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Computer-aided design and manufacture in design and technology: Ripley St Thomas Church of England High School

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Brief description

The school demonstrates how computer-aided design and manufacture (CAD/CAM) can be integrated successfully into design and technology provision in a secondary school. Students confidently use professional standard software and manufacturing equipment and, as a result, their vocational skills are exceptionally well advanced by the time they leave school. Students have an advanced understanding of modern and smart materials, electronics, systems and control and make outstanding use of CAD/CAM resources to stay up to date with developments in research and innovation.

Overview – the school's message

'When I started as a teacher at the school 12 years ago there was virtually no access to information and communication technology and computer-aided equipment except for a large-scale vinyl cutter which was gathering dust. GCSE results were well below average and the department had been judged to be inadequate in the Ofsted inspection. We wanted to improve and we started by addressing the teaching of design skills and integrating them into project work. Our vision includes setting high standards at Key Stage 3 to make innovative, precisely made products. Computer-aided design and manufacture is the natural extension of this vision and we agreed a rolling programme of improvement with the headteacher and senior leaders more than three years ago. Without their support over the last few years, current standards and achievement would have been impossible.

D&T is now popular and successful and students achieve well from their average starting points on entry to the school. In the GCSE Product Design course, 77% of students gained A* and A grades in

2011 and 150 students are studying D&T in the sixth form. In Year 13, all students gained A or B grades at A Level.'

Stuart Douglas, Head of Design and Technology

The good practice in detail

A clear vision is shared with staff and students and underpins the development of all projects. It enables students to use their design knowledge strategically to convey their ideas, while holding fast to the principles of good design. The process progressively engages them in projects that are as close as the school can make them to working practice.

An example of a project in Key Stage 3

The foundation of good practice in using computers to support the designing and making of products takes place in Key Stage 3. Students in Year 9 learn how to use CAD as one of a range of design tools. In one project, they design and make a case for a USB memory stick and sketch ideas and design proposals. The lessons are taught by an experienced D&T teacher working with a university student.

Students are keen to make their own working USB memory stick and the lessons quickly capture their interest. The introduction to the lesson is brief, sharply focused on the learning objectives, and clear about what is to be achieved by the end of the session. The teacher defines CAD as 'any design or drawing process using a computer programme,' during a quick demonstration of a professional CAD package. Challenging questions make the students think hard about its use and purpose, for example, 'How has CAD affected the modelling of design ideas?', 'What difference has CAD made to the development cost of a product?' and 'What impact has it had on the quality of products?'. The students work on two screens. One has a video tutorial developed by the staff to simplify the use of complex professional software in the initial stages and the other contains the CAD package.

The students learn independently, working at their own speed. The teacher and the university student provide support and advice, and continue to ask challenging questions which increase individuals' understanding at a rapid pace. In turn, the students challenge the teacher with questions such as, 'How can I make it slightly wider at that point?' and 'Is it possible to use curved lines through 180 degrees?'

The students learn quickly how to apply their new CAD knowledge and skills to their own design work. They begin to explore the potential of their own design ideas which they have sketched in a previous lesson. They also gain an understanding of how CAD can be used as a new tool when designing. Comments such as 'Oh, this is amazing, it flies and rotates so you can see it from all angles', and 'You can see the circuit board in fine detail and it makes you want to know more about what is going on' are routine.

Teaching is planned so that students confidently and progressively build on these experiences to become highly proficient in communicating their

visual designs to others and in making accurate models in a range of materials. This provides a secure base for more technically complex, creative and innovative work in later years.

An example of a project in the sixth form

In Year 12, 25 product design students are team-taught by two teachers in order to maximise the benefits to them of their teachers' expertise and industrial experience. The students have been asked to design a new early learning toy for a baby aged between two and 12 months which would be sold by an international company. They work in small design teams and have been given four weeks to develop a product and present it to a panel of judges made up of a mother with a sixth-month-old baby, the two teachers, and two university students who are studying design and working at the school. The work challenges students to explain the rationale for their product. It is a good test of their earlier work interviewing the client or working with a user focus group to investigate in more detail the problems they had with existing products. Students' skills in using different methods and the depth of research are developed throughout earlier key stages and are consistently focused on functionality and usability. This supports students' thinking and the development of innovative ideas to meet the needs of users.

In developing their proposals, students demonstrate that they are highly competent users of professional standard CAD software and use it as one of a range of design tools. This is because they learned about how to use CAD/CAM when designing at an early age. Using the technology helps them to work to fine tolerances to make very precise components. They integrate this with well-developed knowledge and skills in using machines and hand tools to achieve a very high quality of finish in their products.

The teams use the full range of techniques to aid their design work which can be seen in the slides of their work on the department's blog. The following examples focus on the use of CAD/CAM in the projects and how it was used to develop design proposals and manufacture prototypes.

The students gain first-hand experience of developing and pitching their design proposals for critique. The style is similar to television programmes such as *Dragons Den* and *The Apprentice*. There are time constraints and clear rules for the teams to follow. Presentations must include a high-quality physical model using an appropriate range of materials such as modelling foam, wood and fibreboard, vacuum-formed plastics, and rapid prototype resin. A digital representation of the proposed design and a mock advertisement for the product are also required. The design teams use CAD/CAM equipment to model ideas, present prototypes, and develop advertisements together with many other design resources available in the school.

The presentations were high quality. The full content can be found on the blog, which also includes examples of other students' work in different year groups. The judging panel assessed:

- the quality of research
- the range of design proposals
- the quality of the final model
- the suitability for the client
- team effectiveness

- students' digital representations.

The students referred to the use of CAD/CAM during their presentations with comments such as 'I did a quick rendered drawing of a good proposal using CAD and with minor changes it worked first time', and, 'Using CAD/CAM really helped us produce a professional prototype in the short time we had to meet the deadline'. They also recognised the limitations, as one said 'I used CAD and even then it took a long time to scale the parts down and make a precise prototype'. Final prototypes were put to the test by the panel. They included reactions from the baby and the mother who asked challenging questions such as 'Why did you decide not to go for dangly legs?' to which a student replied, 'It would cost more to manufacture'.

The aims of the project were met exceptionally well. Students made excellent progress and their achievement was outstanding. They rose to the challenge and developed high-quality physical models, under time constraints and using creative digital software, computer-aided design and manufacturing equipment to aid the development and representation of a new product. The students also derived many benefits from working together.

Stuart says, 'The final outcomes of this project were a real joy to critique. The project was devised to take the students out of their comfort zone, designing for a market they know very little about and in the process removing any preconceptions. From the initial brief and meeting with the client (a mother and six-month-old baby), the design teams worked independently. We expected the students to use their full range of skills, knowledge and understanding, including CAD/CAM, to develop a new product. Staff intervened only when asked by students for decisions or advice. This helped us to assess how well students were making relevant use of their earlier knowledge in practice. The opportunity to present their ideas to the client was very rewarding for the students. They effectively communicated the rationale for each decision and their design intent and ideas. This experience, along with further preparation, will stand the students in good stead for university interviews, as many continue on to design and engineering courses.'

The school's background

Ripley St Thomas is a recently formed 11–18 Church of England Academy with 1,650 students on roll. Facilities include five workshops, three food rooms, two textiles areas and a dedicated CAD/systems and control room. Two other IT rooms run the CAD software and are used by all the D&T material areas. All D&T rooms have at least three computers which allow students to access CAD software and to download CAM equipment such as two routers, a laser cutter, a six-thread embroidery machine, a CNC lathe, two rapid-prototyping machines and advanced printing facilities. The department has been nationally recognised by the Design Council and has won the Audi 'Young Designer of the Year' award three times. GCSE courses are offered in product design, textiles, resistant materials, systems and control and food technology. More than 150 sixth-form students are following courses in product design, food, systems and control, and textiles.

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