Remote Sensing in the School Curriculum

Alison Caldwell
Email: AlisonCaldwell@compuserve.com
Luckley Oakfield School, Wokingham Berkshire RG40 3EU
Remote Sensing Society

INTRODUCTION

Remote sensing has major advantages as a vehicle for learning. It provides attractive, familiar imagery that can stimulate pupil interest and enhance understanding of Earth system processes. *"Now that many young people travel in aircraft and see satellite images every day on the television weather forecast, views of our planet from the air, or from space, are a comfortable and familiar part of everyday life. For the teacher these images offer a uniquely powerful resource."* (Barnett et al 1995). Remote sensing crosses a range of disciplines; for example, imagery is mentioned in a GA publication entitled "Geography and Science, Forging Links at Key Stage 3" as providing a "good opportunity for cross-curriculum teaching" (Trend, 1995). Remote sensing also has considerable potential for delivering IT requirements. These opportunities spring from the dependence of the remote sensing industry on IT and the digital nature of the data obtained. Hard copy images and digital image data have potential in the classroom.

A OPPORTUNITIES FOR REMOTE SENSING

a. Skills Shortages

In both industry and society generally the need for pure and applied scientists, and people with ICT skills is recognised but there are fears that the skills shortage is likely to increase. *"Earth observation (EO) will not survive unless its commercial viability is proven"* said Martin Shelley of BNSC (Guest Speaker at RSS Student conference April 1997 at UCL). If a future Remote sensing community is to thrive, suitably qualified personnel, with the relevant scientific, geographical and information technology (IT) skills, are needed in both the data capture and data-user segments of the community. At the Association for Geographic Information conference held on 1 May 1997, *"The Future of Geographic Information. Ten years after Chorley"*, the closing discussion centred on opportunities for, and limitations preventing, continued effective use of geographical information. The importance of highly developed spatial awareness skills within the general population was recognised as a significant factor. Skills shortages, particularly in IT, have been identified elsewhere. The following points are made in an article by Nicholas Booth (11 June 1997, "Skills Shortage Grows", Interface, *The Times*).

- Anthony Parish, the Director General of the Federation of Electronics Industry, "If we are going to grow in our uses of IT, the shortage will have to be addressed quickly".
- The shortage of specialists in the Physical Sciences is a major concern. The number of places being taken up in undergraduate programmes on science courses, in comparison with arts or humanities, is declining. Fewer pupils are opting for post-16 science subjects at school.
- There is a shortage of science teachers, particularly physics specialists. "*A recent survey by the Institute of Physics showed that two-thirds of all Physics teachers are within ten years of retiring*".

A major strength of the NC is that, through the Core and Foundation subjects, it requires the teaching of scientific, information and communications technology (ICT) and geographical skills at secondary level that will hopefully tackle some of these problems. How will the NC requirements be met? Remote sensing has potential as a means of delivering them and there is the opportunity for positive input from the remote sensing community.

b. What role for the new BNSC Earth Observation CD-ROM?

BNSC has been developing a CD-ROM: Window on the World, with the needs of the current education community in mind. The overall aim of the CD-ROM is *"To raise awareness of Earth Observation as a tool for understanding Earth processes and managing resources, to enhance the welfare and quality of life of mankind."* (Martin Shelley, personal communication). The CD has a two-pronged approach; one

area is targeted at the business sector; a second area is targeted at the education sector. The content of the education section, and the structure and functionality of the CD are designed to make it attractive and useful for pupils, teachers and parents. The material is written so as to be accessible to pupils from a range of age groups and curriculum areas. The CD supports the requirements of the NC in Science, Geography and IT, and provides information relevant to post-16 courses such as the GNVQ and A-level Geography/Physics. Pupils who are interested in a career in remote sensing can find information about a range of career options in the Careers Section. The factual content is presented by means of text and graphics, including diagrams, maps, and imagery, supported by video and animation material. Interactive participation by the user is provided in a Games Section. An on-going development programme for the CD-ROM will ensure that it is up-to-date, relevant and useful.

c. Recent Government Initiatives Provide Opportunities for Remote Sensing

i. The National Grid for Learning

In October 1997, the Government announced plans for a National Grid for Learning (NGFL) with a set of targets for the education system. By the year 2002:

- all schools, colleges, universities and libraries are to be connected to the Grid
- all teachers are to be competent and confident in the use of ICT
- all school leavers are to have a good understanding of ICT, and
- the UK is to be a centre of excellence in networked software content.

The NGFL aims to provide a range of quality materials available on the Internet using the gateway of the NGFL Web site. A £100 million funding programme is to get the NGFL started (half the money from the national government and half from local authorities). Part of this grid is a Virtual Teachers Centre (VTC) available via the Internet (address: http://vtc.ngfl.gov.uk), where teaching resources can be accessed.

This initiative will be delivered through a partnership between the public and private sectors. Public money will not be enough. " '*Whatever is achieved by the Government initiatives will have to be supported by others coming from the private sector*' " says Dominic Savage, chief executive of the British Educational Suppliers Association (Cole, 1998/2).

ii. Work Related Learning

The Government is seeking more emphasis on work related learning, particularly in Science at Key Stage 4 (Swaine, 1998). Industries are being encouraged to get involved with schools, for example, the Weather Reports Project, run by PowerGen, which sponsors ITV's weather forecast. Thousands of children are taking measurements using instruments supplied by PowerGen, and then feeding the information into the school's computer. The school deemed to have used the equipment most effectively will win a £5000 METEOSAT system giving direct access to weather satellite transmissions (Edwards, 1998).

c. Opportunities within The National Curriculum

The National Curriculum, first introduced in 1991, lays down a framework for learning, for children aged 5 to 16 years. There is considerable potential for using remote sensing as a means of delivering NC requirements in Science, Geography and IT. The common requirement listed in all subjects specify use of IT. *"Pupils should be given opportunities, where appropriate, to develop and apply their information technology capability in their study of Geography"*. (Department for Education (now DfEE) 1995).

i. Current Teaching on Remote Sensing in Schools

As a discipline in itself, remote sensing is not taught directly in schools. Pupils are most likely to come across remote sensing as part of the curriculum in subject areas such as Science and Geography. This may be in the form of:

- Direct teaching about satellites
- Imagery for teaching specific applications, usually meteorology

- Imagery as display material, e.g. an aerial photograph of the school
- Image interpretation alongside other geographical data, such as maps.

ii. Remote Sensing and the Science Curriculum

An understanding of the methods used to acquire remotely sensed data relies on an appreciation of the physical sciences. For example, placing satellites into the correct orbit requires an understanding of gravitational forces. Understanding how sensors make use of electromagnetic radiation requires an understanding of the electromagnetic spectrum itself and the way bodies generate electromagnetic radiation. Interpretation of the resulting images requires an understanding of the way radiation interacts with different materials.

In the Science NC an understanding of light and forces is important in KS 1 through 4. At higher Key Stages satellite observation of the Earth is listed as a requirement (DfE, 1995). Remote sensing could also be taught in the science NC in the context of the way science influences everyday life, how science can be applied to environmental issues and to deliver scientific terminology – all requirements of the NC. At all Key Stages "Living things in their environment" is a major area of teaching and gives scope for remote sensing, particularly in vegetation studies. A major section on the BNSC CD-ROM is called "Principles of Earth Observation". In this, scientific principles such as the electromagnetic spectrum are explained.

iii. Remote Sensing and the Geography Curriculum

The Geography NC includes Geographical Skills, Places and Thematic Studies.

Skills: imagery provides a powerful medium for teaching of spatial awareness. The most direct way that pupils come across remote sensing is in the teaching of skills in Geography. Here, teachers are generally less concerned with the way the image was acquired than with teaching the interpretation of images. These skills are tested in public examinations. Satellite imagery is often presented to pupils as part of a package of geographical data relating to a particular area. This package includes maps, photographs (from the ground and from the air), charts, tables, text etc. On the BNSC CD-ROM imagery and map material could be integrated into skills lessons at several different levels in the Geography curriculum. There is also a resource list in the Teacher's Notes section detailing teaching packs using imagery.

Thematic Studies: many application areas of remote sensing overlap with NC requirements. These areas include: the weather, settlement, environmental change, tectonic processes, geomorphological processes, ecosystems, economic activities and development. There is always a need for good, up to date case study material. Case studies which are directly relevant to the Geography curriculum are presented on the BNSC CD-ROM, demonstrating practical applications of remote sensing.

iv Remote Sensing and the IT Curriculum

The ground and space segments of an EO satellite programme provides a stimulating case study of the use of IT. The initial rocket launch and control, subsequent operation of the satellite systems, telemetry of data and the application of data including modelling could be used by teachers to deliver the IT requirements.

The IT NC common requirement specifies:

- using information sources and IT tools to solve problems
- using IT tools and information sources such as computer systems and software packages to support learning in a variety of contexts
- understanding the implications of IT for working life and society.

At each Key Stage pupils must be given opportunities to use IT equipment and software, particularly for communicating and handling information and for controlling and modelling.

British Educational and Communications Technology Agency (BECTA) has published the HMI Gabriel Goldstein's "Information Technology in English Schools – A Commentary on Inspection Findings 1995–6". This report identifies a weakness in IT teaching, and highlights a scarcity of work involving control and modelling. remote sensing could be used as a vehicle to address these weaknesses in the school curriculum.

Manipulation of digital image data in different forms, perhaps using the BNSC CD-ROM, or via Internet access, or as data within an image processing package, or Geographical Information System (GIS), are all potential ways of using remote sensing to deliver IT requirements. ERDAS have supplied a copy of their popular desk top package "MapSheets" which is included on the BNSC CD-ROM for those with the computer power to access it.

B. SOME ISSUES AND PROBLEMS

a. Finances

Limited finances are a constraint in both state and independent sectors. According to Dr Rita Gardner, director and secretary of the Royal Geographical Society, a typical secondary school geography department receives just £2.35 per student a year to support all departmental requirements (Brace, 1998). Any expenditure has to be justified in terms of how many pupils will benefit, how often the resources will be used and relevance to the curriculum. If digital images are to be used, the resources must be appropriate for the hardware and software available and the skills within the department. The main question is: will these resources significantly improve the quality of learning? In view of the points raised here it is clear that there is still a great need for high quality, durable, but cheap hard copy images. Suggestions for their use in the classroom have been published (eg Ian Selmes, 1991). The more images that remote sensing companies are prepared to provide, free of copyright restrictions, the more likely it is that imagery can be fitted in with everyday learning exercises in the classroom. Digital imagery is very necessary and learning targets must be built around these to develop skills in IT, but a low-tech approach still has its value. Up-to-date, detailed case study material is often in short supply, especially at post-16 level.

b. Internet Materials

Many materials can be obtained free of charge (although not of cost) from the Web. It is estimated that 6000 schools are linked to the Internet and this will probably increase significantly in 1998 (Cole, 1998/1). However, Research Machines (RM) (1998), "*Report on the Internet in Secondary School Education*", details that, out of 300 schools in the survey, 46% had only one computer connected to the Internet and 24% of the respondents expressed concern that the Internet was "too unreliable and time-consuming" to use in lessons.

The remote sensing community is active in developing resources for schools over the Internet. The EURISY Association seminar, held at Frascati, Italy, in May 1998, "Integration of Earth Observation into Secondary Education", provided a platform for discussions concerning the establishment of an Internet Web site, as a common European source of information on EO for schools, based on a satellite image bank.
BNSC is currently developing such a web site to support and enhance their earth observation CD-ROM. The Satellite Project[1], based in Dyfed, is supporting government initiatives by a pilot scheme as part of the Education Department's Superhighways Initiative:

"Superhighways – Opening the Door to Satellite Remote Sensing. Supported by the INTEL Corporation, this project in Dyfed will provide support to teachers to introduce remote sensing to enhance the teaching of Geography at Key Stage 3 and above. It will also provide in-service training for remote sensing from the Satellite Centre, and on-line access to a large archive of remotely sensed images, image processing software and support to use them. Through ISDN the project also aims to deliver remote sensing

[1] The Satellite Project, Dyfed. Tel. 01239 710662

enhancement modules to National Curriculum studies. The eight pilot schools will be resourced to allow simultaneous video-conferencing and data sharing. (Virtual Teacher Centre Web site)

c. Hardware in schools

Robert Uhlig reported in the *Daily Telegraph* IT magazine (Tuesday 4 March 1997) that *"the National Council for Educational Technology research showed PCs in schools are, on average, six years old. Many are much older"*. Far too many teachers still lack sufficient ICT skills or the time to develop them (Cole, 1998/1). The Government plans to use mid-week lottery money to fund ICT staff development but this will not come into force until 1999. Teachers would best learn by having a home computer and it has been suggested that tax breaks could be made available for teachers to purchase these (Hibbs, 1997). However, the DfEE is still to discuss this with the Treasury.

What software is being made available for schools in image processing and GIS? How many packages have been specifically designed for use in school? Are they watered-down versions designed for industry and for specialist users? What platforms and operating systems are these packages designed for? The ones in use in industry are likely to be at least 6 years ahead of the most common technology used in schools. Do software designers take this into consideration? A recent *TES* article (John, 1998) recommended that schools buy machines with more than 32 Mbs RAM, over 200 MHz speed processors and a minimum of 4 Gbs hard disk memory. How realistic is this for the mainstream? IT is a rapidly changing world. New hardware and software is constantly appearing, involving expensive upgrades at regular intervals. The cost constraints inevitably mean that schools lag behind. Replacing hardware and software may be the norm in industry, schools cannot be expected to follow the same route. This should be recognised by software providers. These continual changes in technology also have implications for training – teachers may be reluctant to tackle new systems. Many teachers have had limited training which quickly becomes out of date when new systems are set up in the school. According to Paul Heinrich, a rule of thumb in industry is to spend £1000 on training for every £1000 spent on hardware and software (Heinrich, 1998). The BECTA report mentioned earlier identified a lack of time for training, even though this is recognised as vital.

d. Teaching Situations and Methods

Practical considerations, such as lack of access to a sufficient number of machines during lesson times and technical support, can be stumbling blocks. The introduction of computers is often seen as a panacea. IT is a powerful tool, it can provide a wealth of data for the pupils. However, this does not mean that students will have the skills to select and use appropriate data effectively. The Internet has been taken up as the latest educational initiative/bandwagon. "*To integrate such technologies requires a development plan and above all time to assess the educational possibilities of the medium and to integrate these into curriculum planning"* (Heinrich, 1998). The BECTA report summarising OFSTED inspection findings for IT in schools comments on unstructured and superficial use of multi-media such as CD-ROM. These problems need to be addressed. Appropriate learning strategies must be developed.

Recently teachers have been encouraged to adopt whole class interactive teaching methods. This is a response to the poor achievements in maths tests in British schoolchildren compared to other countries around the world, carried out by the Third International Maths and Science Study. Whole class interactive teaching predominates in countries where children score highly in these tests. What are the implications for teachers wishing to expand the use of IT in learning situations?

CONCLUSIONS

Advances in modern technology and the Government initiatives are providing great opportunities for the expansion of remote sensing in schools. Vital skills and knowledge can be taught through the NC in Science, Geography and IT using remote sensing. Imagery can motivate young people, encouraging them to take up careers in EO. New resources such as the BNSC CD-ROM; Window on the World are appearing at a critical time in terms of the changes taking place in education in England and Wales. A number of obstacles remain. However, with vision and determination, and the appropriate support from government and private sectors, these must surely be dealt with, to the benefit of our society as a whole.

Acknowledgements

I would like to thank Stuart Armstrong, who until recently was the Geography Advisor for Berkshire, for giving me his time in relation to this paper.

References

Barnett, M; Kent, A; Milton, M (Eds), (1995), *Images of Earth – A teacher's guide to Remote Sensing in Geography at Key Stage 3 and GCSE*. The Geographical Association.

Brace, Matthew, (1998), "Mapping new horizons" *TES*, 27 March.

Booth, Nicholas, (1997) "Skills Shortage Grows", Interface, *The Times*, 11 June.

Cole, George, (1998), "New Wave Learning", *TES*, 9 January.

Cole, George, (1998), "We're off on a Learning Marathon", *TES*, 13 March.

Department for Education (now DfEE), (1995), *Geography in the National Curriculum*, HMSO Publications.

Department for Education (now DfEE), (1995), *Science in the National Curriculum*, HMSO Publications.

Edwards, Allen, (1998), "Partners through rain and shine", *TES*, 6 February.

Heinrich, Paul, (1998), "Managing Change", *Educational Computing and Technology Magazine*, March.

Hibbs, Jon, (1997), "Blair might offer tax breaks for Internet teachers", *The Times*, 21 March.

John, Hugh, (1998), "The Future Proof Machine", *TES*, 13 March.

Research Machines, (January 1998). *The RM Report on The Internet in Secondary School Education.* [Available from Research Machines plc, New Mill House, 183 Milton Park, Abingdon, Oxon, OX14 4SE (tel: 01235 826000)]

Swaine, Carolyn, (1998), "Discovery by experiment", *TES*, Friday Magazine, 6 January.

Selmes, Ian, (1991), Oakham School, "Using Satellite Images in Teaching Geography", *Teaching Geography*, October, Geographical Association.

Trend, Roger (Ed), (1995) *Geography and Science, Forging Links at Key Stage 3*, Geographical Association.

Uhlig, Robert, (1997), "Schools must get IT right", *Daily Telegraph* IT magazine, 4 March.

Abbreviations/Acronyms

BECTA: British Educational and Communications Technology Agency
(formerly the **NCET**: National Council for Educational Technology)
EO: Earth Observation
GA: Geographical Association
GNVQ: General National Vocational Qualification
IT: Information Technology
ICT: Information and Communications Technology
KS: Key Stage
NC: National Curriculum
NGFL: National Grid For Learning
QCA: Qualifications and Curriculum Authority
VTC: Virtual Teacher Centre