period, and this is an environment and a structure that lends itself nicely to developing autonomous decision-making by learners.

Within this environment, learners need to be introduced to the magnificent breadth of what is possible with materials, tools and a progressively more bewildering array of technologies. But at the same time, we have an ideal setting within which to develop their personal decision-making and responsibility. I have long held the view that technology teachers are almost uniquely fortunate in operating within this rich framework.

> ...the child will move in small steps from almost total dependence on the teacher to almost total independence....The function of the teacher...is to to steer children towards the goal of independent thought and action along the tortuous path of guided or supported freedom.
>
> (Kimbell, 1982, p.16)

From its earliest days in the late 1960s, when Design and/or Technology was first written about as a serious curriculum activity this feature of personal decision-making has been central.

> "Individuals are expected, as they mature, to solve problems on their own and to make decisions wisely on the basis of their own thinking. Further, this independent problem solving is regarded as one indication of the individual's adjustment. It is recognised that unless the individual can do his own problem solving he cannot maintain his integrity as an independent personality."
>
> (Schools' Council, 1975, p30)

"The project" became the standard modus operandi for teachers, and the project would enshrine a subtle balance between the things the teacher wanted to teach and the scope for learners to make decisions for themselves. For example, in a "room label" project, learners might each identify a specific room in the school and design a logo/label to describe what goes on therein. These designs might then get translated into moulds for vacuum forming and the finished plastic mouldings subsequently fixed to the various doors. The teacher would have designed the project specifically to teach the disciplines of vacuum forming, so if a learner produced a design that did not lend itself to this technique, the teacher would negotiate with the learner - manipulating it to the point at which it could be made to work as a vacuum forming.

Through this approach - allowing some freedom within a controlled framework - teachers built their whole teaching course. Introducing metal casting in this project, or electronics components in that one, dyeing fabrics here and automating a pneumatic system there. But technical content was only part of the progression in projects, for there was also an explicit and progressive pathway towards procedural autonomy. Projects would be expected gradually to place ever-greater responsibility on the learner and accordingly the teacher's framework for introducing the content would be ever looser. Early projects would be tightly constrained and would allow little deviation from the parameters set by the teacher. But gradually these constraints would become negotiable and permeable to the point where GCSE projects would be only very loosely controlled by the teacher and A level projects would be almost entirely at the discretion of the learner, involving only tutorial dialogue with the teacher.

In the hands of a good teacher, "the project" became an infinitely flexible teaching and learning tool. It built technical expertise and procedural autonomy and inevitably therefore produced some outstanding work. But in 1989, when NC AT1 ("identifying needs and opportunities") hit the classroom, this structure for project planning was thrown into confusion. The reason for this confusion lay in a deadly combination of the two issues discussed above, for the two central planks of NC AT1 were that projects would be seen to derive from real "needs and opportunities" of end-users (clients) and that the learners should be the ones to identify these needs and opportunities.

The two issues merge

The words in the Technology Order appeared to weld these two sets of issues together into a formulation that placed far more responsibility on the learner than would formerly have been expected.

- Ask questions which assist them to identify needs and opportunities for d&t activities in familiar contexts.
- Recognise in their identification of needs and opportunities for d&t activities that the likes and dislikes of users is important
- learners should develop activities which offer opportunities for open-ended research leading to the identification of their own task...

(DES/WO, 1989)

For teachers who were used to the subtle exercise of control through the restrictions they built into design tasks, this was a serious body-blow. What were they being expected to do?

Some very unfortunate activities resulted from the confusions that followed the publication of the first NC Order for d&t. Teachers inevitably drew on their only experience of learner initiated project work - which they had formerly reserved for much older learners at GCSE or even A level. They selected or created contexts in which learners were encouraged to find needs and opportunities for themselves. "The shopping centre"; "the play group"; "the high street" all became targets for hordes of youngsters on the look-out for "needs and opportunities". In some of the more extreme cases these learners ended up designing a road-crossing system, or a youth club or an advertising campaign. No-one can deny that these are genuine design tasks, with identifiable clients and valuable outcomes. But they can so easily be utterly unmanageable and inappropriate as teaching and learning experiences. Inevitably, many young learners found it very difficult to operate in such an unfocussed way and ended up getting lost in the multiple demands of such projects. The teachers felt that they had to allow it to happen - the NC Order appeared to require it - but their instincts told them it was wrong.

It is now a matter of record that things were changed. The Order was re-written (several times) and teachers were exhorted to reassert their control of task setting to focus learner activity more tightly and to worry much less about the wider contextual and client-based setting for it. Four years after the original (radical) publication of the d&t Order, we reverted to a document that would have been readily recognised had it been written six years before.

Research data illuminates the issues

In the early years of the national curriculum there was much debate about how these two issues should be reconciled into teaching and learning programmes for technology, a good deal of heat has been generated - and far too little light. And it was with this in mind that we decided that our new ESRC project "*Understanding Technological Approaches*" should deliberately collect data that would enable us to describe and explain the consequences of the current position on learner performance in the classroom.

The approach taken by the project was broadly to observe learners throughout entire projects - registering data of particular kinds for every five minute interval. Some of these projects were quite short; around 120 minutes, whilst some run for up to 1300 minutes. The projects span all four Key Stages (5-16 years) and in total we observed 80 projects in 20 schools. The data we collected informed a whole range of performance related issues, including *engagement with the task* (speed and intensity of work), *interaction* (with teachers and amongst learners), *direction of work* (what priorities are followed), learner *intentions* (that steer their work), and the *manifestations* of these intentions in terms of studio/workshop behaviour. Given this breadth and detail of data, and given that it was collected every five minutes throughout the projects, this represented an enormous database of 'real-time' learner performance on tasks in schools. And sections of these data illuminate directly the two issues that I have outlined above;

- concerning the 'ownership' of the task in terms of who (teacher or learner) is in control
- concerning the wider world of clients or users and their 'needs'.

Data to inform the locus of control

Among the many observations built into the observer schedule is one that registered the points at which the teacher is *directing* the learner to do something in

particular or is *supporting* the learner when they are trying to do something of their own choosing. This provided us with a crude but simple way of representing the axis of control in a project. It is important to remember that we were making no judgments about the value or wisdom of this direction or support - we merely note that it is happening.

Theoretically, the teacher might be directing or supporting in 100% of the 5 minute time slots but in reality this never happens. The following twelve project examples are taken directly from the data and show two things. First they demonstrate how the balance of direction and support indicates who is driving the project (project 2 for example having 4 times as much direction as support). But also the data provides a measure of the 'lightness of touch' of the teacher. Some projects (e.g. no 3) show the learner receiving either direction or support from the teacher in about 50% of the 5 minute slots throughout the project. Others (e.g. in project 7) show the total amounting to only 20%. In this case the teacher is allowing the learner to get along on his/her own for much longer periods.

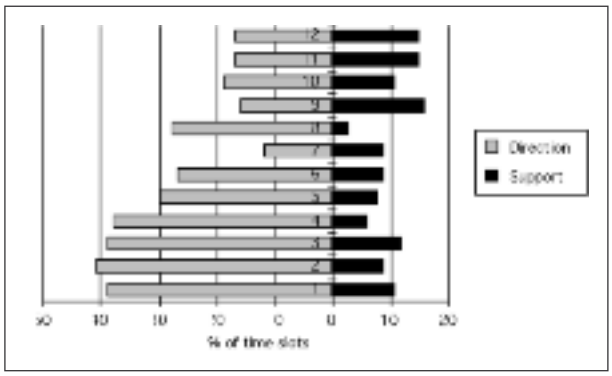

Fig 2. Percentage of project time when teachers are 'directing' or 'supporting' learners

Even this however is a serious oversimplification of the position, for in reality the balance of direction and support is not constant through a project. If the data is plotted against time we can see how this balance varies through a project. For this purpose we have divided the projects into 5 phases, each representing 20% of the time of the project. The following chart shows this balance in a single project but spread over the five phases of activity.

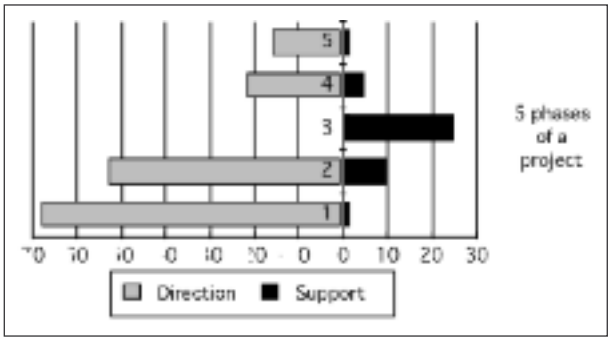

Fig 3. Percentage of 'direction' and 'support' through the phases of a project

In the first phase of the project there was a very high level of direction - with minimal individual support, but gradually as the project gets up-and-running the teacher backs off and in phase 3 spends all her energy supporting individually. The end of the project then reveals further steering by the teacher. The average figures over the life of this project are 30% direction and 8% support (it is project No 5 in the chart in Fig 2).

A quite different pattern emerges from another school (project 9 in the chart in Fig 2). Here the teacher spends as much time supporting the individual as in directing activities - even at the outset of the project. Interestingly, the greatest amount of direction arises in the heart of the project where most of the making will be going on, suggesting a degree of technical instruction of skills/procedures.

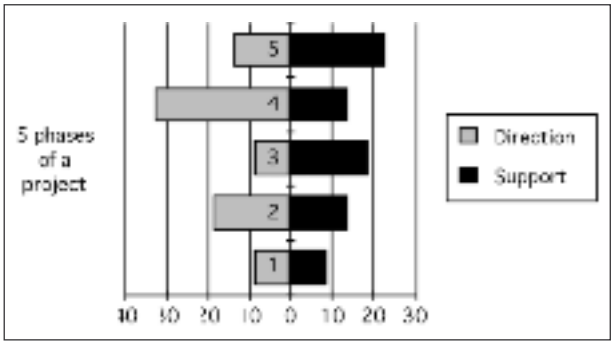

Fig 4. A teacher with 'light touch'

The average figures for this project are very different; 17% direction and 16% support. This not only reflects a more even balance of direction and support, but also indicates a "hands-off" approach by the teacher with the learner working independently (without either direction or support) for significant chunks of time.

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It is one thing to describe these effects, and quite another to interpret them and we combined the data to see - for example - whether the differences of approach are associated with differences of outcome in the assessment and evaluation data. It is interesting to note for example that project 5 (30% direction and 8% support) is a secondary school project whereas project 9 (17% direction and 16% support) is a primary school project. Indeed we have been struck by the consistency of this trend in the data. When we plot these data from the whole data-set and organise it according to years (y1- y10) a fascinating picture emerges. We find individual 'support' outweighing 'direction' in primary schools, and the reverse in secondary schools. Moreover the transition between y6 and y7, as learners move from primary to secondary schools, is particularly stark.

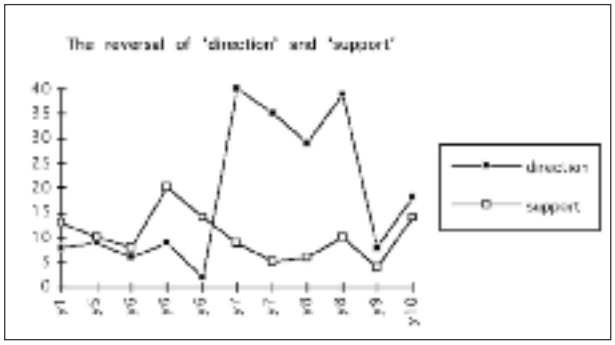

Fig 5. 'Direction' and 'support' data by year group reveals sharp discontinuity between y6 and y7

In y6, it appears to be the norm for teachers to spend much more of their time supporting individually than instructing or directing. In this setting, learners appear accustomed to taking significant responsibility for managing their work, using the teacher to advise and support when problems arise or advice is needed. In y7 the contrast could hardly be greater, with between 30% & 40% of the five-minute slots registering an instruction or direction, either to the individual or to the class as a whole. This is a totally different way of working, and one that must come as something of a shock to learners used to a very different approach to teaching and learning.

In terms of the growth towards personal autonomy, this y6-y7 boundary appears to represent a major step backwards. From a condition of relative independence and responsibility in y6, the learners have reverted to a frightening level of dependency on the teacher. They wait to be told what to do - even when they know perfectly well (and are prepared to tell you) what they might sensibly do next. They seldom do it, preferring to join a queue of other similarly timid souls waiting to ask teacher what they ought to do.

One thing that emerges very clearly from these data, is the extent to which technology projects in y7-y9 in our sample of secondary schools are heavily teacher directed. The HMI report on the first year (1990-91) of implementation of the NC (DES, 1992) criticised the work in y7-y9 in "some schools" where "...learners often spent much unproductive time trying to identify needs". Our project has been observing projects since 1992 and we have seen no evidence of this. Indeed we have observed quite the reverse - and the data outlined above suggests that y7-y9 teachers currently see their role in very different terms to that implied by the HMI criticisms of 1990-91.

Data to inform the role of the user/client

What then of the other major issue outlined above - concerning the role of the outside world and the "client" or "user". As we saw earlier, there is a good prima facie case for suggesting that in order for us even to call the activity "technological", the user's role must be clear. If there is no purpose to a project beyond teaching a skill or internalising a piece of knowledge, then the activity would more appropriately be called craft or science or history (depending upon what kind of knowledge/skill is involved). If learners are genuinely to be designing and making in technological terms, then they are design and making *something for somebody* - even if it is only for themselves or their mum. The user therefore ought presumably to make a significant contribution to the exercise.

In order to explore this dimension through our data, we used a measure that distinguishes between times when the learner is dealing with *user/task* issues, and when they are dealing with *manufacturing* issues. "User issues" would be registered when the learner is considering e.g. *how* big it should be or what shape it might be for people to hold it comfortably (whatever 'it' is). "Manufacturing issues" would be logged when the learner was working out how to manufacture it - or actually doing the manufacturing. We would therefore expect manufacturing issues to outweigh user issues if only because a considerable amount of time on a project is typically spent in 'making'. But in terms of the user/client issue, this approach allows us not only to quantify the extent to which learners are dealing with it - but more interestingly it allowed us to register how this concern changed through the life of a project.

The data shown below are from 47 projects in 11 schools and two matching trends are clear when they are plotted against year groups. Concern with manufacturing issues rises to a peak in y6,y7 and y8, and falls back towards y10. By contrast the 'user' data starts high in y5, drops to a low in y7 and rises back to y10.

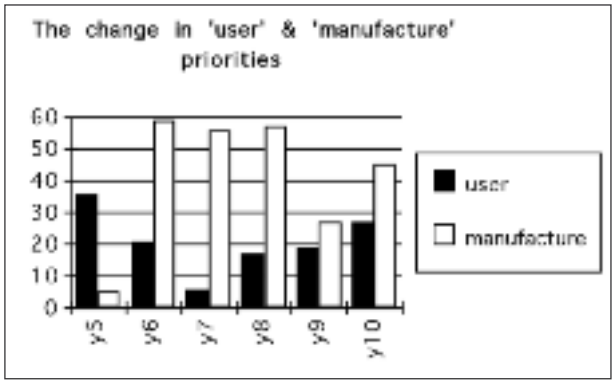

Fig 6. Learners designing for 'users' and for 'manufacture' y5-y10

A somewhat clearer picture emerges if we merge the data within year groups, and the trend in the "user" figures is very clear whilst that for "manufacture" is somewhat less so. In y7 projects in particular there is scant regard to any user and in y6, y7,and y8, there is a dominant concern with manufacturing issues. A more balanced picture then re-emerges in y9 and y10.

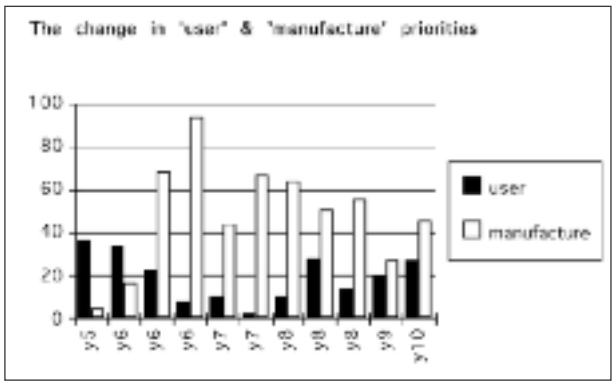

Fig 7. The dominance of 'manufacturing' issues in y 6/7/8, and especially y7

However these are average figures for year groups, and - as before - when these averages are spread across the five phases in the life of single projects we see a very interesting pattern. We can observe for instance the reconciliation of the user/manufacturer balance in the following two patterns taken from a project in y7 and a project y10 respectively.

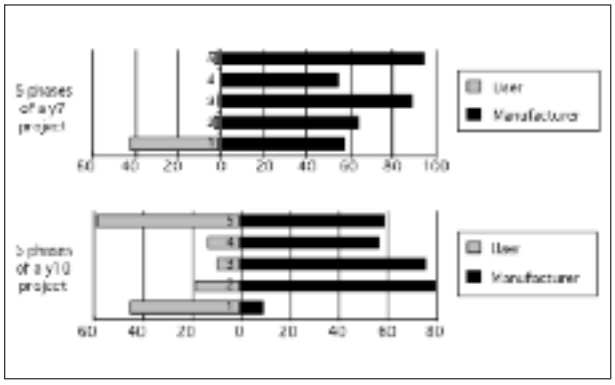

Fig 8. User/Manufacturing data across the 5 phases of the projects

The y10 pattern of 'user' concern is as one might conventionally expect. It is high at the outset of the project (phase 1) when the task is being clarified and detailed, and towards the end of the project (phase 5) when the performance of the product is being evaluated. In between these peaks, manufacturing issues dominate the learner's activity. But the y7 project however reveals a quite different pattern. At the outset (phase 1) there is significant user concern - but this disappears almost totally thereafter, with manufacturing concerns completely swamping all else. These data suggest that whilst the y7 learner did not see the user as significant or relevant to their activity, the y10 learner was significantly influenced by this factor.

Conclusions from the data as a whole, and clues for the future

Taken as a whole, these data suggest that technology projects are seen as very different things in the four key stages from age 5-16. When we combine the observation data outlined above with the more discursive and interpretive data derived from conversations with teachers and learners, the different characters of technology across the Key Stages begins to emerge.

Cultural technology ..."its all around you and always has been" , is characteristic of projects for 5-7 year old learners. Projects tend to be topic-centred across the whole curriculum (e.g. the Saxons) and technological activity derives from within the topic, involving Saxon forts or transport systems.

Problem-solving technology ..."try it for yourself - can you make it work", is more commonly associated with 8-11 year olds. Projects often have a fixed starting point – e.g. a wood strip vehicle chasis - and the challenge is to make it travel as far/fast as possible. It is common here for projects to amalgamate technology with investigations under the auspices of science.

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Disciplinary technology ..."you need to know about this", emerges sharply at the start of secondary school (12-14 year olds). Projects are contrived specifically to include a small range of skills/knowledge from the (still largely separate) disciplines on the timetable. Pendants (to teach metal fabrication & enamelling), alarms (to teach simple circuits and sensors), snack-bars (to teach ingredient mixes and processing).

Simulated technology ..."this is how real designers work", progressively emerges with 14-16 year olds. There is a move towards individual projects - identified by the learners themselves and therefore generally having some reality. Within these projects learners are expected to be rigorous in the application of an abstracted designerly process and the development of a portfolio that reflects it.

These contrasted models of how technology should be pursued explain why "users" are largely seen as irrelevant to 12 year old learners at the start of secondary school. It is difficult to take a personalised user too seriously when the whole point and focus of the activity is an instructional one common to all learners in the group. The situation is very different from 5-7 year olds work where the whole experience (e.g. of the Saxons) leads to some awareness of them as living in (and hence users of) castles or wagons. Similarly, with14-16 year olds - where the user re-emerges as significant - it is not infrequently the genuine needs of the user (e.g. best mate/grand-parent) that prompts the project. The four different models of technology also explain the contrasted pedagogies, with top juniors frequently trying to work things out and investigate things for themselves and new entrants to the secondary school learning to do (largely) as they are told.

Given these contrasted models of what technology is about, we should not be surprised that there is no universal interpretation of what a technological task is like. Tasks evolve to fit the picture that teachers have in their heads of what technology is. We can sensibly talk about a 5-7 year old task or a 12-14 year old task - but there is very little common ground between them that allows us to speak about technological tasks *in general*.

That is what we found from the data in the UTA study. The big issue of course is that having *observed and described* this progression of models of technological endeavour, it does not follow that they ought to exist. As the philosopher G E Moore (1903) first observed, you cannot argue from "what is" to "what ought to be". It does not follow that because these trends do exist - it is right that they *should* exist. They may well be completely wrong-headed.

The fact is that in 1993 technology as a curriculum activity from 5-16 was so new and so undeveloped that it would be little short of astonishing if classroom practice was anything approaching coherent across the years of schooling, especially given the very contrasted cultural practices of primary and secondary schools. The national curriculum acted as a provocation to get technology started in many primary schools and even in secondary schools it was a baby in the curriculum. The mid 1960s would be a generous estimate of its date of origin. The levels described in the national curriculum d&t 'Order' sought to lay out a progressive pathway towards capability throughout the compulsory years of schooling, but the pathway was derived not from painstaking observation of what is going on in classrooms so much as from an abstract rationalisation of what *ought* to be going on.

The abstract rationalisation was important, and so too was the detailed observation and analysis of what is currently going on – as exemplified in our UTA project. It is necessary to bring them together and raise the level of debate about what technology *ought* to be like as a whole. Should there be such different models of technology across the age groups? Should we not plan learning activities for one year group with rather more understanding of the qualities that lead up to it in earlier years and flow from it into subsequent ones?

Resolving this matter will of course require teachers to come together and learn to talk - in a common language - about capability in technology. Such a dialogue would allow the profession to develop a securely rooted model of progression towards this capability. Given this wider perspective, we could then profitably debate what tasks should be like and what demands they should make on learners.

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