

**THE UNITED KINGDOM
NATIONAL REPORT
FOR
PHOTOGRAMMETRY AND REMOTE SENSING
1989 - 1992**

Prepared for the UK National Committee
for Photogrammetry and Remote Sensing
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ABSTRACT

The National Report of the United Kingdom outlines routine activities and new developments in photogrammetry and remote sensing during the period 1989-92. The involvement of all sectors is described including government, institutions and education, suppliers of systems and equipment, consultancy, contract services and end users. An attempt is made to estimate employment in photogrammetry and remote sensing. Facilities are categorised as internal resources, contract services and suppliers of systems. A wide range of applications is reviewed. The continuing commitment of the United Kingdom to education, mapping and environmental monitoring around the world is emphasized.

COMPILATION OF THE REPORT

Previous UK National Reports have contained over 80 pages. This abbreviated version, to comply with ISPRS space restrictions, is experimental and has been prepared from replies to questionnaires sent to organisations involved in Photogrammetry or Remote Sensing or both, from published literature, and from the authors' personal knowledge of activity in these disciplines in the period 1989-1992. 75 questionnaires were sent mainly to named individuals known to be active in Photogrammetry and replies were received, with a little persuasion, from 58 of them, a response rate of 77%. About 250 questionnaires were sent to organisations involved in remote sensing and 108 responses were received.

The authors have used editorial discretion in presenting the opinions expressed by respondents. The report does not necessarily reflect the views of the UK National Committee for Photogrammetry and Remote Sensing.

KEY WORDS: United Kingdom. National Report. Research. Applications. Employment. Institutions.

1. INSTITUTIONS AND PUBLICATIONS

The UK National Committee for Photogrammetry and Remote Sensing is the adhering body to the International Society for Photogrammetry and Remote Sensing and is funded by the Royal Institution of Chartered Surveyors, the Photogrammetric Society and the Remote Sensing Society.

The Photogrammetric Society was founded in 1952, and currently has 369 UK individual members plus 254 overseas members, almost identical to the numbers reported four years ago, and 8% more than in 1974. There are also 56 corporate members, 9 of which are based overseas. The Photogrammetric Record, the official journal of the Society, has been expanded in size by about 20% compared with the four-year period before the previous Congress.

The Photogrammetric Society has instigated and is financing a research project being carried out by C D Burnside into the use of analogue photogrammetric equipment in the UK from the earliest times up to the present day. In an attempt to

preserve some of the more important pieces of equipment, instruments are being labelled and catalogued with the hope that some will be preserved in museums and collections of historic instruments.

The Remote Sensing Society was established in 1974 and has a membership of about 850 (nearly the same as in the last report) of whom about a third are overseas members. New categories of membership have been introduced over the past few years to supplement its Ordinary, Student and Corporate memberships. These are Professional (Fellows and Associates), Retired, School and Affiliate Memberships. The Society operates Special Interest groups in education, geology, ocean colour, GIS and vegetation. The official publication of the Society is the International Journal of Remote Sensing, and it also publishes a quarterly Newsletter, an Annual Report and occasional monographs. A number of awards are given by the Society. The major event is the Annual Conference (which used to be called the Annual Technical Meeting) at which the Annual

General Meeting of the Society is held. Other one- and two-day meetings and workshops are also organised often by the Special Interest Groups and often jointly with other societies.

The period covered by this report has shown a huge increase in the number of remote sensing publications. In 1992, the International Journal will publish about 220 papers in 18 issues: this is to be compared with about 115 papers in 12 issues in 1987 and 25 papers in four issues in 1980. Dozens of books enter the market each year (of special note is the Remote Sensing Yearbook) both as textbooks and conference proceedings. These are far too numerous to list. Many organisations now produce their own newsletters and bulletins.

A landmark in this reporting period was the formation in October 1989 of the Survey & Mapping Alliance (SMA) to reflect the consensus of opinion on all aspects of surveying and mapping and to organise co-operative ventures. The need has long been recognised to bring together the traditional disciplines of land and hydrographic surveying, remote sensing, photogrammetry and cartography, with new technology for collecting and managing land information to meet the needs of our time. SMA has taken over responsibility for organising the fourth UK national Survey and Mapping conference in Spring 1993 for the nine participating societies and institutions:

- The British Cartographic Society
- The Hydrographic Society
- The Institution of Civil Engineering Surveyors
- The Photogrammetric Society
- The Remote Sensing Society
- The Royal Institution of Chartered Surveyors
- The Society of Surveying Technicians
- The Association for Geographic Information
- The Guild of Incorporated Surveyors

Discussions are actively taking place between the Remote Sensing Society and the Photogrammetric Society into ways of drawing the two societies closer together, initially with reciprocal benefits and mutual publicity.

The National Association of Aerial Photographic Libraries (NAPLIB) was also formed in 1989 to publicise and stimulate the use of existing sources of aerial photography and has prepared a directory of collections of aerial photography.

2. PHOTOGAMMETRY

Photogrammetry provides scientific interest or employment or both for about one person in every 60,000 of the working population of the United Kingdom (28.3 million in 1991). Employment in photogrammetry in the private sector and in the Ordnance Survey has declined as a result of the current economic recession, and increased productivity resulting from improved technology. Mergers amongst the larger manufacturers and distributors of photogrammetric instruments have also resulted in some staff rationalisation. Other sectors seem to have remained static or even expanded slightly. Photogrammetry is reported to provide employment for the equivalent of 387 full time person years including the proportion of people whose time is only partly devoted to photogrammetry. As our survey was not comprehensive, this must be an underestimate,

perhaps of around 20%. Few would regard photogrammetry as their primary discipline, being trained in land surveying, engineering, information technology etc. It is particularly difficult to quantify the efforts of people who devote only a small proportion of their time to photogrammetry; those who cross the traditional barriers between surveying, cartography and data processing; lecturers who teach some photogrammetry amongst other surveying subjects; and those who apply photogrammetry and other techniques for measurement and analysis as expert users in medicine, industry, environmental sciences and the like.

2.1 Changing patterns of employment

There are now only three organisations employing more than 25 people in photogrammetry (Ordnance Survey, Directorate of Military Surveys, and BKS Surveys). Several of the large air survey companies, like Hunting Surveys which operated world-wide for forty years, have ceased operating and been succeeded by numerous small companies. As a result the number of private mapping companies which are corporate members of the Photogrammetric Society has increased from 9 to 17 between October 1987 and October 1991. More than half the total number engaged in photogrammetry work for 13 organisations which employ f between 6 and 25 people. 31 organisations employ between one and five people. 18 organisations (28% of respondents) reported activity in photogrammetry at less than one person year. There are probably many more in this category who were not sent questionnaires.

TABLE 2.1
Organisations providing employment in photogrammetry with estimates of number of full time staff employed:

Employment (person years)	Number of Organisations	Numbers employed (person years)
Over 25	3	90
6 - 25	13	195
1 - 5	31	93
Less than 1	18	9
TOTALS	65	387

2.2 Types of Organisation

The private sector accounts for over half the organisations engaged in photogrammetry as users; manufacturers and system support; providers of aerial photography, mapping and close range measurement; and consultants. Educational establishments represent 25% and government 18%, divided between mapping, conservation of heritage and environment, and applied research.

TABLE 2.2 Photogrammetric organisations by type:

	Government	Private	Non-profit Institution
Number of Organisations	12	36	17
Percentage	18%	56%	26%

2.3 Applications

Respondents were asked to apportion their photogrammetric activities to the applications listed in Table 2.3. Most suppliers of photogrammetric services cover a wide range of applications.

TABLE 2.3 Applications of Photogrammetry:

	Main > 50%	Major 10-50%	Minor < 10%
Education/training	13	2	-
Research	-	7	6
Consultancy	2	1	10
Manufacture/software	4	-	2
Distribution/Support	4	1	
National Mapping	2	1	2
Project Mapping	9	6	5
Resource Surveys	-	2	1
Protection of environment	3	-	2
Defence/Police/Emergency	1	-	1
Hydrography	1	-	-
Monitoring change	1	2	7
Close range photogrammetry			
Architectural	2	2	9
Industrial/Engineering	4	4	5
Archaeological	-	-	2
Medical/Scientific	2	-	4

Education and training were reported to be the main activities of the largest number of respondents (13), followed by mapping (11), and then manufacturing, software and support services (8). Specialist organisations with a single application include Oxford Hospitals (medical), Nuclear Electric (engineering), English Heritage (architectural), English Nature (protection of the Environment), the Hydrographic Office (nautical charting) and the Directorate of Military Survey (defence). A large number of organisations did some research and some consultancy.

Topographical mapping continues to be the predominant application of photogrammetry employing around 160 people. Close range photogrammetry was listed as a minor activity of a large number of firms providing contract services, and the main application of eight specialist units.

Several respondents believed that analytical plotters and associated software had increased the activity in close range and industrial applications. This does not appear to be confirmed by the employment figures, estimated at around 50 person years, which does not seem to have expanded much in recent years.

More conclusive is the revival of design and manufacture of photogrammetric systems in UK which had been in decline for many years:

- Camera Alive - digital cameras and stereo analysers;
- Cartographical Engineering - AP190 analytical plotter;
- Ross Instruments - stereocomparators and digital mapping systems;
- University College London and others - software packages.

The numbers employed may also be approaching 50.

2.4 Education

University College London (UCL), Glasgow University, Newcastle University, and the Polytechnic of East London (PEL) offer graduate and postgraduate courses in photogrammetry or surveying and topographical sciences with a substantial photogrammetric content. Several other universities and polytechnics include some photogrammetry in more general courses such as the University College of Swansea, Edinburgh University, De Havilland College, University College of Wales (Aberystwyth), Kingston College, and Portsmouth Polytechnic. The teaching of photogrammetry in geography, engineering and environmental science courses may have declined because of the pressures to introduce new subjects instead.

A new four-month certificate course in Air Survey Photography was introduced in 1991 by University College London, Aerial Imaging Systems and Photair and is to be repeated annually.

Most of the universities and polytechnics specialising in photogrammetry also offer to undertake research, consultancy and photogrammetric production tasks as repayment services.

2.5 Facilities

The facilities available for internal use, to provide contract services and for manufacture and supply are summarised in the following table.

TABLE 2.5 Photogrammetric facilities

Facility	Manufacture & Supply	Contract Services	Internal
Aircraft	-	5	5
Air survey cameras	1	10	14
Terrestrial cameras	3	12	15
Ground control/data	3	7	17
Photographic processing	-	8	26
Stereoplotters/comparators	2	9	25
Analytical plotters	3	8	23
Digital plotters	3	1	1
Orthophoto	1	1	5
Digital mapping	5	12	33
GIS/LIS	1	12	20

2.6 Projects

Surveys for motorway design and road improvement schemes have been the main source of work for air survey firms in UK for many years. As the emphasis has shifted from the design and construction of new motorways to the improvement and upgrading of existing trunk roads to motorway standard, a new requirement has evolved to measure the levels of existing road carriageways to high standards of accuracy. Traditional field survey methods can only be used safely by closing part of the road which causes traffic congestion. Various techniques have been developed for precise height measurement of road carriageways without disrupting the flow of traffic, some using photogrammetry and some using lasers and total stations from the road-side. Photarc has developed a system using photography flown by helicopter at an altitude of about 300 feet with a Zeiss UMK camera. Other firms have used fixed wing aircraft and full format cameras with forward movement compensation.

Investment in new London commuter rail services has generated requirements for control and large scale route mapping for the London Underground Jubilee Line Extension and the CrossRail Project which is planning to drive main line railway tunnels under the centre of London. The Channel Tunnel Rail Link is also expected to require extensive route surveys once the final alignment has been selected.

2.7 Research and development

University College London reports the following research programmes:

- * stereomatching algorithms;
- * dynamic geometry of satellite imaging;
- * automatic monitoring of environmental change;
- * automated non-contact surface measurement;
- * change detection using SAR;
- * involvement in NASA Mission to Earth;
- * measurement in hazardous environments; and
- * calibration of CCD cameras.

The National Physical Laboratory continues to develop precision photogrammetric cameras, bundle solution and image analysis for high precision metrology.

Newcastle University is researching the use of polaroid photography for photogrammetry; and photogrammetric measurement of ten sample city centre sites to estimate building surface area naturally available for fitting photovoltaic modules.

Camera Alive demonstrated a remote real time photogrammetric system based on electronic stills cameras and a stereo image processing system to the Photogrammetric Society in February 1992.

Nuclear Electric continues to develop specialised short range cameras for use in nuclear plants.

The Oxford Orthopaedic Centre has developed a TV image-assisted digitising system, and automatic landmark identification for hip x-rays.

Laserscan reports the development of a stereo matching and real time transformation system for the Royal Aerospace Establishment, Farnborough.

2.8 Significant Changes in the period 1989-1992

Some take the view that photogrammetry has reached a state of maturity in both development and application. Advances in related technologies, such as GIS, GPS, IT, reduction in computer costs, etc, have improved its performance and range of applications more radically than developments within the subject which have been less spectacular. The following trends were noted:

- * **Analogue plotters**, although no longer made, are still widely used and there appears to be a brisk trade in second-hand instruments both in UK and overseas. This may indicate that analytical plotters have not proved

sufficiently more productive for routine air survey to justify the investment where serviceable analogue instruments are still available.

- * **Analytical plotters** are now used almost as widely as analogue instruments. The associated software has broadened the range of applications of close range measurement and encouraged the use of non-metric or semi-metric cameras. A growing market for low-cost analytical plotters is reported (forty AP190s have been sold).
- * **Digital photogrammetry** and stereo image analysis systems, using digital or video imagery or scanned photographs, are now considered to be economically viable and operationally robust, particularly for close range non-contact measurement and inspection.
- * **Aerial survey cameras with forward motion compensation** are now widely used for large scale mapping for engineering projects because of the improved image quality and ability to operate in more marginal weather conditions. In combination with analytical plotters, it now appears to be economic to produce 1:200 scale plans by a combination of field and photogrammetric survey methods.
- * **GPS** is being used increasingly to establish photocontrol on the ground and **Airborne GPS** is being tested experimentally to supplement or replace ground control. The predicted savings in time and cost have yet to be demonstrated in practice.
- * **User friendliness** is now being taken seriously by photogrammetric system designers to make photogrammetry accessible to non-specialists and occasional users.
- * **Economic constraints** were widely reported to be inhibiting national monitoring schemes, education, research and investment, and have certainly reduced the private sector market, increased competition and reduced prices. The Ordnance Survey has introduced shift working for the first time to reduce production costs, in line with private sector practice over many decades.

2.9 The overseas contribution

The three largest photogrammetric employers (Ordnance Survey, Directorate of Military Surveys and BKS Surveys Ltd) retain substantial overseas commitments in technical assistance, military mapping and terrain modelling and contract mapping. Many of the companies supplying systems, contract services and consultancy also trade worldwide.

Specialist services in underwater inspection and non-contact measurement, developed by Camera Alive to meet the needs of the North Sea oil industry, have been extended to Europe, the USA, Brazil, West Africa, South East Asia and Australia.

The Universities and Polytechnics continue to attract a substantial proportion of overseas students for graduate, postgraduate and specialist courses.

3. REMOTE SENSING

Remote sensing is becoming more and more widespread in almost every walk of life. It is now being introduced into the national curriculum at schools in both geography and science; and teaching material, including workpacks and satellite imagery, is being developed for schools. Most undergraduate geography and environmental science courses, as well as meteorology and geology courses, introduce some remote sensing to a greater or lesser extent. This has made it impossible to produce a detailed analysis for this report. Similarly, in the commercial world, the number of new enterprises has proliferated (admittedly one or two have closed) reflecting the increased use of remote sensing, increased environmental awareness and the increased amount of data coming on-stream.

After playing it cool on the involvement of Britain in the European Space Programme, the Government has now given strong backing to the Earth Observation programme, and the Prime Minister is indeed taking the initiative in developing international collaboration in the use of satellite data for environmental monitoring. This is, of course, against the background of fears of global warming, the greenhouse effect and ozone depletion.

3.1 Changing patterns of employment

In general there was an air of buoyancy and optimism amongst respondents, with over 80% claiming expansion since 1988 (often by large factors) and only 3, all educational establishments, saying they have diminished activity (mostly for organisational reasons). Increased teaching in Universities, growth of global change studies, significant improvements in workstation price/performance, growing recognition of the need to integrate GIS with remote sensing, the coming together of digital photogrammetry with remote sensing, involvement in large national and international programmes, the opening up of Eastern and Central Europe, the establishment of a coherent satellite programme for the 1990s and the increase in data volume were all cited as reasons for this. Amongst the few complaints were the cost of data and the lack of public funding, mostly by a few educational establishments.

With no comparable figures in the 1988 report, it is not easy to comment on any change in employment pattern. The responses produced the following breakdown according to size:

TABLE 3.1

Employment (person years)	Number of Organisations
over 25	12
6-25	29
1-5	48
less than 1	15

Incomplete responses account for the total not being equal to the 108 responses received. At least one commercial organisation declined to give any information for reasons of commercial confidentiality.

No private organisation admitted to less than 1 person year, and only 2 government institutions and 2 educational establishments stated more than 25 person years. More than three quarters of all respondents employed between one and 25 people. One private company claimed to employ 125 people on remote sensing-related activities, and another that its staffing had increased from 10 in 1988 to 70 in 1992. Both these companies have been involved in the setting up of NRSC Ltd and it is not clear whether these refer to new jobs or just reorganisations within and between existent employers.

The distribution in each category respectively was:

Government	-	2,	3,	12,	7
Private	-	8,	8,	9,	0
Educational	-	2,	16,	25,	8

3.2 Applications

The response to the question on activities elicited the following information:

TABLE 3.2

	main >50%	major 10-50%	minor <10%
Education/training	19	33	7
Research	13	41	5
Consultancy	2	26	4
Manuf/software devt	6	8	5
Distribution etc	2	2	-
National mapping	-	2	-
Project mapping	-	11	1
National Res Survs	-	11	1
Project Res Survs	-	16	3
Protection of Environment	-	7	3
Hydro/Oceanography	2	10	2
Met/Space	1	9	-
Monitoring Change	1	15	3

A number of points must be noted:

Only just over 100 replies were received (27 from private organisations, 27 from Government institutions and 54 from "non-profit institutions", which were in fact almost all educational establishments), and this therefore may not accurately reflect the smaller users and those who use remote sensing only incidentally.

There seemed to be some confusion in interpreting the question by a few respondents who did not consider the headings to be mutually exclusive. They considered that the types of activity (education, research, consultancy etc) could be further subdivided into application (mapping, surveys, meteorology etc) and hence the total sometimes came to well over 100%! It is not known to what extent this confusion affected other responses.

The group "major" should perhaps be subdivided in that this group contains a great number of 50% and 10% responses with not many in between.

The different sectors showed different usage patterns. Education establishments, understandably, predominate in the fields of education and training (14,25,1 in the respective categories),

research (10,29,-) and consultancy (-,5,4). Government institutions figured more highly in the survey, mapping and environmental monitoring applications, whereas private institutions were fairly evenly distributed over most of the headings.

No response fell within a single heading. Nearly 60% of all respondents include some education or training, and about the same number undertake research to a greater or lesser extent. A significant number seem to undertake a little of most things.

3.3 Education and training

The growth of awareness of remote sensing at all levels in the education sector has already been mentioned. The provision of teaching material for schools and training courses for teachers is a healthy portent for the future. Undergraduate courses in environmental sciences have increased, the remote sensing content in geography courses, as well as in physics courses has also grown. There are also more postgraduate courses and research posts now. Postgraduate courses in remote sensing are given at the Universities of London, Dundee, Aberdeen, Cambridge and Edinburgh and at Silsoe College. Courses in GIS are available in the Universities of Nottingham, Edinburgh, Leicester and Leeds. Other courses in photogrammetry, meteorology, climatology etc may include some remote sensing but several "modular" MSc courses, although ostensibly called remote sensing courses, may contain only a few modules in remote sensing amongst others such as computing, land management, pattern recognition and artificial intelligence, neural network theory, GIS etc.

One significant development during this reporting period has been the huge expansion in the availability of image processing facilities at all levels. PC-based systems were being introduced during the previous reporting period, but many educational establishments were still relying on mainframe and mini-based systems and 12 of the 25 establishments had none. Many educational image processing packages now exist at all levels, and sophisticated processing is now available even to undergraduates.

Specialist workshops for training in particular applications or techniques (analysis of ERS-1 data, image processing etc) are becoming increasingly popular as a way of updating employees in specific areas.

3.4 Research and development

There is considerable activity in all sectors of the community. New data sources, more national and international programmes and new techniques and equipment have all contributed to increased activity in the standard research fields as well as in new applications areas. The multidisciplinary approach and the growing political awareness of environmental issues have also helped, as has the increased use of GIS.

A number of new developments were mentioned:

- * new, cheaper image processing and software;
- * high resolution display systems;
- * graphical user interfaces;
- * applications of neural networks;
- * UNIX-based software;
- * interactive hypertext interfaces;
- * parallel processing;
- * integration of raster and vector data sets;
- * the development of intelligent knowledge-based systems;
- * low cost SAR processing;
- * integration of satellite data into GIS;
- * applications of microwave remote sensing;
- * studies of climatic change;
- * non-meteorological uses of meteorological satellite data;
- * development of global environmental data bases.

3.5 Significant changes in the period 1989-1992

A number of factors, commercial, technological and sociological, have contributed to the increase in remote sensing activity in this period:

- * The reduced cost and increased reliability of computing
- * The advances in Geographical Information Systems
- * The commercialisation of remote sensing
- * The increased awareness of environmental matters
- * The launch of ERS-1
- * The opening up of Eastern and Central Europe
- * The Europeanisation of Britain and involvement in European projects under EC programmes
- * Involvement in international programmes such as the International Satellite Land Surface Climatology Programme (ISLSCP), the World Climate data Programme (WCDP), the World Ocean Circulation Experiment (WOCE) etc.
- * The setting up of a European Environmental agency.

In particular, these have led to some national developments:

- * Setting up of the British National Space Centre
- * The commercialisation of NRSC Ltd
- * The acceptance of Earth observation as a legitimate activity
- * The setting up of the Earth Observation Data Centre (EODC) Processing and Archiving Centre (PAF)
- * The development of BARSC and its European equivalent EARSC

and some international developments:

- * The designation of 1992 as the International Space Year
- * The "mission to Planet Earth" programme of the 1990s
- * A coherent international satellite programme.

The period has seen the commercialisation of data distribution with companies such as EOSAT, SPOT IMAGE, ERSUN being set up, as well as the setting up of the National Remote Sensing Centre Ltd. This was founded in 1989 to commercialise the operation of two government-run earth observation data processing facilities, NRSC and EODC, both co-located at Farnborough. They are to run the UK processing and Archiving Facility (PAFF), under contract to the Defence Research Agency, for the processing, archiving and distribution of data from ERS-1 for ESA and to offer a one-step total remote sensing capability.

4. SOURCES OF INFORMATION

4.1 Photogrammetry

The Photogrammetric Record, edited by K B Atkinson, and the Photogrammetric Society newsletter which is produced by R A Baldwin, are the main sources of information on photogrammetric activity in UK.

A list of members, and addresses of corporate members, is published in the April issue of the Record every year, and the index to Volume XII can be found in the October 1988 issue, and the index to Volume XIII in October 1991.

4.2 Remote Sensing

The main source of information on remote sensing activity is the "Remote Sensing Yearbook" (1990) edited by A P Cracknell, L W B Hayes and W G Huang and published by Taylor & Francis (London).

Other useful sources include "Geographic Information 1991", the Yearbook of the Association for Geographic Information edited by J Cadoux-Hudson and D I Heywood, and "The European Community, Crossroads in Space" (1991), report by an advisory panel.

The responses to the questionnaires and the correspondence relating to the production of this report are deposited in the Photogrammetric Society archives at University College London and with the Remote Sensing Society.