The Independent Schools' Microelectronics Centre

Technology at Brentwood

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This paper describes how Brentwood School are incorporating aspects of micro technology within the life of the school. They are using a design based, problem solving approach which serves to bring together applications in both science and the arts.

This paper has been specially written by Alan Robinson, who is head of the Applied Science and Technology Department at Brentwood School.   The Centre is grateful to him for his contribution.

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Introduction

Within a decade, parents who wish to send their daughters
and sons to Independent Schools will expect these schools
to be equipped for learning how to live in the Technologi-
cal age.

Not only will they expect pupils to have access to micro-
computers in laboratories, subject areas and classrooms,
but also in the school offices, so that Headmasters and
Headmistresses can have rapid access to information, in the
same way that Bank Managers have at present.   The Common
Room will have computer facilities, not just for mark
analysis, but for administrative purposes, and lesson
preparation.

At Brentwood School we are beginning to take our first
steps towards this.   The department of Applied Science and
Technology links work in computing, electronics, and commu-
nications with work in science and in other areas of the
curriculum.   The article describes and tries to justify
what we have done, and what we aim to do in the near
future.

Why teach microelectronics/computing

The reasons why Brentwood School has become involved with microcomputers are:-

1. Pupils are interested in them. They are already using
    them at home. (Only two out of this year's fourth
    year Upper stream class do not have access to a
    computer at home.)

2. Parents are keen that their sons and daughters are able
    to use computers. Some regard the ability to use
    computers effectively as important as being able to
    read!

3. Microcomputers could aid the learning and understanding
    of certain topics in a number of subjects, as well as
    providing teachers with an increase in the variety of
    means by which ideas can be presented to a class. A
    computer can be a blackboard, film projector and
    quizmaster all rolled into one.

4. In the design-based science and technology subjects,
    such as Applied Science and Technology, they provide
    the opportunity to develop both logical and inventive
    thinking, as there are many project situations in which
    microelectronic components and microprocessors can be
    used to solve problems. They also provide an almost
    continuous and up-to-date stream of examples of how
    microelectronics and informatics are changing our
    world, which is helpful in developing an understanding
    of the process of Technology.

5. As their price falls, it is becoming cost effective to
    use them in schools.

What is done : Outline

Brentwood School, Essex, is an Independent School which
consists of a Preparatory School containing 230 boys
between the ages of 7 and 11 years, and a Main School
containing 870 pupils aged between 11 and 19 years.   It is
about three quarters day and one quarter boarding.

The majority of the work concerning Microelectronics is
done in the Applied Science and Technology Department which
functions as part of the Science Department, alongside
Physics, Chemistry and Biology.   The Applied Science and
Technology Department is housed in its own separate
building which contains two project laboratories, library,
workshop and preparation rooms.   Currently, other depart-
ments, Economics, Mathematics, Geography and Science are
making use of the Computer facilities available in the
Applied Science and Technology Department.

The work in the Applied Science and Technology Department
is divided into two parts, work undertaken during school
(or timetabled time) and work done through the Applied
Science Clubs.   In practice, there is considerable over-
lap between these parts.

Form Structure : for first to fifth years

After the first year, pupils are streamed into five forms -
an Upper stream, with the four other forms being divided
into two pairs of parallel forms.   The timetable
allocation is the same for each form in a pair:

Upper stream	— Ux
Two parallel Middle stream forms	— MxA and MxB
Two parallel Lower stream forms	— LxA and LxB

A three-"A" level Sixth Form course follows the "O" levels
taken in the Fifth forms.

Notes concerning the table on Page 7

(1) Underline First to Fifth years

In the third year all forms are allocated to the Applied Science Centre Computer Room for one Mathematics lesson each week for "Computing for Mathematics", (taught by their Mathematics teacher).

The following departments will be using computers for demonstration purposes: Physics, Chemistry, Biology and Geography.

The Applied Science Department has computers available for all members of the sets to use computers.

(2) Sixth Form

The following departments use computers in their course: Mathematics, Physics, Chemistry, Geography, Economics and Business Studies.

Subject Structure (Timetable) (Periods are of 45 mins duration)

Subject	1st year	U2	M2A / M2B	L2A / L2B	U3	M3A / M3B	L3A / L3B	U4	M4A / M4B	L4A / L4B	U5	M5A / M5B	L5A / L5B
English	5	4	5	5	4	5	5	4	5	5	3	5	6
Maths	5	3	5	5	4	5	5	4	4	5	3	4	5
Geography	2	2	2	2	2	2	2	2	2	2	3	3	3
History	2	2	2	2	2	2	2	2	2	2	3	3	3
Physics	2	2	2	2	3	3	3	3	4	4	3	4	5
Chemistry	–	2	2	2	3	3	3	3	3	3	3	4	4
Physical Education	3	2	2	2	1	2	2	1	1	1	–	1	1
Divinity	1	1	1	1	1	1	1	1	1	1	1	1	1
French	5	4	4	4	3	4	5	4	4	5	3	4	5
Latin/German/Spanish	5	4	5	–	4	4	–	3	4	–	3	4	–
Greek/German	–	4	–	–	4	–	–	4	–	–	3	–	–
Spanish/Applied Sci.	–	–	–	5	–	–	5	–	–	5	–	–	–
Applied Science	–	–	–	–	–	–	or 2 +3	–	–	or 3 +2	–	–	–
Biology	2	–	2	–	2	–	–	2	–	–	3	2	2
Biology and Applied Sci.	–	–	2	–	–	–	–	–	–	–	–	–	–
Biology or Applied Sci.	–	–	–	–	–	–	2	4	–	–	–	–	–
Art and Craft	2	–	–	–	–	–	–	–	–	–	–	or	or
Art and Applied Sci.	–	2	–	–	–	–	–	–	–	–	–	–	–
Applied Science & Craft	–	–	–	–	2	–	–	–	–	–	–	–	–
Art/Craft/Music	–	–	2	2	–	2	2	–	1	2	2	2	2
Art/Craft/Applied Sci.	–	–	–	–	–	–	2	–	–	2	–	–	–
Music	1	1	1	1	–	–	–	–	–	–	–	–	–
Clubs/CCF/FSU	1	1	1	1	1	1	1	1	1	1	1	1	1
	36	36	36	36	36	36	36	36	36	36	36	36	36

The Applied Science and Technology Course
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The Applied Science and Technolgoy course is a course
taken to "O" Level by some pupils in years 2, 3 and 4.
It aims to help pupils to develop logical and inventive
thinking at an appropriate stage in a pupil's intellec-
tual growth.   This is done by allowing pupils to study
situations, set up hypotheses and test them against real
world criteria rather than against teacher acceptance.
This seems to aid the development of more mature attitudes
as well as being enjoyable for the pupils.

It is a design based course involving scientific and
technical activities rather than craft based, although
craft is still an important component.   Everyday aspects
of science, mathematics, computer studies and economics
also form important components of the course.   It is a
carefully structured course, certain sections of which can
be done using independent learning which allows pupils to
proceed at their own pace.

The first year of the course (for the second year pupils)
is a foundation year introducing pupils to useful
techniques and ideas needed for their project work.   The
science and technology ideas are examined by studying
everyday examples of their application.

The pupils learn computer graphics, sketching, modelling,
workshop practice, mechanisms, electricity, electronics
and simple systems behaviour.   Case studies are made of
the car and the British electricity system.   A number of
mini-projects are undertaken to help pupils to link their
ideas together and to obtain experience of realising their
own ideas in open-ended situations.

The second year of the course (for third year pupils)
consists of a series of electrical and electronic
investigations or tasks involving motor control, traffic
light control, and elementary robotics (linear and digital
electronics). Aspects of the economics of production and
large scale project planning are studied by means of
system models. The final part of the year consists of an
introduction to Systems Analysis by means of case studies
such as burglar alarm systems, library and stock control,
or nursery school teaching aids.

During the second year of the course, the Mathematics
department use the Centre to teach a period of Computer
Programming each week. Certain ideas from this are used
in the Applied Science and Technology course.

In the third year (fourth year pupils), two-thirds of the
time is spent working on the "0" Level project. Further
computing, some of the more mathematical aspects of
electric and electronic circuit design, materials and
structures, gearing systems, aspects of technology and
society, biological, environmental and information systems
are studied.

At the end of this year, the pupils in the Middle and
Lower streams take their "0" Level in Applied Science and
Technology. This is a Mode 3 examination which is set
and marked by Brentwood School and moderated by the Oxford
Board. 40% of the total mark is awarded for the project,
35% for the theory of Applied Science and Technology and
25% for a Systems Analysis and Design paper.

The Upper stream take their "0" Level in the Fifth year.

What is done : in school timetable time

The Lower A and Lower B forms are setted together for a
choice between either Spanish (a second language) or
Applied Science and Technology to "O" Level. The self
motivating and carefully structured nature of the Applied
Science and Technology course enables pupils to undertake
work in their spare time such as lunch times, after school
and holiday time. The "O" Level Applied Science and
Technology is taken in the fourth year.

The Middle A and Middle B forms take two compulsory
languages and consequently have less time available than
the Lower A and Lower B forms for Science and Technology
to "O" Level.

The Upper stream takes a foundation course in Art/Design
Technology during the first three years. During the
fourth and fifth years they choose between Art or Craft or
Applied Science and Technology.

During the Sixth form subsidiary time, courses are run in
"O" Computing, "A/O" Computing, "A/O" Electricity and
Electronics, "A" Electronic Systems and "A" Computer
Science. (The "A" Levels are only available as fourth "A"
Levels at present.)

The numbers taking the courses in timetable time are:

Year 2 Applied Science and Technology
    Upper stream 2 periods/wk for ½yr with Art   15 pupils (1 set)
    Middle streams 2 periods/wk for ½ year with Biology 15 pupils (1 set)
    Lower streams 5 periods/wk   28 pupils (2 sets)

Year 3 Applied Science and Technology
    Upper stream 2 periods/wk for ½ yr with Craft   15 pupils (1 set)
    Middle streams 2 periods/wk.   30 pupils (2 sets)
    Lower streams 2 periods/wk   38* pupils (3 sets)
            (* 13+ intake set of 10, intensive course)

Year 4 Applied Science and Technology
    Upper stream 2 periods/wk   15 pupils (1 set)
    Middle streams 4 periods/wk   30 pupils (2 sets)
    Lower streams 3 periods/wk   38 pupils (3 sets)

Year 5 Applied Science & Technology
        Upper stream 2 periods/wk   15 pupils (1 set)

During 2 periods of Subsidiary time the following are
available for up to 32 pupils at a time in total at Lower
Sixth, and again at Upper Sixth form level:

    Introductory Systems Analysis and Programming
    Introductory Microelectronics
    "O" Computer Studies
    "A/O" Computer Studies
    "A" Computer Science (+ 3 periods in U6)
    "A/O" Electricity and Electronics
    "A" Electronic Systems

Staffing the timetabled classes

All the staff who teach the Applied Science and Technology
classes teach the majority of their timetable for other
departments with the exception of the Head of Department
who teaches half a timetable of Physics and half Applied
Science and Technology.

In all, five teachers are directly involved in the Applied
Science and Technology course at some stage.   (Three of
these have graduate or post graduate qualifications in
Engineering.)

It is desirable to have staff who are adaptive,
co-operative, have design ability themselves and who can
teach well.   It is not an area of the curriculum for
inexperienced teachers.

What is done : Out of School

The Applied Science Centre is used to support the spare
time interests of pupils in that it acts as a centre for
the provision of advice, ordering of components, supply of
magazines and loan of equipment for project work.

There is a fee of £5 in the Christmas and Easter terms for
those who join the clubs associated with the Applied
Science centre.   The Centre is only open for half a term
in the Summer when the fee is £2.50.   These are the
Computer Study Group and the Amateur Radio and Electronics
Society for the third year upwards.   Club membership is
limited to 160 members.

Monday lunch time	Second Years
Monday after School	Staff
Tuesday lunch time	Closed
Tuesday after School	Third to Fifth Years
Wednesday lunch time	Third to Seventh Years
Wednesday afternoon	Third to Seventh Years
(Club days only)	
Thursday lunch time	"O" Level Applied Science and Technology candidates
Thursday after School	Closed
Friday lunch time	First to Seventh Years
Friday after school	1st and 2nd Years Electronics Club
	1st and 2nd Years Computer Club
Saturday lunch time	Closed
Saturday after School	Third to Seventh Years
(Club days only)	

Those pupils taking "O" Level Applied Science and Technology do some of their design, programming or electronics practical work during lunch times and after school on Tuesday evenings. Pupils doing computing and electronics projects have computer or laboratory access during lunch times and on games afternoons, if they undertake some exercise first, usually swimming, squash, badminton or running.

Pupils taking "A" Level or who enter competitions have almost unlimited access at lunch times and have either one evening after school or two Private study periods in the Centre each week. The competitions entered are the NELEX (North East London and Essex Schools Science and Technology Competition), Kent Software Trophy, Young Engineer for Britain, Young Designer of the Year and when it was running, Young Scientist of the Year.

On Fridays the first and second years have last period for Club activity. Sixteen of these attend Junior Computer Club and sixteen attend Junior Electronics Club.

The Combined Cadet Force Army Signals and Motor Transport sections, as well as the Naval section, have technical support for their coursework, as well as for certain projects, provided by the Applied Science Centre.

Staffing : After school (club times)

Five members of staff use their spare time to work in the Applied Science Centre, after school and on games days. They are assisted by one or two laboratory assistants when the Centre is open.

The Centre closes after school and on games days during periods of examination marking and report writing, as well as for Staff meetings.

How much does it cost?

Costs vary from region to region and situation to situation. They can be estimated as follows:

(1) CAPITAL COSTS
(a) Laboratory space
In certain cases a Physics Laboratory could be modified to teach both Applied Science and Physics, a Craft room might be modified to teach Applied Science and Craft or a purpose built centre could be provided.

(b) Furniture - Benches, cupboarding and shelving.

(c) Equipment (2nd - 7th year)
£6,000-£10,000 to cater for one set of 16 at a time.
£11,000-£18,000 to cater for two sets of 32 pupils at a time.
This includes at least 16 microcomputers (Amstrad), and all the books and standard electronic equipment including oscilloscopes.

(2) RUNNING COSTS

(a) Teaching staff time and laboratory assistance.
(b) Heating, lighting, cleaning, maintenance, insurance and telephone.
(c) Exercise books, new books and new equipment to replace obsolete or worn out equipment.
(d) The payment of a club subscription can be used to reduce running costs substantially.

The payment of a club subscription (£5/term/pupil, £2.50 in the summer term) contributes to substantially reducing running costs. Of the £2000 per year income produced, £1000 is spent on expendables: solder, computer paper, telephone calls, electronic components and booklets for basic courses. The other £1000 is used to pay for library books, meters, soldering irons and oscilloscopes which are loaned to club members who need them for project work. It may soon be possible to allow microcomputers to be lent out to club members for the holidays.

Possible Future Developments

Future developments that are envisaged but which still require considerable thought are:

(1) The introduction of Amstrad, BBC or Spectrum microcomputers into those Departments requiring them for teaching and demonstration purposes.

(2) The use of a mini-computer or microcomputers for school administrative purposes (including careers information and testing).

(3) The installation of a microcomputer in the Common Room for administrative purposes and lesson preparation.

(4) Introduction of 6th Form Technology courses to A-level.

Development of Micro-electronics in School

In order to obtain effective development of micro-electronics in a school you require all your subject teachers to be able to evaluate computer programs produced for their subject. If possible there should be at least one person in each department assessing the material as it becomes available. They will need time and easy access to the microcomputers.

The other important area is associated with the development of teaching Applied Science and Technology. You require a department which can evaluate and generate both hardware and software for educational use and run design (or systems thinking) based Technology courses. Again such a department must have appropriate manpower, time and resources. The expertise and information that this department has needs to be readily available to others in the school.

APPENDIX

"O" LEVEL IN APPLIED SCIENCE AND TECHNOLOGY (MODE 3),
BRENTWOOD SCHOOL, ESSEX.

Aims of the Course

(1) To help to develop a more rational and inventive
approach, with greater insight, to problem solving and
decision making using Systems thinking.

(2) To enable individual pupils to try out their own ideas
by means of a project requiring analysis, synthesis
and implementation.

(3) To make pupils aware of the nature of technology as a
purposeful activity by which man attempts to satisfy
his perceived needs by the control and processing of
energy, matter and information.

(4) To make pupils aware of the nature of their environ-
ment, industry and business in terms of systems models
and to relate these models to current, everyday tech-
nological situations.

SYLLABUS

The syllabus has been divided into two parts, a common
core and specialist topics.   Pupils are expected to study
at least three of the specialist topics.

Common Core

(1) Systems and systems design.
(2) Visualising, drawing and sketching.
(3) Elementary properties of materials and workshop
    processes.
(4) Load bearing structures.
(5) Mechanical systems.
(6) Electrical and electronic systems.
(7) Applied mathematics and computer systems.
(8) Ecological systems.
(9) Industrial and business systems.
(10)Technology, and society.

Specialist

(A) Workshop processes, materials and the design of
    structural systems.
(B) Design of mechanical systems.
(C) Design of electronic and electromechanical systems.
(D) Computer systems and applications.
(E) Ecological systems and investigations.
(F) Other topics by special arrangement.

The examination consists of two theory papers and a
project as follows:-

Paper (1)

Applied Science and Technology ($2\frac{1}{4}$ hours, maximum mark
105, 35% of the overall exam percentage).

Questions are set on the syllabus which follows. The
paper is divided into two sections.

Section A (85 marks) consists of compulsory questions
taken from the common core of the syllabus. It includes a
comprehension exercise (10 marks), short questions
requiring analysis and synthesis (65 marks), and a
question concerning Industry, Technology and Society
involving decision making (10 marks).

Section B (20 marks) consists of a choice of two questions
chosen from not less than four set on the specialist
sections of the syllabus. These questions are part
analysis and part synthesis.

Paper (2)

Systems Analysis and Design ($2\frac{1}{4}$ hours, maximum mark 75,
25% of the exam percentage).

One situation will be chosen from three situations. A
systems analysis will be made (35 marks) followed by a
choice of a solution from the analysis and the design of a
possible system (40 marks). The system design will be
presented in the form of annotated sketches and diagrams.

Project

(At least two terms' duration, maximum mark 120, 40% of
the examination percentage).

This will be a systems study comprising of analysis,
synthesis, implementation and iteration. The studies may
be either:

(A) laboratory/workshop based systems construction
    projects, or

(B) workshop/laboratory/field based systems investiga-
    tions, or

(C) laboratory/field/computer based systems investiga-
    tions in order to meet a defined purpose.

Marks will be awarded for:-

(i)   Analysis. Investigation, description and systems
       analysis of the situation. Definition of system's
       purpose(s).

(ii)   Synthesis. Construction of models, propositions of
       alternative solutions, combining components into sub
       systems and systems. Perceiving emergent proper-
       ties. Refining the information to produce a plan,
       best solution or justified course of action.
       Iteration.

(iii) Implementation. Construction or realisation of a
       new system. Testing it and listing its limitations.
       Iteration.

(iv)   Presentation of the write-up.

The project work will be assessed by the school and will
be moderated by an external examiner.   (A project marking
scheme is included with this syllabus.)