The nature of learning and progression in Design and Technology

E W L Norman and P H Roberts
Department of Design and Technology, Loughborough University of Technology

Abstract
The National Curriculum (NC) model of design and technological capability is intended to become the institutionalised model. As the first cohort reaches Key Stage 4 GCSE syllabuses will be altered to fall into line and no doubt the reform of A and AS levels will be expected to follow, but how well-founded is the basis for all this reform?

This paper seeks to offer the basis for discussion of the well-foundedness of National Curriculum Technology in a number of ways:

* *by considering the apparent model of design and technological capability that is at its centre*
* *by questioning its fundamental ideology*
* *by discussing its documentation*
* *by reflecting on other models of design and technology.*

The discussions concerning changes to GCSEs and educational provision for the 16-19 age range are vital in determining future design and technological capability, and it should not be taken for granted that the existing model of NC design and technology will prevail.

The introduction of National Curriculum (NC) Technology has resulted in detailed statements of attainment and programmes of study covering the 5-16 age range. It is not obvious that these adequately define the meaning of design and technological capability and the nature of progression, but nevertheless they are rapidly becoming institutionalised. As the first cohort reaches Key Stage 4 GCSE syllabuses will be altered to fall into line and no doubt the reform of A and AS levels will be expected to follow, but how well-founded is the basis for all this reform?

This paper seeks to consider the well-foundedness of National Curriculum Technology in a number of ways:

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* by questioning its fundamental ideology
* by discussing its documentation
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The discussions concerning the shape of GCSEs in the future, revisions to A and AS level design and technology syllabuses and the introduction of courses with a strong vocational element are all vital in determining the nature of the technological education of the next generation, and it should not be taken as a foregone conclusion that the existing model of NC design and technology will prevail. The NC Technology Working Group achieved a great deal against a background of tight organisational and time constraints, and its work can be seen as one of the landmarks in the evolution of design education - it did not however produce ‘tablets of stone’, nor did it intend to. It is essential that their work be reviewed and developed.

The NC model of design and technological capability

The NC version of achieving design and technological capability is represented in the five attainment targets:

AT 1	Identifying needs and opportunities
AT 2	Generating a design
AT 3	Planning and making
AT 4	Evaluating
AT 5	IT capability

The first four ATs are intended to reflect an approach to the assessment of design and technological performance based, presumably, on the nature of the activity. The model draws attention, for assessment purposes, to theoretically distinguishable aspects (or ‘stages’) of the activity-in-progress. It is nevertheless not - and, even less, therefore - descriptive of how the activity unfolds. An essential issue here is to do with the extent to which a model derived from assessment needs may get in the way of developing capability. Evidence from the field suggests, ‘considerably’. The point -

frequently unrecognised - is that the NC model as represented in the ATs is, indeed, a model. That is, first, it is particular and singular, even though offered as a generalisation; and second, the model indicates something of a possible manifestation of designing, but it is not a good description either of the nature of activity or of how it may, in other ways, legitimately occur. A fundamental weakness of the NC model is that it has the effect of saying that pupils are not engaging in Design and Technological activity unless they go through, and demonstrate, its stipulative and theoretic 'stages'. The point has been made many times: the model is not intended to represent design and technological activity as being necessarily linear in its occurring. That point is perhaps by now well taken; the essential criticism of the NC model is that it is singular; it is misleading because it is an inadequate depiction of the complexity of designing (which does not mean that a better model would be complex); and it is based on the necessity of producing things as an outcome (in order to count as design and technology) whereas effective design does not, in fact, entail the production of things but, rather, the achieving of a resolved state of affairs. In short, the model and the NC documentation fail to make clear that the model is a theoretic model: there is no distinction between a model on the one hand and the phenomena to which it refers on the other. Second, its usage for assessment purposes leads to attempts - doomed to predictable failure - to use it as a teaching model: it is sufficient neither as a teaching nor a learning model. And third, it is inadequate because, in spite of superficial appearance, it fails to represent either the low level of specificity or the high level of generality.

Some matters of ideology

Contexts and progression

The Working Group appears to have strongly believed that progression in design and technology could be related to moving from a familiar to an unfamiliar context. For instance, in the Working Group's report it states;

'Specifying levels of attainment is far from being a simple matter of expanding knowledge and skills incrementally. In some instances, levels are increased by extending the range of performance, such as working with a broader range of resources or working in unfamiliar contexts'.[1]

At first glance it seems reasonable, but it is not an obviously defensible generalisation. Can a musician progress by learning to play a scale on a piano and then moving to 'unfamiliar' instruments like the violin or the piano and learning to play the same scale again? It is a kind of progress but not what is normally meant by progression. This is a vital issue because it has great implications for both student learning and the school's organisation of teaching. If you required a musician regularly to change instruments there can be little doubt that you would severely hamper his or her chances of achieving high standards. Might we be doing this to young designers? If you allow musicians to play the same instrument but change the musical style at intervals it seems a little less damaging - say from classical to jazz then to blues or folk - but there still remain some fundamental issues concerning the timing of such changes in relation to the development of technique.

Some schools seem to have interpreted the NC model of design and technology as requiring students to spend equal amounts of time in a variety of subject areas. There may be grounds for this e.g. avoiding gender bias or the effective use of existing resources, but it may have little to do with progression in design and technology. Before the Working Group's Report it was often argued that design and technology could be taught by simply repeating the same project in greater depth as the students' capability increased. You might not choose to for all sorts of reasons, but the possibility was acknowledged.

Making methods explicit

Also in the Working Group's report it states:

'Another feature of progression is the ability to reflect upon practice and from this make explicit the concepts, procedures and strategies involved so that these can be carried over and applied consciously to new design and technological situations'.[2]

Again this seems reasonable initially, but what exactly is being claimed? The suggestion seems to be that the explicit statement of the methods employed is evidence of increasing design and technological capability, and moreover that this explicit expression makes them transferable. These ideas are worrying in that they have echoes of the academic respectability of criticism rather than capability. Do poets (or chess players) write better poetry (or play better chess) because they may be able to make explicit the concepts, procedures and strategies involved? There may be a relationship of some kind, but a causal one seems optimistic. Many creative people may actually argue that such an approach is stifling, but it would seem to be embedded in NC design and technology. It is by no means clear how the human mind handles complexity. Creative 'leaps' in design (or chess) have much to do with pattern recognition or making unexpected connections rather than following particular procedures; and the ability to make explicit the underlying principles of action is not a necessary marker of progression with regard to capability.

Perhaps the essential feature of the claim lies in the idea that making the concepts, procedures and strategies involved explicit means that they 'can be carried over and applied consciously' to new situations. This seems defensible in relation to the 'transfer' of a scientific concept like the conservation of energy, but much less so when applied to design procedures and strategies.

Some issues from the documentation

The programmes of study are the matters, skills and processes which are required to be taught during each key stage. As such they define what is to be covered and are of crucial importance. Table 1 shows items from the programmes of study related to the design of mechanisms. There is a fundamental problem associated with using ten 'levels' to define progression. Having got so far as improving the efficiency of a mechanism by the end of KS3, what is there left to say? At KS4 pupils must maximise the efficiency of a mechanism and use minimum quantities of materials and components. These are clearly wholly inappropriate words and imply a level of analysis beyond school students. These are tasks which university students might attempt. This might not matter so much if teachers were not legally required to teach their pupils how to do these things. It is hardly surprising that no examples were given.

The problem really lies with the approach. If you have got to write ten levels and you try to use language indicating progression in a number of streams of knowledge or skills, then you are bound to run into difficulties. Progression actually lies in the number of factors you are trying to deal with at once - the complexity of the process of synthesis - not in the degree of difficulty of any individual factor. Bronowski stated this very elegantly in The Ascent of Man:

'Man is distinguished from other animals by his imaginative gifts. He makes plans, inventions, new discoveries, by putting different talents together; and his discoveries become more subtle and penetrating, as he learns to combine his talents in more complex and intimate ways.' [4]

It is this process that the statements of attainment and programmes of study should reflect; and the ten levels (sic) should be reviewed - partly because our theoretic understanding of design and technological capability is inadequate to sustain them and partly because they appear to represent - but cannot - an interval scale.

Other models of design and technological activity in general education

Clearly there are many other models of design and technological activity which could be discussed, but one obvious choice is that used at A-level (though this is not necessarily to suggest it is the best exemplar).

Advanced level

In 1986 an Inter-Board Working Party was set up to develop a response to a CNAA initiative 'A'-Level Design and Technology - The Identification of a Core Syllabus'. This group must also have faced great difficulties because of the wide range of design traditions represented by the different A-level syllabuses available at that time. This group identified the aims of the core as follows:

'Design and Technology' offers the opportunity for exposure to the processes involved in beneficially harnessing the resources of people and the earth they inhabit, through the creation of appropriate artefacts and/or systems.

A course based on the Design and Technology core will:

(i) enable students to participate in the process of designing and, whilst doing so, exercise responsibility towards identifying and meeting needs in the made world;

(ii) provide the opportunity for students to exercise initiative, imagination and resourcefulness, to acquire interdisciplinary skills and knowledge in the pursuit of designs;

(iii) encourage students to develop critical awareness of the made world, and learn how they can be constructively involved in influencing it.' [5]

These can be directly compared with the approach that the NC Design and Technology Working Group took as summarised at the start of their report of June 1989 [6]

'... we have aimed to ensure that they provide the means by which pupils develop the ability:

* to intervene purposefully to bring about and control change;

* to speculate on possibilities for modified or new artefacts, systems and environments;

* to model what is required in the mind, symbolically, graphically and in 3-dimensional form;

* to plan effective ways of proceeding and to organise appropriate resources;

* to achieve outcomes of good quality which have been well appraised at each stage of their development;

* to appraise artefacts, systems and environments created by others;

* to understand the significance of design and technology to the economy and to the quality of life.'

It can be seen that the NC model of design and technological activity makes the useful addition of environments but otherwise adds very little. If anything the list offered by the Working Party lacks the eloquence of 'provide the opportunity for students to exercise initiative, imagination and resourcefulness, to acquire interdisciplinary skills and knowledge in the pursuit of designs.' However, it is in the treatment of resources for design and technological activity that the models significantly differ. The Working Group summarised their approach as

'* the description in programmes of study of a core of knowledge, skills and values as resources to be used in design and technological activity.' [7]

The A-level model defines resources for design and technological activity in terms of technological understanding, aesthetic awareness and constraints. The syllabuses offered by different boards define these resources in different ways and to varying extents and thereby gain some of their distinctive characteristics. The definition of these resources is important as it is through them that practice and practitioners in different areas of design are often distinguished. An understanding of materials and graphic modelling might be associated with 3D product design, an understanding of circuit theory and mathematical modelling might be associated with electronic design, an understanding of flow charts and programming techniques might be associated with software design etc. One of the weaknesses of the NC model is the attempt to even-handedly define specific resource areas to be taught. Consider the following extracts from the JMB A-level syllabus notes -

The aim of the syllabus is to enable centres to provide a course, suitable for both sexes, which permits a broad and balanced approach to design and technology with special attention to 'hands on' experience across a range of design and technological activities. Such a course should encourage innovation, take account of the varied interests of students and enable students to learn about design in a design-make-test-evaluate context. As well as acquiring knowledge of the design methods, experience of techniques and awareness of technological concepts, the students should develop a sound understanding of safety as an integral part of all design/technological activity. They should also develop an awareness of the social implications of design and technology, perceptual sensitivity, aesthetic judgement and the ability to design functionally for a variety of situations.......

It is not intended that this syllabus be taught in a content-based, theoretical manner but it is expected that candidates will, in their course, have experienced a series of practical activities and problems supported by a selective study of related subject material......

It is stressed that courses should be process-orientated , providing a framework in which candidates can exploit local opportunities and resources and thereby experience a varied programme of design and technological activities. Ultimately courses should be concerned with the ability of the candidate to conceive and follow through a design/technological project to a successful conclusion.' [8]

The programmes of study within NC design and technology reflect traditional subject-based interests in the school curriculum; the introduction of NC Technology could have been the opportunity for a review of the subject-based conception of the curriculum, or, at least, consideration of subject relationships. Teachers already have the resources of the whole 5-16 school curriculum to draw on when teaching design. As at A-level a balance between prescribed work and local decision-making should prove the most effective approach.

A-levels syllabuses have often dealt with the issue of resources through modular approaches - examples are the syllabuses offered by the Cambridge and London boards - and this approach is being developed and extended through the Wessex project. This is concerned with allowing for continuity and progression by extending the wide range of pre 16+ experiences and developing the whole design continuum. Table 2 shows the modules which have already been developed. Such a modular approach may well be one of the routes for the future, both pre- and post-16.

Conclusions

The Working Group presented a view of design and technology which, in the words of Lady Parkes,

'.... is intended to be challenging and new. The aim of our proposals for design and technology is to prepare pupils to meet the needs of the 21st Century: to stimulate originality, enterprise, practical capability in designing and making and the adaptability needed to cope with a rapidly changing society.' [9]

The vision has been rather lost in trying to sustain all traditional interests and impose a coherent overall framework. The entirely appropriate objectives of minimum entitlement are in danger of preventing the celebration of justifiable and wholesome differences.

References

1 *National Curriculum Design and Technology Working Group: Interim Report.* DES/Welsh Office (1988), p.9. HMSO.
2. ibid, p.9.
3. *Technology in the National Curriculum*, DES and Welsh Office (1990)
4 Bronowski, J *The ascent of man.* British Broadcasting Corporation (1973), p.20.
5. Notes on Common Core supplied by Tom McLean, University of London Examination Board, exact source unknown.
6. *Design and Technology for ages 5 to 16*, DES and Welsh Office (1989), p.1.
7. ibid, p.1.
8. *Design and Technology (Advanced),* Joint Matriculation Board, 1993.
9. *Design and Technology for ages 5 to 16*, DES and Welsh Office, (1989), p.vii.

Table 1 Items selected from the programmes of study related to mechanisms (3)

Developing and using artefacts, systems and environments

Pupils should be taught to:

		Examples
(KS1)	* know that a system is made of related parts which are combined for a purpose	a bicycle; a house
	* identify the jobs done by parts of a system	a bicycle chain; a kitchen
and for level 1		
	* recognise that materials can be linked in various ways to make or allow movement	puppets, mobiles, pop-up books, hinges and zips
(KS2)	* use mechanisms to change one type of motion into another	gears, pulleys, cams, levers
(KS3)	* select and use mechanisms to bring about changes and control movement	mechanisms such as linkages and gearing; changes such as directions of motion or speed

and for level 7	Examples
* recognise how the efficiency of a mechanism can be improved when designing a product	designing a buggy, study the effects of the design and the use of different materials on the distance the buggy travels
(KS4) * maximise the efficiency of a mechanism	
and for level 9	
* design and make efficient mechanisms using the minimum quantities of materials and components	

Table 2 Modules currently available in the Wessex project modular A-level

Structures - a means of support

Appropriate technology

Marketing a product - how is it sold?

The designer

Systems of communication

Product design and modelling

Materials - fitness for purpose

Textile technology

Systems of control in industry, commerce and community

(Students take four of these modules)