The future for Advanced level

Royal College of Art Schools Technology Project Team:

David Perry
Director

Louise T Davies
Deputy Director

Anthony R Booth and Jim Sage
Assistant Directors

Abstract
There is an increasingly diverse group of students opting for at Advanced level work in design and technology and GNVQ Manufacturing. Broadening the range of students means, in particular, that more academically successful ones are joining manufacturing and design and technology courses, increasing the demand on teachers for versatility. This article begins by considering how to offer appropriate courses for academically successful students, and the teaching and learning styles to which such students respond.

The article then continues by exploring the nature of the subject at post-16, including characteristics of work at Advanced level for the whole ability range and how this significantly extends the level achieved at Key Stage 4 by increasing autonomy and decision making, offering a higher level of designing and manufacturing skills, working with and for clients, taking account of a wider range of issues, and making use of a much wider range of support, including student mentor partnerships. The article also discusses the range of the learning activities including focused tasks, research tasks, product evaluations, design tasks, design and make assignments, manufacturing assignments, lectures and demonstrations, visits, working in another location, tutorials and seminars, and simulation activities.

Catering for more 'academic' students

For many years debates about change in the post-16 curriculum have emphasised the need for all students to have a broader education in the 16-19 period. The need for courses to cater for varied learning and assessment styles has been recognised with the advent of the GNVQ, and proposals for Baccalaureate style credit accumulation schemes. Changes in levels of participation and the broadening of the range of subjects studied combine to increase the number and range of students involved in manufacturing, design and technology courses. There has been clear evidence in many schools that, especially if Intermediate GNVQ courses are not provided, GCE A and A/S level classes have housed students who do not learn effectively in that context. Typically, fairly average achievers have dominated and they may or may not have found GCE A level courses suitable. Broadening the range of students means, in particular, that more academically successful ones are joining manufacturing, design and technology courses, increasing the demand on teachers for versatility.

The Dearing review of the National Curriculum identified a "very large number of students whose interests and talents lie primarily in academic study". Traditionally, post-16, this would mean those who follow a sixth form education, those in grammar schools, those taking A-levels, going on to university. Many teachers' definitions of 'academic' would preclude design and technology – they would not see it as an academic 'subject'. In practice, the antecedent subjects to design and technology (CDT, Home Economics etc.) usually had very small A-level groups which were, in A-level terms, a skewed cohort. That is, they were often not clearly suited to A-level learning approaches, or A-level learning approaches were not suited to them. A few departments captured a small number of strong A-level students (i.e. those following a three or four A-level course, tracked for a university place in a mainstream subject). Rarely, though, were these the highest flyers.

The history of the design and technology area of the curriculum does not suggest that 'high flyers' will come forward in large numbers for Advanced courses of any type. However, there is increasing support from influential people for a more balanced valuing of what different subjects have to offer, and for the most educated elite from our schools to have a better understanding of the world of commerce and industry even though they may be destined for careers in law, medicine, the civil or diplomatic services. This latter group will include many of the major decision takers in our future society. For that reason alone, those committed to the place of manufacturing, design and technology in education will want them to continue to be involved in their post-16 education.

There have been some interesting studies which have attempted to redefine popular concepts of intelligence and broaden the

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range of characteristics regarded as evidence. Anyone who has attended seminars at Oxford and the Royal College of Art will have been able to identify some similarities and some differences. Probably the differences are less marked the higher up the spectrum of ability you go. High levels of intense concentration, a relentless pursuit of ideas through to an acceptable conclusion, long term diligent commitment to a project once it captures their imagination, a combative enjoyment in taking a position, and a ruthless determination to destroy insubstantial work of any sort are characteristics to be found in able students in any context. But this risks stereotyping, and we must remember others such as those whom children now call 'nerds', introvertedly intense in (usually) concentration on a problem of high particularity; or the blazing extrovert with little apparent commitment to study, who then reveals masterly ability at a stroke; and yet others.

What any of these might react against in an academic approach to design and technology is a teacher who lacks depth of understanding, or high levels of competence in the subject, or a broad awareness of contemporary issues. They may resent more than others any association with the second rate (lessons in a 19th century factory-like workshop, a fussy over-concern with trivial details obstructing a grand vision), any over-regulation that lacks intellectual justification (the examiner expects you to do it this way...), or any form of organisation or regulation that gets in the way of their progress.

What then, in manufacturing, design and technology should be stressed for the academically successful? There are implications in much of the above which might guide us in serving the needs of these students. Our teaching and learning approaches need to be flexible and responsive, allowing the pursuit of long term and very personal objectives. Unwavering commitment to a project in hand may have to be tolerated, at the expense of not working systematically through the syllabus. Perhaps intense specialisation to a very narrow area may support more general understanding of the subject, and not deny it as we would normally expect.

The relationship between teacher and taught has to be defined on a very equal basis. This remains a threat to those who are insecure in their authority, though no problem to those teachers who are really committed to design-based approaches to learning. Indeed, the latter group know that design-based learning requires such a relationship.

The subject matter must be challenging and be treated in a demanding way. Boundaries also need to be broken. Neither the knowledge base, nor the resources available can be confined to those conveniently available in the classroom or even the school. Bright ideas must be followed through with the least possible obstruction. The thrill of entrepreneurship must be given reign such that the students are pursuing what they need wherever they may find it.

Is this especially for the 'academic'? Those familiar with the development of design and technology in British schools will recognise the pre-conditions for successful work in the above, that do not only apply to the 'academic'. However, the contention here is that the needs of academic high achievers strengthen the requirements set out.

Manufacturing, design and technology courses are mostly very individualised in their approach, and by nature they require a very diverse range of learning styles including the analysis and written expression that are at the heart of the humanities, the logic and numerical ratification from the sciences, as well as designing, making and evaluating. Differentiation through varied emphases must therefore result from individual projects, each with their own particular requirements. A poster design does not require the same disciplines as typography any more than a food product requires the same knowledge base as control technology.

Some facets of design and technology, though, demand different treatment for these students. If we are to exploit the characteristically argumentative tendency they have, then time and space must be given to it. Every teacher knows that many students do not respond well to higher-education-like seminar discussions of issues. Yet others thrive on it and they should be accommodated. Similarly, intense interest in the technical, social or environmental issues, visual acuity and understanding of the material culture, are all possibilities for an academic approach that suits some students better than others.

How might this be done? The picture painted here makes demands on the teachers and also on the nature of syllabuses, the school timetable and the working practices in the classroom, studio and workshop. Most particularly, schools do not usually have the student numbers or the flexibility to run alternative courses side-by-side in the manufacturing, design and technology area. Answers therefore must lie in a single or very small number of syllabuses so staffing economies may be obtained through larger class sizes, in flexible assessment schemes to reward different individualised responses and differentiation in teaching styles. Schools and colleges might then be able to secure some separate time for different groups though this is demanding on staffing. There are many common elements in Advanced courses such as Art & Design, Home Economics, Manufacturing, Design and Technology, Health and Social Care, Engineering, and Business Studies. Schools and colleges offering more than one of these can achieve economies in staffing by combining large groups for some elements and selecting which aspects to maintain small, separate groups for.

The doing of design and technology, i.e. the students experiencing the processes of evaluating designing and making, is the very stuff of the subject. Without this first hand, practical, 'hands-on' experience one cannot be said to be studying design and technology. However, with this comes a body of knowledge and understanding that enriches and informs these core activities, some of which falls under these headings:

- analysing products and their applications
- product semantics
- design history
- the history of technology
- the impacts of technology on society and the environment
- the nature of designing
- manufacturing methods.

A wider range of teaching styles than is usually experienced in manufacturing, design and technology is beneficial. 'Academic' students are capable of adopting some higher education methods such as an individual preparing for and leading a seminar discussion, or planning and presenting a new subject or concept, with support in the form of tutorial guidance.

Here is an example in the manufacturing field:

The tutor introduces the four categories of manufacturing to all students.

Students in pairs research one category, prepare and give graphic presentations to the rest of the group – tutor has one advisory session with each pair.

Project activity (later?) focuses on design for volume production. The group designs the product, the necessary production system and aids (jigs and fixtures), and part of the group manufactures a batch.

The tutor conducts a seminar focusing on the impacts of high volume production on society, the other part of the group are set an essay assignment as follow-up.

This sort of integration and yet differentiation of different learning styles will need to be explored further, both in the final key stage of the National Curriculum and post-16.

In taking this academic approach into the 16-19 age range, a wider range of teaching styles will also need to be developed. Help for this is widely available and at hand, of course. Colleagues teaching traditional A levels will be practised in techniques such as neutral chairing of discussion groups, and tutoring rather than teaching. The students themselves will be strong in skills used and developed in other subjects, such as study skills for information research and the writing of essays. Confidence may be demanded of the teacher, but we are better able to support each other in teaching methods now than teachers were 20 years ago.

Three special characteristics are proposed for a specifically academic 'spin' to be included in manufacturing, design and technology courses:

- appropriate learning (and therefore teaching) styles
- a different bias to (and scale of) the knowledge and understanding base
- increased flexibility in assessment.

Features of manufacturing, design and technology courses

There is a wide range of courses that fit under the umbrella title of manufacturing, design and technology. Some have an emphasis on 'design' and others on 'technology', there are various 'focus areas', there are courses in Art and Design, and Engineering. Many of these courses allow students to work in a range of different materials or in one material only. All Advanced courses in this area share some common features, in particular they all provide opportunities for students to:

- design and make artefacts
- learn about industrial design and manufacturing
- increase technological competence
- understand the many processes through which products are created
- acquire knowledge, skills and attitudes that equip them for careers
- apply knowledge, understanding and skills from many other areas
- take a large degree of personal responsibility for their work.

Manufacturing, design and technology courses require that students bring together knowledge, understanding and skills to create new products or systems as developing students' 'capability' is the centre of all these courses. Design and technology is an intellectual activity, in that it engages the mind in a process of reasoning. The fact that the reasoning may not be verbal and the outcome is a practical product which has to be shown to satisfy objectives in no way diminishes the intellectual content and imposes a form of rigour which is not present in solely theoretical reasoning.

The process of designing and manufacturing relies heavily on evaluative judgements and can be seen as:

- an integrated activity undertaken for a design purpose – to meet a perceived need
- requiring judgements to be made about the design process itself as well about the design proposals
- requiring judgements to be made on sound evidence – sufficient lines of possible development explored to meet the requirements as fully as possible, sufficient breadth and depth of knowledge have been brought to bear, ideas have been fully evaluated in relation to the requirements
- an activity that requires a body of knowledge for the purpose of making secure judgements not as an end in itself.

Manufacturing industries are the engines of economic growth and these industries are also the most prolific generators and disseminators of new technology. Manufacturing integrates more numerous and varied inputs of goods and services and cultivates a greater variety of skills than many other kinds of activity. For these reasons, an emphasis on manufacturing is essential for any Advanced course in the design and technology area.

Manufacturing as an activity can be encapsulated in the phrase 'from customer need to customer satisfaction through manufactured products'. (Of course, customers do not always recognise their own needs, so-called 'latent needs', and innovative manufacture often exploits these.) This phrase embraces all of the functions of manufacturing including marketing, research, design, production, quality assurance, and financial control.

What type of activities should students work on within the industrial 'manufacturing' aspects of an Advanced course?

Firstly, students and teachers might come to appreciate more clearly that the made outcomes of their designing and making will always be just prototypes – more or less well developed expressions of their ideas, but not fully worked-through production examples. As a result of this, these artefacts may be allowed some faults. They may be seen as a 'sketch in three dimensions', a development in dialogue with other models such as rendered sketches and technical drawings which portrays the state of progress which the student and her/his idea had reached when, for reasons of educational management, work on it stopped. In some cases, students may take their work on to a 'fully worked-through' production prototype. They should certainly be asking themselves questions such as:

- how would I design this differently if I were planning to make 100, 1000, 10000?
- what materials could I use?
- would I use the same manufacturing processes?

Another activity might be designing an item for small batch production (say 20 to 200), taking into account issues such as tessellation of parts to reduce materials wastage, minimising the number of parts and assembly operations, the design and manufacture of jigs and fixtures, the organisation and control of production, and team working demands. Major enterprise not mini-enterprise. This might be more achievable using such materials as food and textiles rather than wood, metal and plastics for the speed, economics and flexibility they offer.

Linking batch production experience to the products evaluation aspect of the course might lead to a habit of comparing in-school constraints, methods and outcomes to those which might have pertained in a similar industrial context. 'If we could have injection moulded that, we might have designed it like this...' Certainly, this would bring to our students greater understanding of some aspects of their 'material culture' – the made world which surrounds them, and its consequences on their quality of life.

Students have been heard to ask 'Is that real or is it made?' Adults are often of the opinion that 'Mass-produced means cheap and nasty.' These two attitudes are in direct conflict, and reveal the way that high volume production has moved on in the lifetime of the present parent generation. Mass production demands a high quality of manufacture if parts are to be interchangeable, and in a highly competitive consumer market, unprecedented quality of manufacture has been achieved at similarly unprecedented prices. Cars now cost a fraction of their price (in real terms) 40 years ago, are of inestimably higher quality, and are produced in vastly higher volumes.

It is essential that students on Advanced courses understand the means by which their society supports its needs: how things are made, why they are like they are, why they cost what they do, how they are brought into being.

What do students do on Advanced courses in manufacturing, design and technology?

Assessment in these courses normally focuses both on the **outcomes** of the student's work and the **processes** used to achieve them.

The outcomes could include:

- a design portfolio
- designed and manufactured products
- evaluations of existing products and applications
- industrial case studies
- reports on various aspects of their work such as production plans they have drawn up and used to manufacture products, reports on visits to industrial and other premises, a report of research and investigations they have carried out
- module tests and terminal examinations.

The processes that could be assessed are:

- the quality of the planning, information seeking and evaluation carried out by the students
- how students developed key skills such as IT, numeracy, communication as part of their work
- students' logs and records of actions and decisions taken
- students' evaluation of their work and the actions taken as a result
- the quality of research carried out and how the outcomes of this research are used
- working with others both in and out of school/college.

Characteristics of all students' work at Advanced level

All work at this level should exhibit characteristics at a level which significantly extends that achieved at Key Stage 4.

1 Students' increasing autonomy and decision making

- taking more responsibility for the planning, organising, managing and evaluation of their work
- developing and using their own individual action plans
- preparing themselves for assessment
- developing and using key skills
- making use of a wider range of people to support their work

2 A higher level of designing and manufacturing

One of the key features of high quality work on Advanced courses is that students always seem to be working beyond their expected level of skill and ability – they are constantly being challenged and set goals that are demanding but achievable.

Students will acquire a wide range of designing and making skills but will develop depth in some of these related to their area of interest and the products they develop. That this depth of intensive involvement often takes them beyond their teacher's knowledge demonstrates the importance of working with a range of other people. It also requires the student to develop the skills of working more autonomously and for the teacher to adopt more of a mentoring role rather the being the source of all information.

Students' work should reflect the complete process of manufacturing – from customer need to customer satisfaction through manufactured products.

3 Working for and with clients

At this level students should be identifying clients for at least some of their projects,

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which might be commercially commissioned. This will allow them to develop a wider range of skills and learn about manufacturing as they will be operating in all of the stages of 'from customer need to customer satisfaction through manufactured products'.

4 Taking account of a wider range of issues

Students should be taking account of a wider range of people, user groups rather than individuals. They should take into consideration a wide range of 'values issues' – environmental, social, economic.

5 Making use of a much wider range of support

At this level students should make use of a much wider range of people to support them in their work; this will include people both in and out of school. They should be making contact with local organisations and companies who can provide help and also act as clients for their work. This will need to be managed by the teacher in partnership with the student.

6 Student-teacher-mentor partnerships

The teacher-student partnership is vital for success on Advanced courses. As has already been established, students will need to take much more responsibility for their work on the role of the teacher changes as a result of this. Other people will be involved in supporting the students – sometimes arranged by themselves, at other times organised and directed by the teacher. If this is to work then it has to be seen as a partnership. As with any partnership, this puts responsibility onto both sides but also suggests that all should benefit.

Learning activities on Advanced manufacturing, design and technology courses

The following give an indication of the variety of tasks that a student may undertake as part of their course to develop particular skills, knowledge and understanding

- **Focused tasks** – practical, skills based, focus on a key piece of knowledge or understanding, highly structured or more open leading to a range of possible outcomes, available as support to move on students experiencing a 'block', providing additional breadth or depth for some students

- **Research tasks** – information gathering, investigative, including using information and communications technologies (ICT)

- **Product evaluations** – could have a specific focus, e.g. looking at values issues, design semantics, determining key scientific principles used in the design or manufacturing methods. These tasks are particularly useful as regular student-led discussion sessions

- **Design tasks** – some not necessarily leading to made products, some leading to mock-ups (e.g. in card), some as 'design outcomes' only

- **Design and make assignments** – prototypes, one-off products, higher volume production in groups

- **Manufacturing assignments** when a design is given and teams plan and execute batch production

- **Lectures and demonstrations** – using as wide a range of people as possible, by the students to their peers or to other audiences

- **Visits** – planned by the teacher, planned by the students, general to give wide experience or focused

- **Students working in another location** – short tasks or complete assignments, in industry, college, University

- **Tutorials and seminars** – for individuals and groups of students, by the teacher and/or industrial mentor

- **Simulation activity** – IT based e.g. virtual factory (from *Denfords*) or virtual company (*Free Enterprise from ORT*), or simulating a production process to understand issues of high volume production.

Figure 1

Features of good assignments for advanced students

- a clear assessment framework given to students so they can plan their work to meet its requirements
- the key designing, making, manufacturing and other skills that can be developed by the assignment will be identified
- these skills will be built into clear strands of progression
- there will be opportunities for students to develop different outcomes to allow for their own capabilities, learning targets and creativity
- the assignment will be supported by differentiated focused tasks – some practical, others research, investigating and evaluating products, knowledge based etc.
- links are made to the work of professional designers and industrial manufacturing practices
- opportunities to consider values issues are ensured

Conclusion

This year there are a number of 'focus area' driven A/AS level courses in addition to related GNVQ Manufacturing routes open to students. Teachers and managers face some difficult decisions about what they are able to offer students in the reality of their staff expertise resources and likely numbers of students. Manufacturing, design and technology courses are very individualised and they require a very diverse range of learning styles. Differentiation results from individual projects, each with their own particular requirements. This makes particular demands on schools and the ways departments are organised and managed. Schools do not usually have enough students or the flexibility to run a number of different courses side-by-side. Managers must be creative in the way that classrooms, studios, food rooms and staff are timetabled together to offer different options. Schools and colleges can combine large groups for some elements and choose which aspects to maintain small, separate groups for. A timely consideration of how we might make our subject more attractive to "academically" successful students, and what the characteristics of good advanced level work might help to increase our appeal to and success with the whole ability range.

Note

The term "advanced manufacturing, design and technology" is used to encompass existing A/AS level design and technology and Advanced GNVQ Manufacturing courses

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