Education for a technologically advanced nation

Design and technology in schools 2004–07

Using evidence from Her Majesty's Inspectors' inspections of primary and secondary schools and focused surveys, this report evaluates the provision of design and technology in the National Curriculum.

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Executive summary

This report is based on a three-year evaluation of design and technology in primary and secondary schools. Evidence was drawn from school inspections during the period 2004–05 as well as from focused surveys of design and technology by Her Majesty's Inspectors (HMI), with a minimum of 30 primary and 30 secondary schools inspected each year from 2004 to 2007. The surveys evaluated whether the subject was meeting its National Curriculum aims, including its contribution to educational inclusion, especially through the accreditation of examinations, and food technology in secondary schools.

In the early days of the National Curriculum, the subject covered an excessively broad range of content. Many schools taught this content at the expense of technical rigour and depth. Although the technical rigour has increased to some extent, there is still room for further improvement.

Pupils in the primary schools visited enjoyed design and technology. They were often proud of their creativity and skills as they designed and made functioning products. They behaved well and worked sensibly and safely with tools and equipment. Pupils' achievement and progress across the full spectrum of design and technology were good in about a third of the primary schools visited, but no better than satisfactory in over two thirds. However, there was some evidence of a trend of improvement.

Design and technology was popular in the secondary schools visited. More students chose design and technology at GCSE level than any other foundation subject. Its practical, active nature, and the opportunities for students to work on individual projects, encouraged them to develop their own ideas. This, together with the subject's vocational relevance, was at the heart of their enjoyment. At their best, the products that students made worked realistically, especially when they had been able to use computer-aided machine tools.

In the sample of 90 secondary schools visited over the period of the survey, 47 of the design and technology departments were good and an additional six were outstanding. This suggests a trend of improvement, which is reflected in students' good achievement and progress in two thirds of the schools in 2006/07. Candidates gaining A*–C in design and technology at GCSE level rose from 54% in 2003 to 59% in 2007, although this remained below the average for all subjects of 63%. Leadership and management of the subject, and students' safe use of a wide range of complex manufacturing equipment, were also good in two thirds of the schools during this period.

Boys continue to achieve considerably less well than girls, although there are good examples of changes to courses and teaching methods, which often involve improved technological rigour, which have raised boys' achievements. A minority of students in the secondary schools visited found an abstract, paper-based approach to designing and evaluating too difficult and might have benefited from more practical alternative courses. Many might also have benefited from projects which were better chosen to meet their interests and taught more effectively.

In most of the primary schools in the survey, design and technology continued to be on the margins of the curriculum. Only a third of schools offered a provision which rose above the bare minimum to be judged satisfactory. This lack of attention to the subject is related to the understandable focus on English, mathematics and science, as well as to the difficulties schools perceive in teaching a subject which is a complex amalgam of a number of formerly separate subjects, and includes substantial technical content.

Various external sources of support have been provided for the curriculum, staff and the development of resources since the start of the National Curriculum. Staff in schools where provision is less than good have not taken sufficient advantage of such support or had ready access to it. In these schools, there has been no sustained positive impact on learners' achievements because of piecemeal, short-lived provision, with insufficient funding. It is questionable whether, without more sustained and systematic support, they are capable of doing what the more effective schools already do.

At least two thirds of the primary schools and a third of the secondary schools have not realised the potential of design and technology to help all learners become confident and capable members of a technologically advanced society. Although it exists in a very small number of local areas, the school system as a whole does not have sufficient capacity to enable design and technology in schools to keep pace with technological changes in society. The education system lacks an overall research and development capability to help the subject fulfil its potential to meet learners' needs.

Key findings

- Much has been achieved in developing the subject. However, deficiencies persist and the subject lacks strategic, long-term planning and support. It requires resources, accommodation, including, for vocational courses, expertise in teaching, and the accreditation of examinations. Provision remains too variable, with deficiencies in primary and secondary schools.
- Achievement and progress were good in a third of the primary schools visited and satisfactory in the vast majority. Standards rose during the period of the survey.
- Achievement that was no better than satisfactory was the result of primary teachers' limited expertise and confidence. Many newly qualified primary teachers lacked the expertise to teach design and technology effectively because of insufficient time allowed for it in their initial training. Effective teaching was often supported by a well-structured curriculum and careful attention to the skills of thinking and making. The Qualification and Curriculum Authority's (QCA) scheme of work has helped to establish the subject.
- Achievement and progress were good in two thirds of the secondary schools and have improved steadily. Between the ages of 11 and 16, boys performed

significantly less well than girls. Achievement that was no better than satisfactory was the result of staffing shortages, lack of specialist expertise, and poor coordination of the Key Stage 3 curriculum which continued to undermine continuity and progression. At Key Stage 4, formulaic teaching of coursework diverted students from creative designing and making.

- Some students of average and lower ability in the secondary schools were frustrated by abstract teaching of designing and evaluating. Design and technology projects in secondary schools did not always capitalise on the mathematical and scientific knowledge of more able students.
- Design and technology was popular and contributed well to learners' personal development. Learners were motivated, especially when they had opportunities to develop and realise their ideas. They behaved well, understood the subject's relevance and learnt to use complex and expensive equipment effectively. Teachers made strenuous efforts to promote health and safety.
- Advanced technologies such as computer-aided designing and computer-aided manufacturing (CAD/CAM), when used effectively, motivated learners and raised their productivity. However, the gap was growing between schools which used such technology well and those which did not; the latter lacked equipment and the necessary expertise.
- Many teachers did not keep sufficiently up to date because of a lack of in-service training. This restricted the development of teaching and learners' technological capability. The Key Stage 3 Strategy's pilot scheme for design and technology produced good training materials which brought tangible improvements in the 10 local authorities which received funding for it, but its impact elsewhere was negligible.
- Recruiting specialist teachers, especially in food technology and systems and control, was an intractable problem in parts of the country. At worst, some schools no longer taught these curriculum areas. Although graduates are recruited to secondary initial teacher training from a wide range of disciplines, their degrees frequently do not provide a sound enough basis for teaching a reasonably broad span of design and technology without further training.
- Well-focused initiatives have recently been set in motion to improve the supply of specialist teachers of food technology and to overcome the weaknesses in the teaching of cooking and nutrition previously reported by Ofsted. Time is now needed for these initiatives to take effect.

Recommendations

The Department for Children, Schools and Families (DCSF) and the Department for Innovation, Universities and Skills (DIUS) should:

- consider a national development plan to coordinate the necessary improvements to develop design and technology

- consider how, in the long term, science, technology, engineering and mathematics research and development might be used to create modern design and technology projects, with mathematical and scientific content, to enable schools to keep pace with technological advances
- ensure, together with the Training and Development Agency for Schools, an adequate supply of specialist teachers for food technology and systems and control in all parts of the country
- specify minimum resource requirements for primary food technology and systems and control, and for secondary CAD/CAM and vocational subjects
- consider how the continuing professional development programme devised to improve the teaching of design and technology in Key Stage 3 might be made accessible to all secondary schools
- publish revised guidance on accommodation for design and technology to reflect the requirements of the new vocational courses.

The Qualifications and Curriculum Authority should:

- ensure that GCSE course specifications are effective in promoting creativity and technological rigour in coursework
- promote awareness of appropriate, practical-based, accredited courses to better meet the needs of students who find GCSE design and technology and vocational design and technology courses too difficult
- provide guidance on applying rigorous technological, mathematical and scientific knowledge in designing and making projects in secondary schools.

The Training and Development Agency should:

- provide training opportunities for primary and secondary teachers to update and maintain their subject and teaching skills and for primary headteachers to develop and manage a broad and balanced curriculum which includes design and technology.

Secondary schools should:

- improve creativity and technological rigour in coursework
- secure effective continuity and progression in Key Stage 3 courses
- provide adequate resources for CAD/CAM and ensure that at least one teacher is trained to teach it throughout the age range
- ensure appropriate access to subject training.

Primary schools should:

- improve teachers' subject knowledge and awareness of teaching materials for design and technology

- improve the assessing, recording and reporting of pupils' progress.

Providers of initial teacher education should:

- ensure that, as far as possible, the subject expertise of newly qualified teachers is adequate for them to teach design and technology to high standards.

Design and technology in the curriculum

1. The introduction, 15 years ago, of design and technology in the National Curriculum presented most schools with a major challenge. The subject's main precursor – craft, design and technology – had been well established through development and training initiatives in the 1980s. Reports by Her Majesty's Inspectors from that time show how well advanced the standards, quality of teaching and deployment of resources were in many secondary schools and, in parts of the country, some primary schools. However, curriculum development, staff training, new equipment and materials were needed to meet the new statutory requirement for design and technology effectively in all maintained schools.

2. Design and technology was compulsory from ages five to 16 until 2007, at which point it became optional for 14 to 16-year-olds while remaining compulsory from ages 5 to 14. However, all students retained an entitlement to study it. In terms of the numbers of students taking it at GCSE level, it remains the most popular National Curriculum foundation subject. Just under 355,000 students were entered for the full GCSE examination in 2007. It is also taken by students in the 16 to 19 age range at GCE AS and A2 levels, and it has close links to a number of vocational areas in the 14 to 19 age range.

3. Design and technology is the part of the curriculum in which pupils learn to design, make and evaluate functional products or systems. Much of the learning should take place through practical and technical activity. Within the National Curriculum, pupils are expected to cover set competencies to enable them to develop the design and technology capability to help them improve their quality of life. These include:

   - creative designing and problem solving
   - making functional products and systems
   - considering aesthetic, social, economic and environmental issues
   - reflecting on other people's designing and making
   - becoming discriminating consumers of products and systems.

4. Design and technology aims to develop learners' ability to design and make products in a range of technological fields. They are expected to develop procedural capability – 'knowing how' – as well as to acquire and apply propositional knowledge – 'knowing that'. They are expected to develop the competence to achieve results within design and technology as well as to understand it as an academic subject.

5. Before the National Curriculum, the subject evolved from a group of closely connected practical and technical subjects. These were combined, updated and made more challenging by applying modern technology, strengthening designing, and by placing a broader emphasis on industry and commerce. Design and technology currently has four areas of focus:

   - food technology
   - resistant materials (metals, plastics, wood)
   - systems and control (including electronics)
   - textiles.

6. At GCSE level, graphic products form another major area. Increasingly, courses in product design are taught, and vocational subjects such as engineering and catering are provided, sometimes with colleges of further education or industrial training organisations. In practice, the specialist areas tend to be organised as distinct but closely connected projects in primary schools, and as distinct but loosely connected subjects at secondary level, with their own specialist resources and making procedures.

Part A: Design and technology in practice

Primary schools

Achievement and personal development

7. In about a third of the schools in the survey, pupils' achievement and progress across the full spectrum of design and technology were good. There was some evidence to suggest a trend of improvement, but examples of outstanding provision were rare. Achievement was no better than satisfactory in over two thirds of the schools surveyed.

8. This rise in standards has been helped over nearly a decade by schools' increasing use of the model scheme of work published by the Department of Education and Employment/QCA in 1988.[1] This is sometimes supplemented by teaching materials produced by the Design and Technology Association and by a small number of local authorities and institutions of higher education that

[1] *A scheme of work for Key Stages 1 and 2: design and technology,* QCA, 1988.

have the capacity to carry out such development work. The most effective schools have gone well beyond these schemes to develop their own interesting and well-structured projects, which are closely linked to a carefully planned curriculum. The following case study shows the good progress pupils made in such circumstances.

Case study 1: Outstanding achievement in design and technology

This large school, with 375 pupils, serves a disadvantaged area in the Wirral.

Pupils develop design and technology capability to high levels. This represents excellent achievement and progress across almost the full spectrum of the subject, as advocated in the QCA scheme of work. Pupils get off to a good start in the Foundation Stage. They take part in a rich variety of practical and investigative experiences, mainly related to ‘knowledge and understanding of the world’, and they are successfully encouraged to carry out tasks with precision, concentration and imagination. This provides an excellent foundation for their subsequent learning.

In Key Stage 1, pupils’ progress is excellent. They work through a good range of ‘design and make’ projects, based well on units of work developed by the QCA; the staff have adapted and developed them carefully. This helps pupils to see the links with the rest of the curriculum. They develop very good skills in designing, making and evaluating and know very clearly how well their products meet their intended needs.

Designing is carefully structured within the projects and the introductory work stimulates pupils to think creatively. Their designs are imaginative. Pupils solve technical design problems in their practical work. They work competently in compliant materials, food, fabrics and construction kits, and develop particular competencies in mechanisms, control and structures. They are able to explain well how they have developed their designs and why they made particular decisions. Their evaluation is thoughtful and takes good account of the criteria set for the designing.

Given the low attainment on entry, pupils’ achievement is excellent. The inclusion of all pupils in design and technology is also excellent. By the end of Key Stage 2, 71% of pupils attained Levels 4 or 5 in 2006 and 18% attained Level 5.

9. Pupils in the schools visited for this survey were highly motivated by designing and making, and especially by the opportunity to think innovatively and develop their own ideas for products which worked, solved problems or met real needs. As they did this, the positive impact of activity which was matched to their

needs was obvious. In the best cases pupils developed self-confidence in using tools and materials and perseverance as they refined their motor skills.

10. Generally, teachers' planning did not give sufficient attention to pupils' evaluation of products. Increasingly, however, pupils were learning from careful analysis how to judge the effectiveness of products and, in the best examples, how to use their insights in their own designing. The next case study shows how carefully structured teaching can enable pupils to evaluate rigorously.

Case study 2: Effective teaching of thinking skills

This small primary school with 107 pupils serves an area of significant disadvantage in Halton. It has a high proportion of pupils with learning difficulties and/or disabilities. Pupils start school with below average attainment.

The curriculum is planned around a two-year cycle of topics for foundation subjects, subdivided into categories. The 'creative' category includes design and technology and art and design. Design and technology skills and knowledge from the QCA scheme of work are mapped carefully against the topics, taking appropriate account of progression.

The school was encouraged by the Department for Education and Skill's (DfES) publication of *Excellence and enjoyment: a strategy for primary schools*.[2] It has put considerable effort into developing methods to strengthen pupils' thinking skills, using materials published in the United Kingdom and the USA. Ideas on the teaching of thinking from published authors have been developed into a collection of techniques used consistently throughout the school. The school believes that the policy has improved pupils' enthusiasm for learning, their self-confidence and their capacity to see connections between subjects.

Year 5/6 pupils were taught techniques to evaluate the products they had designed and made. The teacher placed pupils into four groups, reflecting their different levels of literacy, and gave them exercises at varying levels of difficulty. Although pupils are often bored by such evaluation work, in this case it was lively and interesting. It encouraged them to distinguish between the areas they needed to evaluate in the mechanical wooden toys they had made. The pupils were stimulated to think more broadly and deeply than usual. All of them went well beyond statements such as 'The toy moves well' to more detailed statements about the required function, mechanical effectiveness and the likely response of users to the models' decoration.

[2] *Excellence and enjoyment: a strategy for primary schools* (ISBN 1841859931), DfES, 2003.

11. Increasingly, peer evaluation is used as a way of evaluating products. In the following example, a Year 4 class had designed and made money containers from fabric. One pupil wrote:

> 'Lauren's work is very good. Her drawstrings are nice because the stripes are very colourful and the pattern is diamond shaped. Lauren's finished purse looks the same as her design which means she has tried very hard. The money container is very useful but Lauren could improve it by doing a small pocket.'

12. The teacher's assessment was in tune with the pupil's evaluation and also made a teaching point about improving products:

> 'Lauren has used a variety of stitches within her design and finished the product very successfully. Her design and final product are very similar and reflect her understanding of the overall task and thorough investigation and evaluation of the original examples examined. A press-stud fastening inside the purse would have added security.'

13. A strong feature of the high standards some schools achieved was the use of practising artists, designers and other adult consultants to work with pupils. An example of this was the high-quality work seen in one school when Year 5 pupils created working models of moon buggies during a visit to a local authority centre which had specialist equipment for design and technology; Year 6 pupils worked with an engineer from a local oil company to create elastic-band powered vehicles in a project related to alternative energy uses.

14. In the schools where achievement was good or better, some units of work were enhanced by sharply focused links between planning for design and technology and subjects such as art and design, information and communication technology (ICT) and science. As pupils conceptualised their ideas using design sketches and models or in discussion with teachers and their peers, they also sharpened their understanding of basic principles. The following provides a good example of this.

> Pupils in a Year 5 class worked through a detailed, carefully sequenced project to design and make functional paper carrier bags which were to be decorated using motifs and lettering from their current work on Japan.
>
> The class started by examining a wide range of commercially available bags and analysed some of their functional and aesthetic characteristics. Skill-building on cutting, folding and precise joining followed, including instruction and practice, with ample feedback from the teacher until pupils were able to do what was needed. The class investigated the strength, durability and construction of different handles. They designed their bags, making quick prototypes to work out constructional and decorative details.

The project encouraged clear thinking and opportunities to formulate and test ideas. Throughout, the teacher ensured that pupils concentrated fully. As a result, standards and enjoyment were high.

15. Satisfactory rather than good achievement was often associated with teachers' limited competence in the subject and a narrow curriculum. In particular, pupils' access to aspects of the subject such as food technology, systems, control and electronics, or work with the more resistant materials such as wood, were restricted. More able and older pupils were not always challenged sufficiently.

16. Design and technology learning often supported pupils' personal development and well-being effectively. The schools surveyed were well aware of the specific health and safety implications of pupils working, for example, with sharp tools and hot materials. Most of the schools had well-formulated health and safety policies, supported by effective adult supervision. Pupils were usually clear about basic rules: they acted safely and sensibly with the equipment and were frequently proud of the outcomes of their practical work.

17. In the rare instances where achievement was inadequate, the curriculum was poorly designed to give pupils a broad and balanced education. Staff lacked skills in design and technology and pupils had too little time to engage in designing and making. Poor-quality materials and inadequate instruction in using tools efficiently made it difficult for pupils to make their ideas work, so they often became frustrated and demotivated. These schools did not assess pupils' progress properly and their view of their provision for design and technology was inaccurate.

Teaching, learning and assessment

18. Teaching and learning were good in around a third of the schools in the survey, with evidence of slow but steady improvement.

Case study 3: Excellent teaching of design and technology

This large school, with 375 pupils, serves a disadvantaged area in the Wirral.

The local authority's advisory teacher for design and technology has provided clear advice and the coordinator has taken part in a two-day training course at the City Learning Centre. As a result, she has provided excellent support to other staff. She has rigorously analysed the National Curriculum requirements for design and technology which have been used in planning. Well-selected and intelligently used external schemes support this. The management of resources is excellent.

Careful planning, for individuals and small groups, allows for the right levels of challenge in work as well as outcomes which reflect pupils' abilities. Information from websites and published teaching materials is used well in projects.

Teachers' are generally highly skilled. They use interactive whiteboards well to show video clips and moving visual aids to illustrate working mechanisms, which strengthen pupils' understanding. They also involve them well in learning theory and technical vocabulary. Pupils with learning difficulties and/or disabilities are well taught with the support of dedicated teaching assistants and this promotes high achievement.

Excellent direct investigation in the local community, as well as the nearby City Learning Centre, stimulates pupils to think about design problems and solutions. Teachers recognise that pupils should design and re-design as they proceed, rather than just at the beginnings of projects.

19. Teaching and learning was satisfactory in three fifths of the schools in the survey. Many of the teachers observed had good generic teaching skills but weaknesses or gaps in their knowledge of, or skills in teaching, design and technology meant that their teaching of design and technology was satisfactory rather than good. The teaching was characterised by sound but unimaginative use of externally provided schemes of work to support planning. The teachers had a reasonable command of learning objectives and how the units promoted these. Guidance and support in carrying out routine project work were often good.

20. However, many teachers do not have sufficient subject knowledge for teaching the more technologically demanding aspects of design and technology or for helping pupils with the more difficult technical problems which arise routinely. This limits their capacity to manage practical making lessons and to challenge pupils, and to help them to make their designs to such a standard that the products function. This situation might be improved if schools enable semi-specialised teaching to take place later in Key Stage 2, as in this case study.

Case study 4: The impact of an outstanding curriculum for design and technology

This high-performing junior school, with 160 pupils, serves an advantaged rural area in South Gloucestershire.

The design and technology curriculum is organised very effectively and sufficient time is allocated to it. The QCA's scheme of work is implemented successfully and is complemented by the school's additional projects. Enrichment activities (including visits to a science and technology activity centre; visits from a local authority technology bus; involvement in several national design and technology competitions; the 'Tech-link' project) and a transition unit with a local secondary school enhance the curriculum. A teacher with specialist expertise related to design and technology teaches all classes in Years 5 and 6. The teacher's excellent subject knowledge enables pupils to develop and communicate their design ideas very clearly.

Pupils enjoy design and technology and it promotes their personal development and well-being very effectively. The school supports those with learning difficulties and/or disabilities effectively and they achieve very well.

Pupils have a deep knowledge and understanding of design and technology, and they use tools, equipment, materials and components skilfully to make high-quality products. Their capabilities in working with food, resistant materials, textiles, systems and control are of an equally high standard. Their progress and standards in lessons are never less than good and often outstanding. The quality of their designing is at least good across all years and, in Years 5 and 6, some design work is outstanding in its depth and inventiveness. Pupils in Year 5 also show high levels of capability in the use of CAD/CAM in the project with the local high school.

Curriculum continuity is outstanding. ICT is used frequently and effectively. Good assessment procedures ensure that pupils' design and technology capability is evaluated in each unit of work against subject-specific learning objectives. In all, pupils experience a wide range of activities that meet the requirements of the National Curriculum very well. As a result, achievement and standards are outstanding.

21. The next case study shows how training and local partnerships can make a big difference to the expertise of staff, and to pupils' attainment.

Case study 5: The impact of externally provided continuing professional development on the curriculum

This primary school in Coventry serves an area of average socio-economic conditions.

The school has made a great deal of progress recently in developing design and technology. As a result of sharply focused development deriving from expert external guidance, design and technology is now good with some outstanding features. This has shown the clear benefits of training and curriculum development.

The design and technology coordinator has gained excellent subject knowledge. He has a good understanding of wider design and technology issues through his membership of the Design and Technology Association, together with training from and work with the Centre for Research in Primary Technology at Birmingham City University. This included its 10-day course for design and technology subject leaders, followed by substantial curriculum development and action research. He has used his learning effectively to improve provision.

Teachers have good subject-specialist knowledge and also apply their knowledge from other areas to enhance design and technology. Theory and making skills are taught well. Effective, focused, practical tasks develop pupils' understanding of materials and strengthen their manipulative skills. Designing is innovative and teachers encourage pupils to exercise their vivid imaginations. Real and contemporary design problems interest and challenge them, such as designing a vehicle that has an environmentally friendly power source. They annotate drawings well to develop their ideas. The school stresses the importance of the high-quality finish of products.

Teachers match their teaching to sub-levels of the National Curriculum for design and technology.

Parents are positive about the work in design and technology because pupils enjoy it. Pupils see design and technology as an important subject because they make things which are useful and meet real needs, and because they see it as relevant to their lives.

22. However, in most parts of the country, external support and training are rare. This case study shows how one school improved provision with minimal external help.

Case study 6: Improving provision for design and technology with minimal external support

This is a large junior school in Stockport with 395 pupils, serving an area close to the centre of the town.

The headteacher and staff are enthusiastic about design and technology because the pupils enjoy it so much. It improves their general motivation and complements a focus on the core curriculum. They can apply what they have learned, especially in mathematics and science, which is important in an area where many adults work in technical and manufacturing jobs and small businesses. The coordinator argues convincingly that many of the pupils are used to making things at home with skilled parents and grandparents. Staff have helped pupils to investigate independently using the internet and online learning resources.

Staff have had no formal training in design and technology but they have developed individually in areas such as textiles and the coordinator has given coaching and guidance to meet individual needs. This has been crucial, given that the school has not used external sources of training.

The key aim, which has been achieved well, has been to build up confidence and resources gradually and for individuals to try out and evaluate new ideas. The coordinator has good subject skills, helped by being able to extend the skills she gained in her previous role as a specialist art and textiles teacher in a secondary school.

Overall, improvement has been steady and sustainable. Pupils' design and technology capability is above average by the end of Year 6. This reflects the good quality of the school, the enthusiasm and drive of the headteacher and subject coordinator, and the professional competence and willingness of the staff to improve. This approach could be replicated in other schools.

23. Headteachers from the schools visited frequently reported to inspectors that design and technology was not a current priority. This was understandable as they felt they had to concentrate on raising standards in English and mathematics. Many of them were concerned about recently qualified teachers' lack of subject skills in design and technology. In some of the initial training courses, trainees had had fewer than 10 hours' tuition in design and technology. This may reflect the curriculum which must be covered in initial training and therefore the need to be selective, but it does not enable new entrants to the profession to teach design and technology effectively without further basic training through continuing professional development.

24. Assessment procedures are less comprehensive in design and technology than in the core subjects. Even so, in the schools which taught design and technology well, collecting, recording and using assessment information on pupils' design and technology capability were usually satisfactory and, occasionally, good. Pupils knew the level of the National Curriculum they were working at and feedback from teachers and other adults showed how they might improve.

25. However, in the majority of the schools in the survey, assessment fell short of this. Common weaknesses included insecure assessment against national benchmarks, failing to assess and record in depth, the lack of pupils' involvement in assessing their own progress, and little use of data. Design and technology coordinators, as full-time class teachers, rarely had time to analyse assessment data in depth. In around a quarter of the schools surveyed, assessment was inadequate, as in this typical example.

The school was not able to show the progress pupils were making or their attainment at the end of a unit of work. Records on their progress and attainment in the different aspects of the subject were insufficient. The school intended to assign a National Curriculum level to each pupil's work at the end of each key stage but it did not have sufficient exemplar materials to guide teachers' judgements.

The curriculum

26. A large majority of the schools visited had used support such as the QCA scheme of work effectively to improve their coverage of the National Curriculum programme of study. The design and technology curriculum was good in a third of the schools sampled towards the end of the survey and satisfactory in the rest. This was significantly better than in recent years, when over half of the schools did not allocate sufficient time to cover the programme of study.

27. Teachers in the more effective schools in the survey complemented the units from the QCA scheme of work well by devising additional activities. They allocated sufficient time to the subject, used it efficiently and took account of progression. Planning for design and technology enabled pupils to experience a wide range of activities that met, and extended beyond, the National Curriculum requirements. ICT was used frequently and effectively to support learning. At its best, the range of enrichment activities and visits beyond the school broadened pupils' understanding of the pervasive nature of design and technology. It was at its best when embedded within a broad and balanced whole-school curriculum, which was strongly supported and managed by senior leaders. The planning and management of the design and technology curriculum had been improved significantly in schools where coordinators had attended effective external training.

28. The more effective schools had moved from teaching the QCA units separately to including them in topics to provide a context for designing and making. This approach needed additional monitoring and management to ensure that design and technology knowledge and skills were covered fully and progressively, and were supported by adequate resources. Links with other subjects were continuing to improve, although some teachers continue to be unclear about the differences and similarities between art and design, resulting in confused teaching.

29. Lack of time for design and technology was the critical issue where improvement was needed. Time was sometimes a problem where the headteachers felt they had to concentrate teaching on the core subjects. Additionally, provision was sometimes limited by lack of facilities or resources, especially for cooking, or the 'high tech' aspects of systems and control, or computer-aided designing. Schools are still not allocating enough resources for teaching ICT through design and technology.

30. Progression between the key stages in the teaching of designing and making was unsatisfactory in a quarter of the schools visited, although the joint teaching of a transition project sometimes supported pupils' move from primary to secondary school.

Leadership, management and resources

31. Leadership and management of design and technology were good in three fifths of the schools surveyed, which suggests a trend of improvement over the period of the survey. Leadership and management were rarely outstanding or inadequate. One factor was the high number of newly appointed design and technology coordinators in the schools visited recently. They were bringing fresh impetus to organising the subject although, in many cases, time will be needed for this new effort to raise pupils' attainment.

32. Design and technology tended to be covered well where the headteachers had the confidence and managerial skills to provide a broad and balanced curriculum. The leadership and support of headteachers continue to be crucial to improving quality. In the best examples, the curriculum provided an excellent basis for design and technology to thrive. Headteachers and subject coordinators developed a provision which excited pupils. Local authorities that had retained the capacity to promote curriculum development and training in design and technology were able to provide authoritative support to strengthen the curriculum. However, this was rare.

33. The quality of schools' self-evaluation was better at the end of the survey than it was three years ago, when it was barely satisfactory. In the last year of the survey, the accuracy of self-evaluation was good in over half of the schools sampled and outstanding in one. Although the capacity of headteachers and subject coordinators to use self-evaluation was improving, they did not always formally record their evaluations of design and technology. Self-evaluation which was less well developed lacked a sharp focus on coverage of the National Curriculum and pupils' performance. However, workforce reform was beginning to provide time for coordinators to monitor teaching and attainment more effectively.

34. Variations in the amount and quality of resources for the effective teaching of design and technology were unacceptably wide across the schools surveyed, although levels of funding overall were rarely a problem. In the best schools, each year group had ready access to good-quality tools, materials and equipment, which were well organised for efficient access and safe use. Some local authorities and other agencies had clear guidelines on what constituted adequate resources for specific projects. Many schools, however, claimed that they lacked easily accessible guidance on what constituted minimum and good levels of resourcing for design and technology although this information is also available through sources such as the internet.

35. The main factors governing the quality of resources were:

- awareness of what was needed and available to support good practice
- the breadth and depth of teachers' subject knowledge

- teachers' willingness or opportunities to develop skills in the more technical parts of design and technology and to acquire resources to teach these to pupils
- the spending priorities of headteachers and governors.

Secondary schools

Achievement and personal development

36. In eight of the 90 schools surveyed, achievement and progress were outstanding; they were good or better in two thirds of the sample in 2006–07. This suggests considerable improvement, borne out by the proportion of candidates entered for GCSE examinations who gained grades A*–C: this rose from 54% in 2003 to 59% in 2007. The percentage of candidates passing the A2 GCE examination rose from 96% in 2003 to 97% in 2007, suggesting a lower rate of improvement than that for GCSE. At all levels girls reached higher standards than boys, very markedly so at GCSE level (see paragraphs 103–106).

37. In the early days of the National Curriculum, design and technology covered an excessively broad range of content. Many schools taught this content at the expense of technical rigour and depth. Although technical rigour has increased to some extent, there is scope for further improvement, particularly in raising teachers' expectations. This case study shows how one school approached this so that all students achieved well.

Case study 7: Technical rigour in GCSE coursework

This is a mixed, suburban 11 to 16 school in Stockport with specialist status for mathematics, science and technology. There are nearly 1,400 students.

Year 11 students were making products for their own use including a holder for remote controls, a rack for snooker cues, a guitar stand, a clock and a bicycle stand. Each project was chosen and designed by the students. Craft standards were high in a wide range of processes, including wood turning, boring steel on a lathe, routing (by hand and under computer control), sanding (hand and orbital). All the equipment was in good order and students used it productively, safely and skilfully, with support from a technician for the routing. The teacher had a detailed checklist of the work each student had done for coursework, such as evaluation, planning, making, and the development of surface finishes. Clear knowledge of the students' performance underpinned the good examination results predicted for the boys as well as the girls. This high achievement was closely associated with the following points.

No ‘laddish’ culture was tolerated. Staff had cordial relationships with the students and were very firm with them.

Staff had very good making skills. They had a very wide range of equipment for wood, metals, plastics, knew how to use it skilfully, and taught students systematically from Years 7 to 10 how to do this. This included a series of short craft projects in which making skills were taught rigorously. This motivated students, developed their very good skills and their confidence to use equipment and machinery.

The single lesson periods plus homework were used to teach theory as well as designing through a series of short, brisk design projects. Class teaching, questions and answers, class brainstorming and other methods stimulated thinking and engaged students. They were then asked to design in silence, to concentrate and produce a high volume of thoughtful work. Students felt secure within this tight framework and their extensive work confirmed its impact on their productivity.

The teachers were convinced of the vital importance of aligning the major project with students’ interests, although they were guided in their choice. By spring of Year 10, the students were well equipped with the necessary ‘pre-project’ skills to tackle their major project. The quality of their coursework portfolios confirmed this.

One of the teachers, an experienced external GCSE examiner, was adept at convincing students of the value of doing the various tasks required for coursework assessment. He understood very well how the tasks contributed to developing their design and technology capability. He challenged GCSE students to aim for the same quality of designing and manufacturing that adults achieved.

38. A significant feature of high achievement in design and technology concerns students generating ideas which are innovative for them if not for experienced adults. This requires students to commit themselves not just to acquiring and analysing knowledge, but to applying this knowledge as they solve design problems. High achievement depends partly, and often very largely, on a department’s ability to encourage students to engage themselves. The next case study illustrates this very well.

Case study 8: Involving students in designing

This is an urban school in Warrington with average standards of attainment in Key Stage 3.

In a mixed-materials workshop, the experienced teacher led a large and lively Year 9 class to the end of a project to design and make small bedside storage units for teenagers’ personal belongings.

The students developed an excellent and varied range of visually interesting and functional forms. They designed in a very practical way, modelling and testing their evolving ideas in three dimensions, using card and other quick-to-use materials rather than traditional and more abstract design sketching.

They evaluated their ideas as they proceeded. Being able to test their ideas in three-dimensional reality and evaluating the designs in progress stimulated them to refine their skills of evaluation and the quality of the designing, and helped them to finalise their successful designs. The teacher avoided the disaffection some less able students show when they want to get on with practical activity rather than design by drawing.

The class used a wide range of resistant materials with some skill, including hardwoods, softwoods, acrylic, PVC and brass. A wide range of making processes included drilling, faceplate turning, vacuum forming, press moulding, and strip heat bending, together with related bench work with hand tools. Craft standards were high and the students' pride was evident in the lengths to which they had gone to reach a high quality of surface finish.

39. Developing products in a realistic way in food technology tends to be difficult and, as Ofsted has reported previously, it is often conducted inappropriately.[3] The following shows how an outstanding design and technology department overcame this problem. The inspector wrote:

What was impressive was the genuine development of food products rather than the minimal adaptation of existing recipes which is often seen. Students' products showed real and inventive combinations of different food types, extensive testing of prototypes in practice, trialling of batch production techniques to see if products for a market could be produced in quantity, and honest evaluations of initial ideas before embarking on a final design.

40. As successful students progress through their design and technology courses, they take increasing responsibility for identifying suitable 'design and make' projects and also for undertaking research into the related needs and opportunities. Sometimes the results are extremely impressive as this case study illustrates.

[3] *Food technology in secondary schools* (HMI 2633), Ofsted, 2006; www.ofsted.gov.uk/publications/2633

Case study 9: Outstanding design and technology coursework

This urban comprehensive school in Cheshire, with 1,039 students, specialises in engineering.

A very capable Year 13 student eventually achieved four A grades at A level in mathematics, further mathematics, physics and design and technology, going on to read for a degree in aeronautical engineering. He developed outstanding research skills in his major design and technology project, working on a concept design for a multi-media tourist information guide linked to a global positioning system (GPS). His portfolio showed excellent evidence of:

- detailed analysis of potential markets
- good understanding of current, related products
- critical review of possible designs and a selection of global positioning system travel and communication guides
- concise yet detailed analysis of problems, potential users and manufacturers
- review of the necessary and optional functions and the new materials which might be used
- research into the existing and emerging technologies of liquid crystal display, touch-sensitive screens, memory cards and flexible screen systems
- consideration of values such as life costs, environmental impact and life-cycle analysis.

All this led to a detailed specification and some highly innovative designing and prototype manufacturing using CAD/CAM and a wide range of other techniques. Throughout this, the student's coursework portfolio showed his excellent skills in time and project management. The final concept model was of a professional quality.

41. During the period of the survey, students in secondary schools benefited increasingly from developments in CAD/CAM, which is widely used in the manufacturing industry to increase productivity. Support came from various sources, especially the 'CAD/CAM in schools' initiative.[4] One outcome was design and technology departments' speedier adoption of sophisticated designing software. When well developed in secondary schools, CAD/CAM

[4] The 'CAD/CAM in schools' initiative is funded by the DCSF, aided by a private sector manufacturer and managed by the Design and Technology Association. It aims, among other things, to ensure that all secondary schools in the UK have access to CAD/CAM. More information is available at: www.cadinschools.org/index.php

increased students' productivity, impressively so in the 14 to 19 age range. Once students had mastered the design software they were able to develop and model ideas quickly and realistically, test juxtapositions of components, view three-dimensional objects from various angles and develop sophisticated design ideas. Some of the products seen during the survey – and these were not isolated examples – were of professional quality, which had not been achieved before in design and technology in schools. This raises standards as well as strengthens the students' self-esteem.

42. Students with learning difficulties and/or disabilities were also enabled to achieve more. Learning support assistants were rarely deployed for such computer-assisted work but subject technicians were often instrumental in enabling students to make progress. Students in one school, who had previously struggled to make their designs because of their weak coordination, were able to realise their ideas and, using a laser cutter, create products which had previously been impossible for them.

43. The new technology of three-dimensional printing, although currently expensive, was already being used in a small number of the schools. It enables students quickly to make complex prototypes of objects which have been designed on screen. Students' ability to model complex three-dimensional forms had improved significantly in the schools which were pioneering this technology.

44. The use of CAD/CAM, however, raises a question. Design and technology departments continue to use ICT extensively, in line with the National Curriculum's intention that students should learn about new technologies. It is increasingly difficult, however, to distinguish between students' attainment which reflects their capabilities and that which reflects the power of the software and hardware. The implications for the reliability, comparability and validity of GCSE and GCE coursework assessment need to be considered carefully.

45. In the schools visited, design and technology contributed significantly to students' personal development and well-being. Attendance, behaviour and relationships between staff and students were good. The subject was popular: a large majority of the students spoke positively about being able to create their own products, develop innovative ideas, work practically with tools and materials, and use modern technology for a real purpose. Most of the students observed saw the practical and project management skills that design and technology teaches as likely to be useful and relevant in adult life, because of its links with industry and commerce, and because of the opportunities it provided to use new technology. In the best provision, students, especially in Years 11 to 13, worked maturely in an atmosphere which reflected that of a professional design studio or industrial production facility. Students and staff managed risks in the practical environment of design and technology very well.

46. The students were generally motivated well by design and technology. Many of them were proud of the products they had created. The more capable students also showed similar pride in their design folders but, for the less able students in particular, the emphasis on desk-based drawing and writing was sometimes frustrating when they preferred practical work.

47. In the schools where achievement in design and technology was poor, standards across the subject's focus areas were sometimes inconsistent. This was usually related to staffing shortages, weak departmental management and, sometimes, to teachers' lack of expertise. Designing was mediocre and formulaic and the products, made with crude craft skills, were often not completed by the end of the course. Poor behaviour rarely impeded attainment but attainment was sometimes held back when students saw little relevance in the work they were given. Boys' underachieved considerably more than girls.

Teaching, learning and assessment

48. Teaching was rarely less than satisfactory. It was good in half the departments and outstanding in six of those visited. The most effective teaching was usually where high levels of cooperation existed between specialist staff. Within cooperative teams, a good range of subject knowledge enabled departments to cover all of the subject's focus areas and, increasingly, some vocational courses. The complementary specialisms of staff were usually deployed well, enabling them to teach to their strengths, although this was often difficult in small schools.

Case study 10: Complementary staffing

This is an urban girls' comprehensive school in Camden with 998 students.

All departmental staff are graduates in a discipline related to design and technology and some have related industrial experience. Collectively, their expertise covers engineering, product design, textiles technology, theatre and interior design and food technology. An exceptionally well-developed view of design and technology education shines through in the department's planning and work. The design and technology staff have developed a highly coherent curriculum and very effective teaching methods which enable them to pass on their expertise and enthusiasm. They keep up to date by extensive contact with various training providers and industrial practitioners.

49. Inspectors met a handful of exceptionally talented teachers teaching across three or four focus areas in Key Stage 4 but, for most teachers, this expectation is unreasonable and counter-productive. It is not generally effective for teachers to teach more than two focus areas at GCSE level and beyond. The most expert teaching, by a wide margin, was usually characterised by specialist expertise, an up-to-date knowledge of how such expertise is used in industry, and an infectious enthusiasm. Expert use of new technologies was widespread

and increasing, although the gap between the most and least effective teachers in this respect was widening because of the reluctance or inability of the latter either to update their skills or access adequate software and hardware, or both of these.

50. An essential part of good teaching is to capitalise on the appeal, relevance and contemporary nature of the technology in project work. This can motivate students to design, evaluate and gain technological knowledge. The best teaching seen in the survey included:

- brisk demonstrations
- ample time for students to discuss real examples of designing and making
- disciplined group work, with time for students to think and formulate ideas
- the making and testing of prototypes
- the use of notes, digital photographs and screen dumps for students to record their learning [5]
- structured discussion and games which required everyone to participate and cooperate
- regular assessments and feedback, from pupils (or students), peers and teachers.

51. In many of the schools surveyed, teaching designing and evaluating was not as well developed as teaching craft skills. The next case study shows how, through well-structured cooperative learning, students can be deeply engaged in the more abstract elements of design and technology.

Case study 11: Cooperative learning in design and technology

This is an outstandingly effective mixed 11 to 18 foundation school for 1,500 students in Cheshire. It has specialist status in the performing arts.

In a Year 10 design and technology lesson in a workshop, the teacher allocated the students to teams of four, based on their assessed design and technology capability. In a brisk and interesting session, they were invited to evaluate a product using criteria chosen by the teacher. First, with time limits, they discussed the product and the criteria in their teams; then a member of each team summarised the views for the whole class. In a short time, the students made an impressive range of observations, doing so with enjoyment and high levels of motivation. In sharing their

[5] Screen dumps are images of items displayed on computer monitors and recorded by the computers.

ideas with each other, they built up a collective evaluation which would have been difficult to achieve had they worked alone.

This sophisticated approach strengthened the learning of students who were already high attaining and well motivated. It was based on well-thought-out learning principles developed by an overseas academic which the staff had applied and tested over a number of years in the school as well as with the feeder primary schools.

The approach was characterised by:

- structured, mixed-ability group work
- timed activities, controlled by a timer the students could see, to promote a sense of urgency, with brief time for thinking
- encouragement and opportunities for all students to participate
- a high degree of interaction within tightly controlled parameters
- a requirement for everyone to participate, including randomly selecting students to give feedback from the group discussion, so that no one felt able to lose concentration.

The department had developed lessons which used a range of interesting games to engage pupils, especially those who were normally reluctant to participate in cooperative problem-solving through discussion. The approach shared characteristics with popular television quiz shows which routinely attract large audiences. It also had much in common with the principles of assessment for learning and the teaching activities in the training materials for the design and technology element of the Key Stage 3 Strategy.

The students' engagement reflected the outstanding teaching in the school and its design and technology department. They were enabled to grapple with abstract concepts within clear structures and to express their ideas confidently to others.

52. Other characteristics of highly effective teaching included the careful sequencing of learning, especially in planning the units of work in the Key Stage 3 focus areas, linking them together to promote progression. The highly effective teachers were also determined to use time to maximum effect. This is becoming increasingly important as pressures on time in the curriculum increase. The following also characterised good practice:

- a focus on the pace of the lesson and adhering to deadlines
- breaking down tasks into manageable, timed chunks
- setting very specific targets for classes and students, often linked to small and focused tasks to teach specific designing and making skills which could then be applied in more open tasks

- asking well-focused questions to show the depth of students' understanding
- requiring students to concentrate and refrain from social chat while designing and making
- encouraging them to carry out precisely defined research about design problems – especially important in challenging more able students
- supporting less able students and those with learning difficulties and/or disabilities to guide them to the required level of attainment
- ensuring that projects motivated both boys and girls.

53. Motivating boys and girls was sometimes achieved by setting two projects, or one project with two routes to a conclusion: for example, one might emphasise the use of computers or designing through model-making and one might emphasise designing by drawing and writing in depth.

54. The most effective assessment is integral to teaching and ensures that students receive good-quality feedback regularly and, ideally, during every lesson. Assessment was good in over half the schools surveyed; it was rarely unsatisfactory. The best teachers assessed students' work confidently, based on their very clear understanding of the levels of attainment students were aiming for. Target-setting in practical lessons was quick and developed students' responsibility.

> Year 10 students in a school were required to identify their key objective at the start of every practical lesson and to write it concisely on the whiteboard for all to see. The students, teaching assistant and teacher initialled the target at the end of the lesson to confirm its achievement and recorded this in their coursework folder.

55. Best practice involved coursework folders being collected regularly and teachers commenting positively on the quality. This motivated students and helped them to identify the next step. In one school, a learning mentor assigned to the design and technology department had a very clear understanding of the schemes of work, knew the students well and supported them very effectively, not least those in Key Stage 4 who were believed to be in danger of falling behind. In the most effective lessons all students had a very good understanding of their purpose. Teachers used questions effectively to ensure that students understood the purpose of each activity and could recall them appropriately; for example, requiring them to justify their decisions about designs. Students were encouraged to work independently. Teachers supported this independent work by making explicit links between the intended learning outcomes of lessons and the students' own targets for those lessons. The following example illustrates these features.

Case study 12: Independent learning targets

This is an outstandingly effective 14 to 19 suburban comprehensive school with 2,034 students in Leicestershire.

In a Year 10 food technology GCSE class, students were covering modelling for manufacture; specifically, ways to make products more cheaply, with higher nutritional value, with improved sensory attributes, or with more effective marketing. After a quick introduction to food preferences linked effectively to Asian food and the use of chillies, students worked in pairs. Each chose one of four criteria to improve the products. The teacher's skilful and effective questioning helped them to clarify how they would improve their product and promoted their thinking. Able students were challenged to work on two criteria.

Each student identified clear targets for the lesson and wrote them on the whiteboard. The food room was well laid out so that students could record their progress clearly on the technical specification sheet, away from the practical area. The students spoke confidently about their choices of ingredients and their intentions to limit the use of fat and sugar. The able students were clear about the nutritional parameters of the product specifications they had developed. Most of the students could explain accurately the appropriateness of the cooking methods they were using and how they would adapt their recipes.

At the end of the lesson, all students used web-cam technology to make a pictorial record of their products for their coursework portfolios, to which they also added concise records from the technical specification sheet.

In this way, and throughout the course, students constructed impressive coursework portfolios. These were an integral part of design, make and test project work rather than an artificial exercise to fulfil examination requirements with the consequent problems of lack of motivation. Not a minute of the lesson was wasted.

56. The good teaching and staffing in design and technology needs to be set in the context of the relative newness of the subject. The good and outstanding teaching, learning and assessment in the schools surveyed represents good achievement in a short time. However, if all students are to benefit from the types of good practice described so far, the following points need attention:

- teachers' expertise
- the current mismatch between the needs of the subject and the expertise of some of those new to teaching it
- opportunities for students to make decisions, plan, analyse and evaluate
- challenge for the least and most able students

- opportunities for teachers to attend training courses locally
- the teaching of mixed ability classes
- the quality of curricular planning
- the problems posed for less able students by paper-based work in design and technology.

57. Teachers' expertise in design and technology is often a critical issue. At its worst, especially in the areas of food technology and systems and control, some headteachers in the survey found it very difficult to recruit suitably qualified specialists and considered reducing provision for food technology. Two very good schools, in the face of continuing difficulties in attracting able specialists for teaching posts, removed food technology from the curriculum and converted the specialist classrooms to other purposes.

58. Less extreme, but more common, is the mismatch between the needs of the subject and the expertise of some relatively new teachers. They had moved from specialisms such as fine art and graphics, and their postgraduate certificate in education training had not included adequate time for them to develop, for instance, the necessary skills for managing design and technology lessons in workshops. The survey showed that this led to inexpert and insufficiently rigorous teaching. Sometimes there was a tendency to over-emphasise the parts of the subject with which the teacher was confident at the expense of the rest. At its worst, expensive capital equipment was unused and this frustrated students.

> An inner city school had an extensive suite of workshops, which was equipped to a high specification by the local authority. One of the rooms was well equipped for engineering metalwork and had high quality machinery for turning, milling, grinding, and drilling metals and plastics. Apart from the pillar drilling machine, the equipment had been idle for some years, largely because staff did not have the skills to teach students to use it effectively. Lack of local opportunities for further training, and the department's naive belief that such metal machining skills were no longer relevant, exacerbated matters. Ironically, 10 years or more before, the local authority had run high quality continuing professional development courses to strengthen teachers' competence in areas such as practical engineering. It was no longer able to fund these, however, despite their clear relevance to the country's advanced manufacturing industry.

59. Although making skills were usually taught in structured and effective ways in Key Stage 3, a common weakness was that teachers did not give students enough opportunity to make decisions, plan, analyse and evaluate. This usually happened when teachers aimed to provide a tightly structured course in which they had firm control over the students' activities. Although structure and discipline are essential requirements for safety and learning in design and

technology, if this approach is not set within a broader course structure, it gives a poor foundation for studying at Key Stage 4. It often fails to motivate higher ability students who are capable of working more independently.

60. There was ample evidence in this survey that students' creativity was thriving in well-disciplined and structured lessons, provided that the work was conducive to creative thinking and that students were committed to seeing a major task to completion. However, insufficient opportunities for teachers to attend training courses meant that many of them were not keeping up to date. Sometimes they lacked the confidence to give students the freedom to develop innovative ideas which might require more than the basic materials or processes.

61. Most of the teaching seen during the survey was organised in mixed ability groups. Teachers had only a short time, typically within teaching units lasting around 10 weeks, to get to know their classes. This was particularly true of Key Stage 3. Unless a school's centrally held performance data was exceptionally detailed, it was difficult for teachers to be adequately aware of the capabilities of individuals in their classes; the result was often a failure to challenge the least and most able students. In the schools where achievement was barely satisfactory or inadequate, this was often because teachers were 'teaching to the middle' in mixed ability classes. Weak curricular planning also meant that students experienced a range of unconnected projects and modules with too little regard for the overall development of their designing and making skills and much wasteful repetition in learning the elements of designing.

62. The survey found that setting pupils by ability was rare but it was often helpful in matching teaching more precisely to students' needs.

63. Less able students on GCSE courses often found the paper-based investigative, design and evaluation work daunting. Outstandingly good teaching is needed to overcome this and such teaching was rare.

The curriculum

64. In most of the schools visited, a broad and balanced curriculum which covered the four focus areas and with between 7 and 10% of the timetable, provided a sound foundation at Key Stage 3 for specialist work in Key Stage 4.

65. Most of the schools taught design and technology through specialist modules in Key Stage 3 and students moved three or four times a year from one specialist module and teacher to another. Such a 'carousel' timetable made curriculum continuity and progression difficult. However, a small number of the schools reduced students' movement between teachers. For instance, each student might spend one weekly session throughout the year with one teacher teaching resistant materials, systems and control, and another session with a different teacher on food technology and textiles.

A very successful urban school, where students' attainment on entry was below average, had had difficulties in recruiting specialist teachers for food technology and systems and control. As a result, the Key Stage 3 curriculum covered resistant materials and graphics and textiles in great depth, with only minimal coverage of food and systems. This significantly reduced the breadth of students' learning within the programme of study. However, the students' achievements were excellent: within the limited range of design and technology focus areas that the school offered, 86% of candidates attained A*–C grades at GCSE level. This was well above the national average and above the figure for subjects across the curriculum in the school.

66. One highly effective department did secure high standards, however, using a Key Stage 3 carousel timetable. The inspector described it as follows.

Planning is exceptionally thorough. Consistency throughout the department is remarkable and the head of department vets each module plan thoroughly.

Each module has a concise yet sufficiently detailed statement of aims. These show how the module fits into the overall course. There is a detailed account of what students are expected to achieve at three levels of attainment linked to their starting points; a precise list of technical vocabulary and language activities; references to links with other subjects and out of school activities; resources needed; links to future learning; a list of risks and a detailed assessment proforma. Within this structure, individual projects are detailed in terms of objectives, teaching activities, learning outcomes, resources and extension work.

Teachers also have a good knowledge of the content of modules taught by other specialists. They feel they are able to promote the 'transfer of learning' by helping students to remember previous modules and apply what they learned to current work.

67. Cohesive and rigorous planning by some departments to cover the programme of study and ensure breadth and balance enabled their students to make successful progress. A range of projects enabled them to design and make high-quality products from various materials. In addition, they learned to test and evaluate their own and commercial products. This required very good departmental leadership and management, but many departments did not have this.

68. This case study illustrates aspects of one school's development of a highly effective curriculum to cover designing.

Case study 13: Teaching designing effectively

This is a large 13 to 18 rural comprehensive school with 1,400 students in Staffordshire. It has technology college status.

The school has a long record of innovative teaching of designing and of forging links with industry to add realism to the design and technology curriculum. Two techniques support the effective teaching of designing: a published system whose structure encourages students to think about cost, aesthetics, function, ergonomics, quality, users and the environment when designing. Students are guided to consider these design factors; to carry out product analysis and research; to annotate and evaluate design ideas, both initially and as they develop; and to carry out final evaluations of their products' 'morphological analysis' to help students to open up initial design ideas and avoid the mental blocks which some experience at the start of a 'design and make' project.[6]

Lessons seen during the survey showed that teachers used these techniques well to teach students to think as designers. They included a strong focus on the skills of sketching clearly and simply in two and three dimensions with the aim of developing speed and competence; sharpening thinking skills through simple morphological analysis and using a modified version of the published system to encourage students to focus their thinking; developing quick modelling using card, foam and computer-aided designing; and, to motivate students, setting problems linked clearly to the world outside school.

Year 10 students created devices to hold pens on a desk using magnetism. They worked very effectively in teams of three or four to produce foam mock-ups of final designs which they had selected and developed in their group. The level of cooperation was very high. All students contributed and were well motivated. Their imaginative designs had drawn from a range of visual stimuli. Sketches of initial ideas were bold and clear and the teacher set regular exercises so that they met his high expectations.

Links with industry were exceptionally strong. Where possible, the department set design briefs linked to industry, such as logo designs for a graphics business. Extensive extra-curricular activities included classes for the Young Engineers' competition, the Engineering Education Scheme, Rotary Young Innovators and Young Chef, Young Enterprise and the JCB technology day.

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[6] Morphological analysis can be used to stimulate students to explore options and generate ideas by prompting them to think about the systematic relationships between different attributes. For further information, see E Norman, J Ryley, S Urry, M Whittaker, *Advanced design and technology* (ISBN 0582328314), Longman Group, 1990, page 32.

69. In over a quarter of the schools surveyed, the programme of study was not covered broadly enough, often because of a lack of teaching time or specialist teachers, inefficient use of time or an imbalance in coverage, and weak teaching of designing and evaluation.

70. The differences in staffing and resources for design and technology between Year 6 of a typical primary school and Year 7 of a typical secondary school were stark and the implications for transition, continuity and progression in National Curriculum design and technology have not been recognised sufficiently. A primary teacher, who also teaches eight or more other subjects, works with around 30 pupils, often in a general purpose classroom. Teachers know their pupils very well, teaching them all, or almost all, week. In contrast, a secondary specialist design and technology teacher will see Year 7 students in a dedicated and specifically equipped design and technology room, certainly for only part of the week, sometimes only for a 10-week module, before they move on. This is a formidable barrier to smoothing the transition in design and technology between Year 6 and Year 7 and is rarely made any easier by a lack of continuity in curriculum and teaching.

71. The survey found no examples of reliable Key Stage 2 data about design and technology being transferred to secondary design and technology departments. Given the lack of moderated assessment across primary schools and the large variations in what they teach in design and technology at Key Stage 2, it is unrealistic to think that secondary design and technology departments could rely on such data were it to be transferred.

72. A minority of the secondary schools in the survey overcame this problem through a transition project at the beginning of Year 7 to settle students into the routines of working in unfamiliar specialist design and technology facilities. Students’ work was assessed and schools used the best examples of such projects to adapt the curriculum. Such projects were more effective when secondary and primary design and technology staff were able to make contact with each other, sometimes by the former teaching in the primary schools, sometimes by primary pupils visiting the secondary department.

73. The best design and technology programmes in the survey contributed effectively to the educational inclusion of all students.

Case study 14: Educational inclusion

This is an urban comprehensive school in Camden with nearly 1,000 pupils. The intake is fully comprehensive.

Assessment for learning has been embedded in teaching and organisation. The design and technology teachers use a wide range of teaching methods to stimulate thinking: for example, guided brainstorming; structured group discussions (stressing students' use of precise technical vocabulary to talk accurately about their design ideas); very effective school-made and purchased visual aids; reference to the work of design and technology practitioners and former students; trips to outside sources, such as galleries, to raise students' sights.

The staff are very responsive to individual students' reactions in lessons and are quick to support them and incorporate the ideas they offer, even if very tentatively, in the discussion. Direct and skilful questioning helps to ensure that all members of the class participate. In part, this reflects recent whole-school training to develop questioning. All this combines to promote deep learning and to ensure that all students are included.

74. One design and technology department enlivened the curriculum and teaching materials by producing very good PowerPoint slide shows for each unit. With interactive whiteboards, staff and students used the PowerPoints highly effectively to support learning. As well as including many elements from the unit booklets, animated sections in the slide shows were used to illustrate how to use the relevant tools or manufacturing procedures, such as vacuum-forming. Students used them freely and very effectively during lessons to remind themselves of practical techniques or for guidance on the next stage of the project.

75. Despite the popularity of design and technology, a minority of students in most of the schools visited found it unappealing. In two of the grammar schools this was because the teaching lacked intellectual rigour, despite students' clear capacity to engage in challenging designing and to apply their good mathematical and scientific understanding. More usually, students in some mixed-ability classes were not given enough opportunity to work and use resources at appropriate levels of difficulty. Less able students were not engaged by some projects and a narrow range of teaching methods. In the worst cases teachers either lacked detailed assessment data to show how individual students were progressing, or they did not analyse the data they held precisely enough. The result was that a minority of students did not benefit sufficiently.

76. Some of the schools met the needs of particular groups of students very well by developing vocational strands, as demonstrated in this case study.

Case study 15: A vocational approach to food education

This is an 11 to 16 school in Tameside with 900 students, 20% of whom are of Bangladeshi origin. It draws from areas of social deprivation.

The school developed catering instead of food technology to reflect the employment prospects in the community it served.

Year 9 students worked in an excellent, well equipped catering room, using a recipe to make a chicken or vegetable curry. They were very interested in cooking but the behaviour of some students in this low set was potentially challenging. Firm, well-organised teaching controlled this effectively, as did support from the technician who had bought the necessary ingredients and had laid them out carefully. This overcame the frequent problem of students failing to bring them. All students paid £2 for the ingredients and were quite willing to do this regularly, regarding it as good value.

A brisk, informative introduction and demonstration, using PowerPoint, started the lesson. Because the students were following the same procedure, the teacher was able to instruct the whole class rigorously, as needed, on precise cooking techniques. They handled the ingredients and utensils skilfully, made professionally presented dishes and showed considerable motivation and responsibility. They had to ask their families to eat what they had cooked and to evaluate it using criteria agreed in the class. Each student was expected to incorporate this into a written critical evaluation for homework.

This provision was particularly effective for students with learning difficulties and/or disabilities; those who were disaffected by an academic curriculum; and also for a large number of Bangladeshi boys who planned to work locally in catering.

In Key Stage 4 the school ran a very popular level 1 National Vocational Qualification (NVQ) course in hospitality with the local college of further education where it enrolled its students. College specialists taught the course in the school's very well-resourced catering provision. Students had realistic vocational experiences: assisting in preparing school lunches as well as working in the college's bistro and on local industry placements. This initiative was highly successful because there was:

- adequate funding for the course tutor and registration fees, and to supplement the costs of food ingredients
- a good level of support from a technician
- effectively managed partnerships with the local college, the school lunch provider and local businesses

- training for teachers in food preparation and cooking
- classrooms which were equipped to teach catering effectively.

77. Food technology remains the principal means of teaching food within the design and technology curriculum. As Ofsted reported in 2006, this has caused concern among pupils, parents and headteachers, especially about a lack of time devoted to learning to cook nutritious meals and too much time devoted to low-level investigative work.[7] In some parts of the country, difficulties in recruiting specialist teachers compounded these problems. In the past two years, efforts to solve these problems have been made by increasing the quota for the training of food teachers; revising the criteria for GCSE examination specifications; plans to fund food technology accommodation for schools without it; strengthening of the teaching of cooking in the 11 to 14 age range; and setting up a network of cooking clubs in schools. Time is needed for these well-focused initiatives to work.

Leadership, management and resources

78. Over the three years of the survey, the leadership and management of design and technology departments were at least satisfactory in all but one of the schools visited. They were good in over half the schools and outstanding in six. Leadership and management were best when backed up by supportive headteachers and governors who took time to understand and meet the subject's particular staffing, timetabling and resource needs.

79. Clear aims distinguished the good departments from the ordinary. In the latter, the aims were drawn mainly from custom and practice, and from simply copying text from the National Curriculum programme of study and the requirements for GCSE and GCE examinations rather than from reflection about what the department wanted to achieve. The resulting teaching was formulaic.

80. The more effective departments were crystal clear about what students should achieve and how best to bring this about. Their aims usually began with the aims for design and technology in the National Curriculum statement (see paragraphs 3 and 4). They struck a good balance between those interconnected competencies. In particular, they did not allow either one of the two key competencies – designing and making – to outweigh the other. Most of these departments saw design and technology firmly as part of general education, although most offered, or intended to in the near future, more vocationally orientated courses for students in the 14 to 19 age range. The next case study exemplifies clear aims which are put into practice effectively.

[7] *Food technology in secondary schools* (HMI 2633), Ofsted, 2006; www.ofsted.gov.uk/publications/2633

Case study 16: Clear departmental aims for design and technology

This is a small and high-performing comprehensive school in Wiltshire. Its 964 students represent the full range of ability. It has had technology status for 10 years, during which time it has developed outstandingly good provision for design and technology.

The department wrote: 'Design and technology is not the recent invention of educationalists. Since the time when man first realised that he could improve the condition of his existence, design and technology activity has enabled him to progress. It is the first thing archaeologists look for and throughout history it has supported every human activity. Today it creates wealth to provide the services our society needs.

Design and technology offers a quite unique curriculum experience and it must not be wasted. As a department we have a special responsibility to each child. We are the third R – wrighting – capability – evidence of which predates, by millennia, man's earliest attempts at the other two Rs – reading and reckoning.

To learn to operate in the real world, children need real design and technology experiences – hands-on and active. By producing products made from the same materials as they would use in everyday life children develop real decision-making abilities, because only real products can be evaluated against real criteria. Real experiences lead to real development of the child's capacity to learn, improve and excel. It is widely acknowledged too that children respond differently when working with different materials and in different contexts so it is essential to offer a varied experience of both materials and contexts throughout each key stage.'

Two of the department's aims were:

'To enable every child to find and develop their inherent unique capability so they are able to take responsibility for their own future well-being, lead a fulfilling life and contribute positively to society. This includes learning to use new technologies to overcome physical impairment.

To give every child the opportunity to acquire, to the best of their ability, the generic employment skills and qualities they will need so that they can earn a living, paramount among which will be learning how to make high quality real-world decisions by applying the design and technology process to any situation.'

81. The best departments translated their aims into well-used, effective schemes of work. Teachers developed coherent courses, enabling students to achieve well and make progress. The teaching not only covered the subject expertly but was matched to local conditions.

> A north London school used visits to the capital's museums and galleries extensively to raise students' aspirations by showing them the work of professional design and technology practitioners, such as architects, engineers and product designers.
>
> A school in Greater Manchester, serving an area with a high proportion of adults employed in manual craft trades, ensured it regularly emphasised to students the relevance of design and technology to local employment opportunities. The school reported that this had parents' strong support.

82. Effective schemes of work promoted progression in learning. In the 11 to 14 age range, they were often tightly structured to establish foundations for later, more independent work. This gave students focused yet real opportunities to make decisions, think creatively and use good craft skills to manufacture high-quality products. The activities often motivated students most when they were in tune with their interests, even though these might seem ephemeral to adults, such as enabling them to download commercially produced ring tones to incorporate into the 'steady hand' wire games which they were designing and making. Increasingly, teachers gave older students more choice, such as developing products which they found personally interesting or which met needs derived from links with the local community, industry or external competitions. A good example was the highly effective device developed by a sixth form student which won the Young Engineer for Britain competition in 2006. It enabled people with certain disabilities to climb or descend stairs on foot, unaided; the device attracted commercial interest from potential manufacturers.

83. Headteachers who were determined that design and technology should flourish also helped to formulate a clear vision for it:

> The headteacher of a large middle school had a good understanding of the nature and value of design and technology and had visited other schools to see good practice. She was committed to giving foundation subjects a high status. When she was appointed eight years previously, the design and technology provision was poor. She recruited a very effective head of department whose work, together with the headteacher's vision for and promotion of the subject, transformed the quality of teaching and the standards of achievement.

84. Most of the headteachers of the 47 schools in the survey where design and technology was good or better valued the subject's broader contribution. They welcomed its practical, active dimension and the extent to which students

enjoyed and were motivated by it, especially in the schools which had to work hard to secure good behaviour. The headteachers valued the way the subject provided a disciplined and safe environment.

85. The best schools set specific targets for students' attainment. This was usually done most successfully when attainment was assessed in detail and targets were set across the curriculum in conjunction with rigorous self-evaluation. For example, in one school, the department's annual self-evaluation included a comprehensive and perceptive evaluation of examination performance. It analysed strengths and weakness and set targets for the next year. It also identified how teaching and learning were to be improved. In food technology, the targets included:

- improving GCSE coursework so that all achieve at least a B grade
- extending the policy of entering able students for GCSE in Year 10 and entering them for AS level in Year 11
- improving the organisation of coursework at AS level
- demystifying food science for AS and A2 students.
- circulating self-evaluation within the school.

86. In the schools visited, managing students' behaviour and ensuring health and safety in design and technology were usually good. Poor or dangerous behaviour was rare. This was partly because students were interested in the subject but also because of teachers' high levels of vigilance in classrooms containing potentially dangerous and expensive equipment. Relationships between adults and students were also generally good, at the very least. Teachers, and, increasingly, technicians and learning mentors, gave careful guidance on coursework, individual coaching and, frequently, significant opportunities for students to strengthen their achievements through after-school activities. In one of the schools, the design and technology rooms were staffed daily for students' use from 08.00 until 17.30. This enabled students to pursue their projects in depth and for design and technology to contribute significantly to personalising learning, especially in the 14 to 19 age range.

Part B: Education for a technologically advanced nation

The relevance of design and technology to pupils in the early 21st century

87. Design and technology is intended to enable pupils to design, make and evaluate functional products. They are also expected to work creatively in this practical and technical subject, using new and established technology, and to be aware of the importance of industrial manufacturing and commerce.

88. A report for the Schools Council in 1967, by one of Her Majesty's Inspectors, reviewed the evolution of practical and technical education in English schools.[8] A defining characteristic of such activities was that they had evolved under differing social pressures and therefore gave rise to diverse objectives. While the intentions for design and technology in the National Curriculum seem clear, in practice the requirements are diverse.

89. Technology, like language and scientific enquiry, helps to define the human species. We can shape our environment and therefore rise beyond simply adapting to it. Technology has developed into a complex set of competencies which help us to maintain and improve our systems for supporting life. These are at their most productive in industry and commerce. Design and technology has been developed to enable schools to introduce pupils systematically to the importance of technology. They develop practical and creative design and technology capability to identify needs; to design, make and test products; and to gain related knowledge and understanding.

90. Manufacturing industry and commerce employ staff who have a varied range of capabilities. A large manufacturing company might need, for example, unskilled shop-floor labouring; semi-skilled assembly line work; skilled tool making; technical support; logistical, supply, marketing and sales operations; research and development; and financial and corporate management. A school design and technology course will touch upon many of these activities. The difference between the educational requirements for, say, a semi-skilled machine operative and those for a chartered engineer who leads a product innovation team is very large. Given that the subject should provide teaching to meet the specific needs of all pupils, there should be provision for all levels of ability and attainment.

91. Manufacturing industry in this country has shrunk as it has become cheaper to carry out many low-level operations in developing countries. Although there are fewer job opportunities for school leavers in low-skilled manufacturing, opportunities remain for more highly qualified staff, especially at craft, technician and professional levels, not least in the more technologically advanced industries. A recent research report, for example, has drawn attention to an increasing shortage of skills in engineering.[9]

92. As emerging economies grow, the global use of natural resources increases. Prices are rising and shortages are predicted. Climate change leads to proposals to reduce consumption of, for example, resources linked to greenhouse gases; there are also contrasting proposals for technological solutions which would not

[8] DIR Porter, 'A school approach to technology', Schools Council Bulletin 2, 1967.
[9] P Patel, R Bohorquez and C Scott, 'Market alert: engineering and project management shortage likely to severely affect development costs and viability', Cambridge Energy Research Associates Capital Costs Analysis Forum, 2007.

reduce economic activity. Education for sustainability therefore becomes a priority.[10]

93. ‘Every Child Matters’ requires schools to promote pupils’ enjoyment of learning; the adoption of safe practices and healthy lifestyles; pupils’ positive contribution to the community; and the development of their skills for economic well-being. Design and technology has the potential to support learning in these areas; for example in helping pupils to develop capability, learn vocational skills and secure jobs; to look after their homes, health and safety by practising skills effectively; develop creativity, enterprise and some understanding of finance through design and make projects; and also to enjoy the subject’s practical and active nature.

94. The understanding of and provision for design and technology was outstanding in one of the primary schools and six of the secondary schools visited for this survey and responded to these needs very effectively. The provision in one third of the primary schools and two thirds of the secondary schools also met these needs well. They presented the subject as a comprehensive set of interesting activities which promoted capability within design and technology and an understanding of designing and technology in the modern world and industry. In itself, or in related vocational courses, the subject helped students to shape their plans for work and life after school, which is borne out by many who were interviewed during the inspections. Most of the headteachers in the survey also valued the way in which design and technology provided opportunities for learners to apply knowledge actively and practically, despite the expense of resourcing the subject. Although there is much scope for further development, increasingly the subject provides a practical focus for considering how our needs for products might be met in more sustainable ways. The subject is very popular in primary and secondary schools: learners enjoy the opportunities to develop their ideas, learn to make things and use new technology to create tangible results.

95. In most of the schools surveyed, and especially in the two thirds of primary and the third of secondary schools visited in which design and technology was not good overall, there was scope to improve the relevance of the teaching, especially in terms of sustainability in designing products and in matching teaching more closely to pupils’ needs.

96. Sustainability in designing needs to be brought more to the fore in teaching and examining, and in the projects set. Some high-quality materials have recently been produced for primary schools. Guidance is also available for secondary

[10] *Schools and sustainability*, (HMI 070173), Ofsted, 2008: www.ofsted.gov.uk/publications/070173

schools.[11] In many of the survey schools, however, teachers' awareness of these materials was low and they were relatively unused.

97. The implicit messages students received from some design and technology projects deserve consideration, especially those relating to packaging. The graphics products GCSE course in one high school had included a substantial project in which students designed and made a 'point-of-sale' display for a product. The packaging design and craft skills were very good and students had found the project stimulating and topical. However, they had paid scant attention to the potential waste of materials in the packages and stands they had designed for mass consumption. The teacher acknowledged this was unsatisfactory but, given the demands of the coursework, he did not feel he could give time to consider sustainability. Design and technology has not yet developed beyond the basic design>make>test procedure to consider how products should be created with the need for servicing, maintenance and disposal in mind. (The project outlined in case study 9 was a refreshing exception.)

98. This report has already discussed matching work to pupils' needs. To improve relevance, schools need to move beyond setting work within projects to provide various levels of challenge, towards redesigning courses for the 14 to 19 age range, once students have received a general foundation from ages 5 to 14. Courses for 14 to 19-year-olds need to reflect better the stratification of staff in industry, as this strongly influences students' attitudes towards courses. For example, students aiming for professional levels of work in, say, engineering or food technology, need a provision which concentrates their learning on the more intellectually challenging aspects such as designing, product development, empirical testing or applying mathematics and science in their projects. Curriculum development needs to be such that university admissions tutors regard the application of mathematics and science in these units of work as rigorous and appropriate for university entrance. Students with these interests also need to be able to use computer-aided manufacturing technology to make products quickly so that they do not spend time on craft skills which might be inappropriate at this level.

99. Conversely, there is a need to recognise that craft skills are fundamentally important to some kinds of adult design and technology as the growing number of modern apprenticeships indicates. It is not true that industry has limited use for traditional craft and technical skills. It is inappropriate for craft skills to be neglected because of the perception that they do not represent an intellectually respectable image of design and technology. For many students, the emphasis should be firmly on practical designing and making, as in the Crowther

[11] See Further information section.

Report.[12] Accredited courses for the least able are also needed, especially at the 14 to 16 stage. Many of the schools surveyed found that the coursework requirements for design and technology and related vocational GCSE courses were too focused on the production of an extensive design folder and were unsuited to the specific needs of some students, especially those with learning difficulties and/or disabilities. In these schools there was little awareness of alternative methods of assessment to better match the needs of some students.

100. Many examples of modern projects which interest adolescents have been developed by the Gatsby Technology Enhancement Programme, and are widely publicised.[13] However, too many teachers continue to teach through outdated projects which, at worst, bore their students. Headteachers need to challenge and encourage their staff to find and use interesting projects: these are readily available.

101. Design and technology is partly concerned with new technologies. Many of the pupils interviewed spoke with some disdain about how provision for design and technology and ICT in their schools was out of date. Although many children and young people are used to thinking about possible futures through science fiction, the survey found no evidence of teachers capitalising on this in design and technology to stimulate their imagination.

102. The best provision for design and technology is highly relevant to learners in a technologically advanced society. With careful curriculum development, the needs of those of all abilities can be met. However, to some extent in most of the schools visited, and to a large extent in half of them, provision needed to be modernised, and established but neglected technologies needed to be used more. Design and technology is equally important in considering sustainability in a global economy and in ensuring that, with related vocational areas, it meets the needs of all learners, not just those who are disposed towards abstract designing.

Meeting the needs of boys

103. Girls consistently and significantly outperform boys in GCSE A*–C grades, more markedly than they do in most other subjects, by around 16 to 17 percentage points. This gap is evident in schools' internal assessments right through to GCE A level. The difference tended to be smaller in most, but not all, of the schools visited where achievement was excellent overall. The few very highly performing departments where boys' attainment at GCSE is close to that for

[12] *15 to 18* (Crowther Report), Ministry of Education, Central Advisory Council for Education (England), HMSO, 1959.

[13] Gatsby Technology Enhancement Programme: see Further information section.

girls have a number of features in common, as exemplified in this account from an urban selective secondary modern school:

> Boys perform almost as well as girls in the GCSE examinations. This performance is partly secured by excellent relationships and discipline, as well as the strong vigilance and tight coursework management of the teachers. Individual students are known and respected well and staff are firm and assertive without being overbearing. There is a high degree of mutual courtesy in lessons and boys are made to feel as included in the activities, and are enabled to see their relevance, as well as the girls. Student enjoyment is palpable and this is related to the extent to which they are able to choose 'design>make>test' projects which match their hobbies and interests. Their progress through projects is aided by their division into manageable parts. Pressure is exerted to keep students who might fall behind on track. Assessment and rewards for success or effort are frequent. Much of the learning is practical. Additional technician help is given to those in need, especially when making complex or precision components.

104. The schools in the survey were beginning to recognise that boys' achievements could be improved by adapting teaching more effectively to meet their needs. Over the past 20 years, efforts made to encourage more girls to take workshop-based design and technology courses at examination level have been successful, with considerably higher numbers of girls on GCSE courses than was the case before the National Curriculum. The issue of girls and technology has now been overshadowed by the underperformance and reduction in motivation of boys. Some boys told inspectors during the survey that they would prefer more emphasis on developing practical workshop skills which they saw as relevant to the craft and technician careers to which they aspired as well as to the prospects of applying the skills at home.

105. The inequality that persists in the performance of boys in design and technology has implications for teachers in closely matching learning strategies to their needs, and for schools in the design of the curriculum to ensure it meets the needs and interests of all pupils. An urban school, for example, raised boys' attainment in design and technology very significantly by specific teaching, as shown in this case study.

> **Case study 19: Motivating boys in an urban setting**
>
> This is an 11 to 16 comprehensive school in Salford serving an urban area.
>
> In 2005, around 45% of pupils attained five or more A*–C grades in GCSE overall. In design and technology the average was 53% (boys attaining 46%, girls attaining 64%). However, in 'systems and control', 95% of the pupils gained A*–C grades. All of them were boys, in a widely mixed ability group. Although the course was open to all students, usually only

boys had chosen it; the course was taught by a male teacher. Good information on individual students' prior attainment was provided centrally.

The teacher had very good subject expertise and personal organisation. He had also developed a well-resourced, specialist teaching base. In a lesson seen during the survey, his effect on the boys' attitudes and learning was outstanding.

He was self-confident and obviously interested in the students. He knew them well: references to individuals' personal interests were slipped in at the start and end of the lesson. Mutual respect and firm control were evident. He was caring and gave praise where it was due but in such a way that students did not feel they were being patronised. The atmosphere might be described as industrial and similar to that prevailing in some effective engineering courses in colleges of further education.

Highly effective teaching methods helped to promote achievement. The objective for the lesson was clear, and its technical content – electrical circuitry for control and its management – was concrete and unambiguous. An interactive whiteboard was used effectively. The teacher directed specific questions to individual students, by name. Virtually each one answered correctly because the questions had been pitched exactly to their abilities. The students felt comfortable with this clarity and lack of ambiguity. They took seriously the challenging and largely practical activities about the electronic control of a model automatic lift system for a high-rise building, even those who, reportedly, were disaffected in other classes. They were thoroughly absorbed in meaningful activity. Its relevance to technical employment and living in a technological world was obvious.

106. This teaching was excellent. Some aspects derived from the teacher's personality; others, however, can be replicated. The benefits of this demonstrably effective way of raising boys' achievement included its technological rigour, its link with the adult world of industry and the extent to which the students saw relevance to their future working lives. They should be considered by schools, although they may be at odds with some views about how design and technology should be taught in the same ways to both sexes. In any event, effective ways of raising boys' aspirations and attainment in design and technology are badly needed.

The infrastructure for design and technology provision

107. To enable it to meet its aims to develop practical capability, design and technology requires a specialist infrastructure, including:

- tools, equipment and two- and three-dimensional materials
- space to use these in a safe and healthy way
- subject skills, training opportunities and materials for teachers
- recognised accreditation for courses.

108. It is a relatively expensive subject to teach. This is compounded by the continuing need for schools to invest in the most up-to-date technology.

109. Much progress has been made since the beginning of the National Curriculum in building an infrastructure which supports effective teaching and high standards. However, significant deficiencies and inconsistencies limit the subject's progress: if it is to realise its full potential, these need to be tackled vigorously.

110. Most of the primary schools surveyed had built up sufficient resources to teach major aspects of design and technology to an adequate standard. However, few had good enough provision to cover all the areas of focus to a high standard. The most striking deficiencies were in equipment for cooking and the space to do this hygienically. The more effective schools solved this problem by, for example, temporarily adapting classrooms for cooking, and using rooms set up for parent–teacher meetings and fund-raising events. Initiatives to tackle levels of equipment, however, have had only patchy success.

111. Many of the schools also lacked resources for the more technological aspects of design and technology, such as control and electronics. This was usually linked to staff's inability to teach these to the required levels.

112. In general, the primary schools visited had adapted satisfactorily to the teaching of practical design and technology in classrooms, although many teachers found this difficult. A few schools had developed effective specialist facilities in otherwise unused rooms. From time to time, most schools used other spaces effectively, including halls for design and technology competitions. There were also external visits, for example to city learning centres and partner high schools for enrichment activities.

113. Further development of design and technology in those primary schools where it had not reached its potential included the need to enhance teachers' subject skills and the management skills of subject coordinators; and to establish adequate time for it within a balanced curriculum. These areas need to be tackled systematically.

114. The relationship between the level of resources and the high achievement of students in the secondary design and technology departments in the survey is direct but complex. In the very high performing departments, the range and quality of capital and recurrent resources were never less than good, but some less effective departments were considerably better resourced. The key impact

of resources on achievement, once an adequate baseline to cover the subject's content has been achieved, is the effectiveness of their management and use. These, in turn, reflect the competence of staff, as well as students' motivation. Excellent achievement, above all, is related to high-performing staff who are adept at making the most of the resources they have, and at acquiring those they need. As the Government's 'Building schools for the future' initiative develops, a critical policy issue is the extent to which school staff are properly skilled to manage the new accommodation and understand clearly how specialist resources can be used most effectively.

115. Government guidelines on accommodation for design and technology were updated in 2004.[14] Some advisers in local authorities, however, are rightly concerned that the guidelines pre-date recent initiatives to strengthen vocational provision and therefore do not reflect adequately the demands which new vocational courses might make on accommodation. Further, they do not give sufficient guidance to architects about good specialist accommodation for such courses in schools. This omission could have expensive consequences if schools being rebuilt or modernised are left with inadequate provision for vocationally oriented design and technology courses.

116. In 2003–04, a Government-funded pilot design and technology training programme was carried out in 10 local authorities under the aegis of the Key Stage 3 Strategy. Each of the 10 local authorities employed a full-time training consultant. They supported selected schools, using good-quality training materials which had been written specifically for the project. They worked particularly to help teachers improve their teaching of design, which benefited considerably from the centrally funded training and subsequent development work. Improved teaching and learning were evident in the variety, range and effectiveness of the teaching of designing. Students' work improved, showing better development and exploration of design ideas, planning and evaluation. The consultants also played a significant role in helping teachers to develop the confidence and willingness to try new ideas beyond their 'comfort zones'.

117. Since the one-year project ended, some schools who were not involved in the pilot have enlivened the teaching of design and technology in Key Stage 3. However, the influence of this well-conceived training has been weak nationwide, except in the few local authorities which have retained the capacity and advisory support to run subject training for their schools. One consequence of the failure to roll out this programme to all schools has been the continuing fragmentation of the curriculum in Key Stage 3. Few schools in the survey had overcome this in the ways the project recommended; they continue to teach a range of only loosely connected projects with little regard for the progressive

[14] *Design and technology accommodation in secondary schools: a design guide*, DfES, Building bulletin 81, TSO, 2004.

learning of designing skills or for eliminating wasteful repetition between projects in teaching aspects of designing.

118. In too many of the schools visited, teachers' interpretation of the assessment requirements meant that pupils were pushed through a series of hoops, corresponding to stages in designing, to secure marks for their coursework portfolios. This rewards the conformist rather than the risk-taking innovator. It stifles creativity and encourages formulaic thinking and the embellishment of design drawing rather than rigorous thinking about designing. Although the QCA, together with partners in higher education, schools and awarding bodies is tackling this, the problem remains deeply embedded.

119. In addition, many of the schools surveyed required accredited courses leading to recognised qualifications for their less able students in the 14 to 16 age range which were less intellectually demanding and more practical than GCSE. The perceived lack of such courses caused high levels of dissatisfaction.

Design and technology: where now?

120. Within the National Curriculum, design and technology was a particularly radical and difficult innovation because of the need to construct a modern technological discipline from a set of loosely connected craft subjects. It needed to be taught by an established workforce using existing resources and accommodation and, initially, within a programme of study and attainment targets which were too complex. Against this background, progress has been impressive. As this report shows, and though much good innovation has been achieved, much remains to be done for the subject to reach its potential.

121. In the past 15 years, various initiatives have been important in promoting improvement, including: those funded by the DCSF such as 'Food in schools' and 'Designerly thinking in the Foundation Stage'; the QCA scheme of work and its published exemplar materials; the support work of agencies such as the Design and Technology Association, the Gatsby Technology Enhancement Programme and the British Nutrition Foundation; and also regional initiatives from universities and by local authorities who remain active in design and technology.

122. Given the scale of development still needed to ensure that provision can become good overall, and Ofsted's consistent identification of weaknesses since the start of the National Curriculum, it must be asked whether a more systematic approach to improvement is needed nationally.

123. The National Curriculum set high expectations for design and technology to promote technological, creative and practical capability – both for learners' personal development and to support national efforts to become increasingly competitive in the global economy. Given these objectives, it has to be concluded that the subject has not made sufficient progress in a large minority of schools.

124. Extensive but relatively piecemeal development has taken the subject only so far. There is now a case for a national development plan to make design and technology in all schools as relevant to the early 21st century as its original architects intended, especially:

- for the schools which, so far, have found modernisation difficult
- to ensure that research and development into the content and methods of teaching design and technology are conducted systematically to enable the subject to keep up with technological progress.

Notes

This report draws on evidence from Ofsted's school inspections from 2004 to 2005 and on specific surveys of design and technology conducted by Her Majesty's Inspectors between 2004 and 2007 in primary and secondary schools. A minimum of 30 primary and 30 secondary schools were inspected each year during this period. Survey work in schools focused, in particular, on the extent to which National Curriculum aims were being met by the subject in the primary and secondary phases, the nature of food technology in the secondary curriculum and the contribution made by the subject to educational inclusion. The report also refers to research papers.

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