Introduction

A Year of Progress

The target for timely analysis established shortly before the start of 1999 was achieved. As a result, we completed analysis for fourteen months of the Bulletin, including more earthquakes than analysed in any previous year. This enabled us to reduce the delay in publishing the Bulletin by two months. We also completed partial re-analysis of 18 months of the Bulletin to correct an error in parsing data from the EIDC.

For the first time, the Centre's new CD included PDF files of the typeset Bulletin; CD sales were robust and further enhancements were planned for future disks. We replaced our web server and several related programs, and now respond more a wider range of data queries.

Computer-related development during the year included completion of the computer replacement program by purchasing and installing a file server. We designed a relational database schema and loaded our complete set of published data, and made progress in several areas related to collecting the data to the database and using it for processing and distribution. We undertook development of a new, more flexible algorithm for automatic association.

Two members withdrew and three new members joined, so member contributions grew in line with indexing of the membership unit the previously agreed. Expenditures were close to budget, and the net value of the ISC's assets changed only slightly. The Centre's liquidity improved as the result of payment of 1997, 1998 and 1999 contributions by the Russian Academy of Sciences. Virtually all contributions expected for 1998 and earlier have now been paid, but at the end of the year 12% of 1999 contributions were not yet received. The value of the ISC's exchange rate stabilisation fund was unchanged, the value of the computer replacement fund grew, and the lien on the ISC's bank accounts was removed.

Data Collection

During 1999 the ISC implemented new programs to parse several bulletin formats, partly in order exclude very badly mislocated events and to avoid inconsistencies in including epicentres and associated phase data. ISC data collection has been selective for many years, *e.g.* excluding teleseismic epicentres computed from local networks. Moscow and NEIC have long reported only larger FSU and US earthquakes (*e.g.* excluding most of the small earthquakes located by regional networks in California). For earthquakes from 1994 ISC has excluded small earthquakes in the JMA catalogue. The ISC also has long-standing procedures to select from print catalogues, *e.g.* Pretoria and New Delhi, due to limited data entry resources. Recently reviewed criteria for selecting from electronic catalogues are tabulated at right.

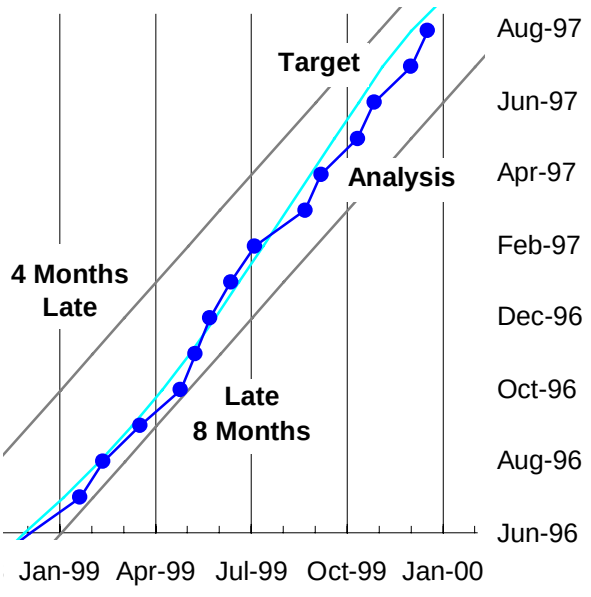
Agency	*Events Since*	*Epicentres Included**	*Phases Included†*
JMA	1994	$h \le 100$: $m \ge 3$ or felt $h > 100$: $m \ge 3.5$	
BER	1997	(local and $m > 3.0$) or explosion	assoc. with regional or distant event
DJA	1997	azimuthal gap ≤ 270° and at least one S	all
EIDC	1997	prime hypocentre	
HEL	1998	$m \ge 2.0$	
LDG	1998	prime hypocentre	
NDI	1998	$m \ge 3.0$ and NDI-computed	associated with non-NDI hypocentre
MEX	1998	$m \ge 3.0$ or explosion	
LIS	1998	prime hypocentre	
MDD	1998	$m \ge 3.0$ or not "proximo"	
SKHL	1998	listed with associated phases	
KRSC	1997	listed with associated phases	
DHMR	1998	(local and $m > 3.0$) or explosion	assoc. with regional or distant event
ZUR	1998	$m \ge 2.0$ azimuthal gap ≤ 270°	$m \ge 2.0$ and gap > 270°

* We generally exclude source data unaccompanied by event time and location. These criteria are in addition to having a reported epicentre.

† We include all phases associated with any included epicentre. These are criteria for including additional phases.

Bulletin Editing

Fourteen months of the Bulletin were edited during 1999. This constituted the greatest amount of data edited in any year in the ISC's history, whether measured by number of events (71,340), hypocentres (168,709), readings (1,609,414) or phases (2,379,089). This was achieved partly by employing a third seismologist, and it is fair to ask if we accomplished as much as might have been hoped.



A seismologist newly joining the ISC comes up to speed gradually and requires time from the existing staff for training. Over their first half-year, a new seismologist typically makes a net contribution equivalent to slightly less than two months of work by a fully-experienced Bulletin editor. Recognising this, the figure above shows that we met the ambitious goal established in 1998 of requiring just 40 "seismologist days" to edit each month, even though a typical month includes 5100 events and 170,000 readings.

Editing did fall slightly behind the target during the IUGG assembly and summer holidays. Full recovery to the target later in the year was impeded by effort required to re-analyse previously truncated amplitudes published in the Bulletin, as discussed below.

Production and Distribution

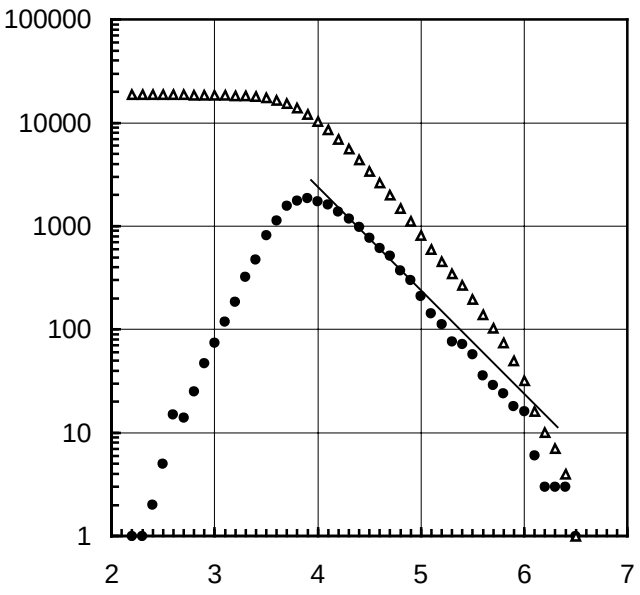
Product	Issue	Distributed
Bulletin	96 May/Jun	02 Feb
	Jul/Aug	05 May
	Sep/Oct	18 Jun
	Nov/Dec	20 Jul
	97 Jan/Feb	26 Aug
	Mar/Apr	04 Nov
	May/Jun	22 Dec
Catalogue	1996/A	17 Feb
	1996/B	19 Aug
CD-ROM	1996	15 Jun

In 1999 we distributed seven bimonthly issues of the Bulletin averaging 191 pages per month and two semi-annual issues of the Catalogue averaging 581 pages per half year. The time between shipping master copies and receiving product from the printer varied between 5 and 11 weeks. Even the shortest time exceeds the expectation implicit in the ISC working statutes, which call for analysis to begin 22 months after the events and bulletins to be distributed within 24 months. Print runs for the Bulletin were held at 350 (230 are required for members and subscriptions), but print runs for the Catalogue were reduced from 500 to 400 (300 are required).

In contrast, the ISC benefits from widespread expectation of turn around times on the order of a week for production of CDs and, of course, the Bulletin is available on-line within hours after analysis is complete. The CD of 1996 earthquakes and readings included the Fixed-Format Bulletin files for the current year (totalling 207 MB) Fixed Format Catalogue files for earlier years (totalling 270 MB) as in the past. This year it also included PDF files of the long version of the typeset Bulletin for the current year, averaging 483 pages per month, totalling 146 MB. In all, 635 of the 650 Mbytes available on a CD were used.

Bulletin Thresholds

The ISC computed its own hypocentre for 49,794 of the 71,340 events analysed during 1999, but teleseismic amplitudes required for ISC to compute its own m_b were reported for only 18,678 of the ISC hypocentres. The cumulative and density distributions of ISC m_b values shown at right suggest a global threshold near 4.3. The threshold for simply detecting all events is probably better, but the m_b computation threshold may be somewhat worse in a few regions.



Notable Sequence

October 1996 included a sequence in Cyprus that was especially challenging. An m_b 6.3 earthquake occurred on October 9 and produced considerable damage and fatalities. The event was reported by over 800 stations and was followed by a large sequence of aftershocks; ISC reported over 500 events from this sequence in October alone.

As with any large sequence in a populated area, a large proportion of the events were reported to the ISC by several international and local agencies. Initial automatic grouping of epicentres became a problem when reported epicentres were shifted, and ISC editors often had to split and re-group epicentres.

Such an outstanding sequence delayed analysis by the Geological Survey of Cyprus, and for initial processing ISC had phase data from Cyprus only for days preceding the mainshock. Apart from Cypriot stations, the closest seismic station is 245 km from the epicentre. Thus it was very important to include Cyprus phase readings to support depth determinations, and the ISC staff made a special effort to associate them. Since these readings were reported to the ISC when analysis was already underway, we implemented an association procedure that is not part of normal ISC analysis. As a result more than 1000 valuable station readings and about 70 macroseismic reports were associated with events and published in the Bulletin.

EIDC Amplitudes

In the Bulletins 1996 January to 1997 June:

- Amplitudes of regional and teleseismic body waves for EIDC stations were very occasionally truncated.
- Amplitudes and periods of surface waves for EIDC stations were often truncated.
- Body wave magnitudes were almost always correct.
- Surface wave magnitudes were based on accurate amplitudes, but miss out EIDC amplitudes. New values differ much only where M_S was computed from an insufficient number of amplitudes.

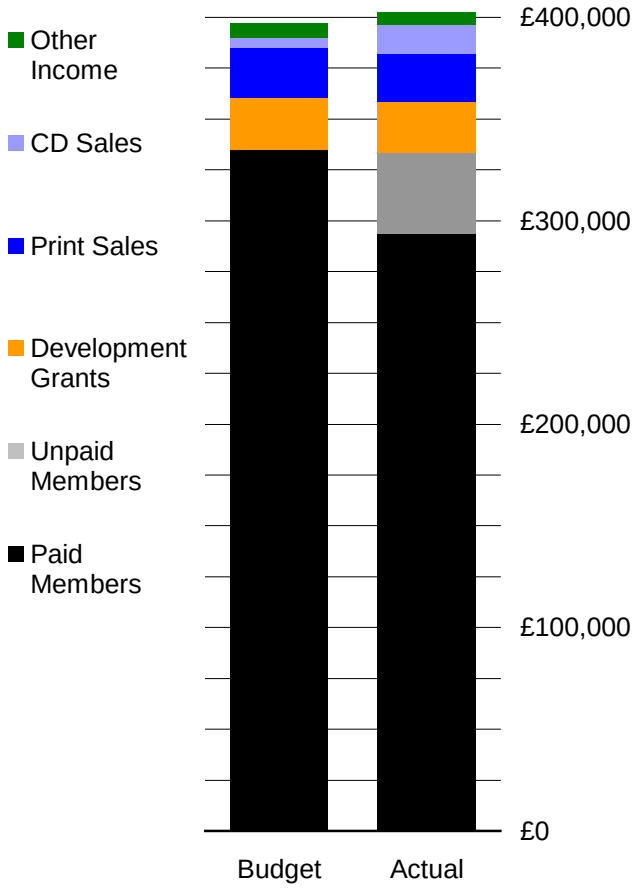
In late 1999 a review of ISC data collection discovered that errors in one of the ISC's data collection programs resulted in truncated values being published in the Bulletin. In the EIDC's REB, leading digits were truncated from slownesses greater than 99.9 s/deg, amplitudes greater than 9.99 nm, and periods greater than 9.9 s. We re-parsed REBs for the affected period, 1996 January through 1997 June, and re-analysed magnitudes for all events in the Bulletin that may have been effected.

Our re-analysis included more than 444,000 EIDC amplitudes that were re-published in the ISC Bulletin. We issued revised Bulletin data with corrections for 11,400 previously truncated amplitudes and 10,300 previously truncated periods. In addition, the revised Bulletin data include approximately 500 EIDC amplitudes and periods that were previously excluded because they appeared to be anomalous as a result of truncation. Finally, approximately 200 amplitudes, which previously appeared consistent with other amplitudes as a result of truncation, have been excluded from the revised data.

In the newly released Bulletin data, the ISC has computed 3567 surface wave magnitudes. Almost all of these, 3461, included at least one amplitude that was previously published with a truncated value. The newly released data include 27,410 body wave magnitudes. But only a small proportion of these, 1019, include a teleseismic or depth phase amplitude that was truncated in the original publication of the Bulletin.

Income

Member contributions (black and grey) fell just short of expectations in the budget from last year's report. Under accruals-basis accounting, this near match reflects that no invoices were posted or withdrawn after the budget was prepared, and that exchange rates were very nearly stable so that the value of invoices did not significantly change when expressed in British pounds.



At year-end, 12% of the membership contribution invoices were unpaid (grey). This is somewhat less than last year, but disappointing in view of the full payment by the Russian Academy. Eventual payment of all unpaid contributions is anticipated, but the delays may require the Centre to pay bank charges maintaining and using a line of credit. Contributions that remain unpaid eventually would be written off as expenditures in future years.

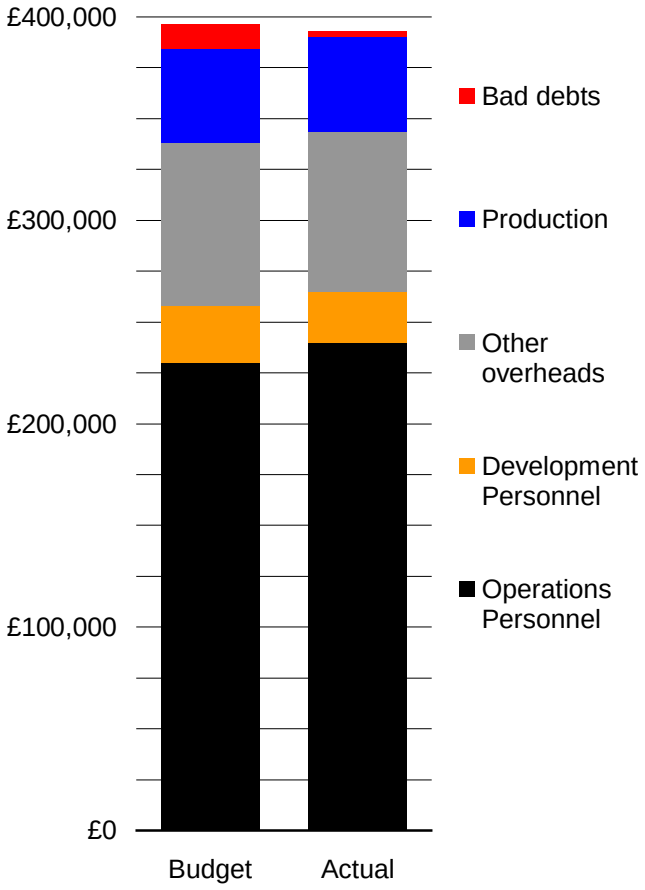
The US National Science Foundation contributed a non-recurring supplement to support software development (orange). An additional grant from the UK Royal Society is not reflected in the income because it was written directly to the computer replacement fund.

Income from printed products (dark blue) nearly matched expectations, an improvement on last year that was made possible by partial recovery of the publication schedule, allowing the ISC to issue all planned invoices. Income from CD sales (light blue) remained strong, again exceeding budget projections.

Other income (green) consists principally of interest on bank deposits, with minor amounts from associate member contributions and sales of services. This income was slightly short of expectations due to a decline in associate member contributions.

Several members made early payment of year 2000 contributions during 1999, the Russian Academy's being the largest. The ISC treated these contributions as deferred income, so they do not appear in the 1999 income and expenditure account.

Total income for the year exceeded the budget by 2%. The difference almost exactly matched excess income from stronger than anticipated CD sales.



Expenditures

Personnel expenditures (black and orange) are comprised of salaries, pension contributions, recruiting and repatriation expenses. The bulk of these costs were close to expectations because there were no unanticipated personnel changes. The budget was exceeded mainly because recruitment costs were unexpectedly high and because some repatriation costs that had been expected in 2000 occurred instead during 1999.

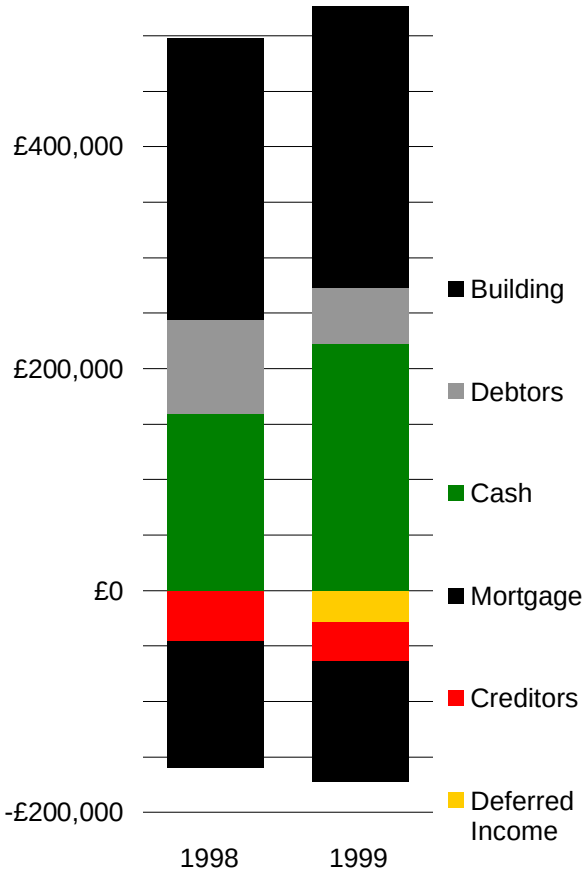
Other overheads (grey) include building expenses, computing expenses, travel by the committee and staff, and exchange rate gains or losses. Building expenses include mortgage payments, which are uncertain only if Dollar/Sterling exchange rates fluctuate. Computing expenses consist primarily of service contracts, purchases of supplies, and additions to the computer replacement fund. Staff travel costs include participation by all ISC seismologists in the IUGG Assembly in Birmingham. Exchange rate gains and losses were minimal because the Dollar/Sterling exchange rate was stable.

Production costs (blue) are almost entirely for printing and distributing the Bulletin and Catalogue of 1997 events, for which subscribers received invoices during 1999. These costs are partly estimated since several issues had not been printed and distributed by the end of 1999. Production costs are larger than last year, as expected, because two issues of the semi-annual catalogue were printed and distributed.

Unpaid contributions that are not likely to be paid within another year are provided for as bad debts (red) and appear as expenditures to remove them from the ISC list of assets. This year, bad debt provisions were small despite withdrawal of Radiomana (France) and Thailand as ISC members because neither had a large backlog of unpaid contributions.

Operating costs are expenditures exclusive of special charges (of which there were none this year) and bad debt provisions. In total, operating costs were 1.5% greater than budgeted, primarily due to greater than expected personnel costs, which constituted more than two-thirds of operating costs when development personnel are included.

Assets



ISC's assets include year 2000 contributions that were deferred, so an adjustment is necessary for net income to conform to the change in the Centre's net assets. This adjustment is shown in the balance sheet as a liability (yellow). It must be treated as genuine in order to obtain an evaluation of the ISC's financial condition consistent with evaluations for other years, when advance payments are normally much smaller.

The net value of the ISC's liquid assets is the difference between cash and creditors, shown in green, red and yellow at the right. This includes the bank balances required for the exchange rate stabilisation fund and the computer replacement fund. The net liquid assets of the Centre increased during 1999 from £113,000 to £158,000. This improvement in the Centre's liquidity is principally thanks to payment by the Russian Academy of its 1997, 1998, and 1999 contributions during the year. Liquid assets provide the ISC with the cash flow required to operate without drawing on committed reserves. Setting aside the exchange rate stabilisation and computer replacement fund balances, at year-end the ISC's unencumbered liquid assets stood at £100,000, sufficient to continue operations for nearly four months.

Current debts owed to the ISC (grey) consist almost entirely of unpaid membership invoices, including, at year-end, the 1999 French, ING (Italy) and New Zealand invoices. The net value of the ISC's current assets is the sum of its liquid assets and current debts, shown in grey, green, red and yellow. Net current assets increased during 1998 from £199,000 to £209,000. With these net current assets, the ISC could have continued operating without 2000 contributions for approximately seven months, but only if all contributions due before 31 December were paid and the Executive Committee authorised use of funds balances.

The ISC's net tangible assets are the difference between the assets (above the "0" line) and liabilities (below the "0" line) shown in black in the figure above. The increase in net tangible assets from £140,000 to £146,000 is due to a decrease in the mortgage, on which the ISC paid 4% of the original principal, as set out in the terms of the loan. Net tangible assets may increase or decrease in the future, partly because the remaining principal on the mortgage, when expressed in Sterling, changes if the Dollar/Sterling exchange rate varies.

The net value of the ISC's total assets, represented by the difference between all assets and liabilities in the figure above, increased from £339,000 to £355,000 during 1999. This level is well within British guidelines for assets of charitable organisations, which suggest that net total assets should not normally be much more than twice the annual operating expenditures, nearly £800,000 in the ISC's case.

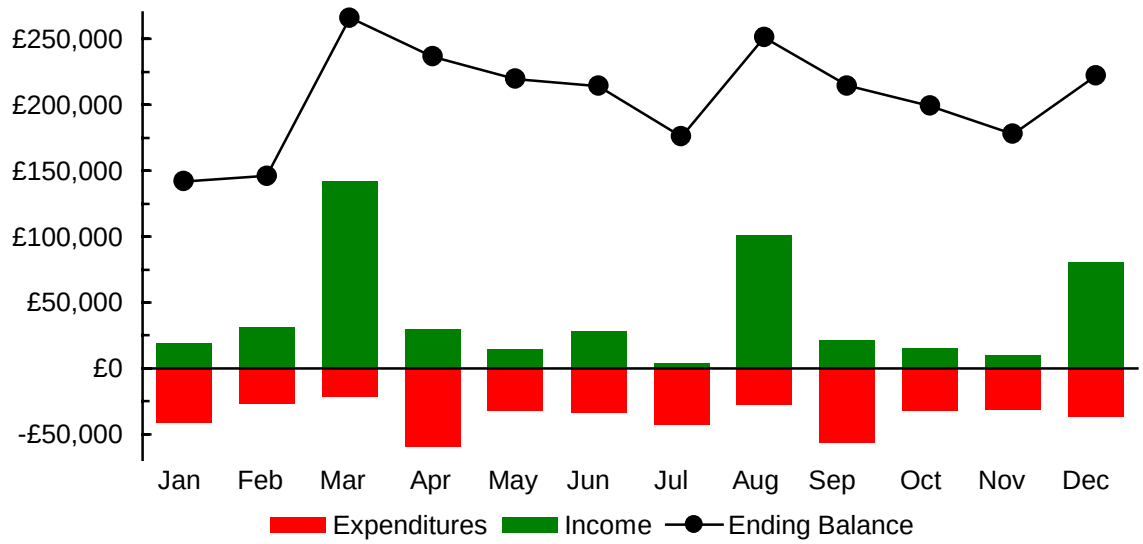
Excess Income and Net Assets

The ISC recognises income from capital-purchase grants only when the capital purchases are made, so that capital-purchase grant income and grant-funded capital expenditures are exactly offsetting. In conformance with generally accepted accounting principals, grant income and capital purchases treated in this way are not shown as income or expenditures, and the value of purchased equipment is not shown as an asset.

If capital grants are received and purchases made in different years, however, there will be an effect in the financial statements. During 1999, the ISC received capital purchase grants of £19,000 but made capital purchases totalling only £16,000. Consequently, the increase in net assets of £16,000 exceeded the surplus income of £13,000.

Cash Flow

Cash flow does not show credit extended to the ISC, debts owed to the ISC, or commitment of assets, such as the exchange rate and computer replacement funds. The cash flow figure below shows large income in March, when the Royal Society and other members made annual contributions, August, when NSF made its contribution, and December, when the Russian Academy made several annual contributions. Large cash expenditures occurred in April, when the ISC paid the invoice on a new computer, and September, when the ISC paid invoices related to the IUGG Assembly, including the Executive Committee and Governing Council meetings.

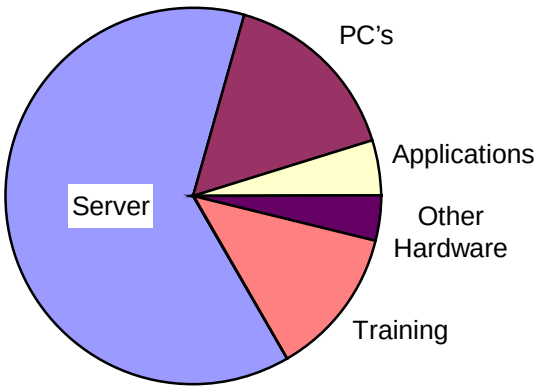


During 1999 ISC bank balances never fell to a level that suggests the ISC might need to use short-term credit, and the ISC reduced its line of credit at Lloyds Bank from £70,000 to £40,000. The assessed value of the Centre's land and building, discounted by a typical rate for commercial property and then with the remaining mortgage balance subtracted, is sufficient collateral for the new credit limit, so Lloyds removed a £30,000 lien on an ISC bank account. If it became necessary, a higher credit limit could be arranged.

Computer Modernisation

Computer modernisation investment in 1999 was 40% less than in 1998. The single purchase of a dedicated server and associated disks for £12,000 (and the MicroVAX in part exchange) constituted nearly 2/3 of all spending in the year. The server is a Sun 250 running Sun's version of Unix, Solaris. The Sun 250 provides services required by workstations on the network, including a shared file system and database. Two PCs were purchased in the year at a total cost of £3,000: a portable for use by the Director while travelling and at home, and a replacement for the failed PC used by Mr Argent.

1999 Computer Related Purchases



Other computer hardware purchased in the year included an Uninterruptible Power Supply for the file server and a new CD write to replace the writer purchased in 1998, which failed just after the end of a one-year warranty. Software purchases included Adobe Acrobat Distiller for creating PDF documents and an updated version of Microsoft Office.

A significant software change was replacement of Sun Web Server (SWS). The Sun 250 came with a later version of Solaris, which required SWS version 2. Unfortunately, Sun is ending support for SWS, and SWS v2 proved unacceptable. Based partly on advice from Sun we replaced SWS with Apache, which is a "shareware" web server program.

Operating system upgrades and patches for the Sun workstations were provided as part of the service contracts. There has not yet been need to expand the 5-user license for Oracle 8. The principal investment in computer training was £2,400 for Mr Harris to participate in Oracle database administrator's classes.

The ISC's further commitment of £7,000 to the computer modernisation fund from the general reserve was complemented by a grant of £19,000 from the Royal Society. Expenditure of £19,000 in the year completed the spending commitments for the 1997 NSF computer modernisation grant and the 1999 Royal Society grant. Computer training costs were taken from the general reserve, so the balance in the Centre's computer modernisation fund increased from £18,000 to £28,000.

ISC Computing Equipment
as of 1 January 2000

CPUs:

Sun 250, and internal disks. Sun service contract.

2 Sun Ultra 1's (1997) and 5 Sun Ultra 10's (1998), Sun service contract.

4 desktop PCs (1998), no service contract.

1 desktop PC (1999), Gateway contract.

1 laptop PC (1999), no service contract.

Peripherals:

Line printer (1990), Compaq service contract.

PostScript Printers: 2 Ethernet laser printers (1995, 1998); PC laser printer (1998); Ethernet colour ink-jet printer (1998).

Scanner (1998) and CD writer for PC (1999).

Sun disk multipack and disks (1997, 1998, 1999) and Sun DLT (1997) and DAT (1998) drives, Sun service contract.

Software Development

Important Software Development Efforts Completed

Porting data collection programs from VMS to Unix: This was a straightforward task of modifying programs that re-format ASCII files. But it required a large effort because a separate program is used for each format in which data are sent.

Designing the database schema: This is the next step after installing a management system in creating a database. It is an important task because poorly designed tables can hinder performance or ease of use and it can be difficult when desirable properties trade-off against each other. We were fortunate to be able to base many of our decisions partly on the experience of other seismological data centres with relational databases.

Loading the published data into the database: Although this may appear to be straightforward, subtle ambiguities and variable formats in the input files led to incorrect database entries in the first attempts. After the first trial load, several months elapsed until we were satisfied that we had accurately loaded the complete data set (*i.e.*, 1904-1963 Historical File and 1964-1997 Fixed-Format Bulletins).

Writing programs to post data from the database: The first "pay-off" from the database came in November, when the ISC offered more flexible on-line access to its data less than two months after we completed loading the data.

Other Significant Computer-Related Projects Carried Out

Transferring ISC data archive to DLT: The complete set of Working Tape Format on 9-track tapes was copied to DLT cartridges and duplicate DAT cartridges. This transfer has eliminated any significant risk that physical decay of tapes might cause loss of unassociated readings collected by the ISC but not associated with events published in the Bulletin.

Writing PDF Bulletin files to CD volume 7: Using Acrobat Distiller, we translated the long-version Bulletin files from PostScript to PDF. The PDF files can be accessed randomly, allowing CD users to view and print arbitrary pages.

Software Development Started

Improving phase association: Associating more readings with the correct event from the outset begins has long been recognised as potentially the most important improvement in reducing the load on Bulletin editors. With a NSF funding to devote a person full-time to this task, a project to attempt this was nearing completion at the end of 1999.

Writing a WTF file from the database: Creating a WTF file that can be used to complete preparation of the Bulletin after several passes of editing is essential to the strategy of replacing elements of the existing system one at a time. At the end of 1999, completion of a program to do this was anticipated within a few months.

Automating data collection: Starting from late 1999, and automated system recognises the source and format of most data e-mails received at the ISC. The system assigns a unique identification to each report and files it appropriately. Further work remains to parse the data in each filed report and enter it into the database.

Personnel Changes

Dr Noureddine Beghoul joined the ISC in January on a fixed-term appointment to implement a new association algorithm. Dr Beghoul holds doctoral degrees in geophysics from the University of Paris and Cornell University, and his previous work includes tomographic inversions using regional phase arrival times from the ISC Bulletin.

ISC Staff as of 1 January 2000

Dr Raymond J Willemann, Director
Dr Dmitry Storchak, Senior Seismologist
Mrs Maureen Aspinwall, Fin & Admin Officer
Mr James Harris, System & DB Administrator
Mr Mamy Andrianirina, Seismologist
Dr Noureddine Beghoul, Seismologist/Developer
Dr Peter Dawson, Applications Manager
Mr Cliff Allen, Data Preparation Assistant
Dr Chen Qi-fu, Royal Society Fellow

Dr Peter Dawson joined the ISC at the end of March as Applications Manager. Dr Dawson has 20 years of experience in commercial software development and thorough knowledge of Fortran. He is responsible for ensuring that ISC software meets stated standards, maintaining existing programs, and developing certain programs. His first significant project is developing a program write a WTF from the relational database.

Mrs Anna Surguy left the ISC in May. Mrs Surguy's responsibilities for data collection and initial and final processing of data in preparing the Bulletin have since been shared among other staff members.

Mr Cliff Allen joined the ISC in September to take up the data entry tasks of *Mrs Carol Tubby*, who left the ISC to pursue personal goals. Mr Allen brings years of data entry experience and familiarity with Internet applications.

Ms Alison Bird completed her two-year appointment at the ISC in December. Ms Bird returned to Vancouver Island, Canada, and took up a post with the Geological Survey of Canada. Her primary responsibility was helping to edit the Bulletin and at year-end the ISC awaited her replacement from the Philippines, *Ms Esmeralda Banganan*.

Scientific Liaisons

In June, the ISC hosted a one-day meeting with a delegation of the China Seismological Bureau that was headed by CSB Director-General Dr Chen Zhangli and included Mr He Qin, Chief Executive of International Cooperation. The ISC held an open house during IUGG99 in which 50 delegates from the Assembly participated.

1999 Visitors to ISC

Chris Argent
Chen Qi-fu, CSB
Harry Cohen, M.P.
Adam Dziewonski, Harvard U.
Jens Havskov, U. of Bergen
Dave Jepsen, AGSO
Ian Marsden
Liu Ruifeng, CSB
Andrea Morelli, Inst. Nat. Geof.
Bruce Presgrave, NEIC
Kiyoshi Suyehiro, JAMSTEC
Graham Sutton, Reading U.
Spiro Spiropoulis, AGSO
Rick Thomas, Partner Re
Belinda Troup, Leeds U.
John Woodhouse, Oxford U.
Akio Yoshida, Japan Met. Agcy.
John Young, AWE.

This year ISC staff members participated in meetings of the European Geophysical Society, the International Union of Geodesy and Geophysics, and the American Geophysical Union. Staff members visited Oxford University and Imperial College, attended IDNDR forums, visited the Provisional International Data Centre for CTBT monitoring, in Vienna, Austria, and participated in London meetings of the Royal Society, the Royal Astronomical Society, the Royal Academy of Engineering and the Society of Earthquake and Civil Engineering Dynamics. ISC staff continue subscriptions to Nature, the Journal of Geophysical Research, and Geophysical Journal International.

ISC staff members regularly analyse the Bulletin in order to help users take full advantage of ISC data, and to help plan, implement or evaluate improvements to the Bulletin. Analyses of broad interest are presented at conferences or published in peer-reviewed journals. The results during 1999 are tabulated at right.

The ISC has only a limited knowledge of how its data are used. Users often do not inform the ISC when they publish research that uses of ISC data. Unfortunately, therefore, the list below of papers using ISC data is incomplete.

ISC Staff 1999 Publications

Storchak et al, Discrepancies in earthquake location between ISC and other agencies, *J. Seis.* (*in press*).

Willemann, Body-wave magnitude thresholds of the ISC Bulletin, *Seis. Res. Lett., 70,* 313-321.

Willemann, Amplitude Biases of Stations Participating in GSETT-3, Euro. Geophys. Soc. 1999 meeting.

Beghoul, Willemann & Storchak, Automatic Association at the ISC, 1999 IUGG General Assembly.

Bird, Storchak, Willemann and Adams, Why the ISC Continues to Search for 'Unreported' Events, 1999 IUGG General Assembly.

Surguy & Willemann, Accessing Data from the ISC, 1999 IUGG General Assembly.

Storchak, Reasons for pIDC Mislocations: A View from the ISC, 1999 IUGG General Assembly.

Willemann & Storchak, Updating the ISC Bulletin, 1999 IUGG General Assembly.

Surguy & Willemann, Accessing Data from the ISC, AGU 1999 Fall Meeting.

Storchak & Willemann, The Impact of Digital Data on Seismic Bulletins, AGU 1999 Fall Meeting.

Willemann, Differences between Independent Arrival Time Picks, AGU 1999 Fall Meeting.

Citations of ISC Data in 1999

Asamori, K., F. Ochi, and D. Zhao, Joint inversion of local and teleseismic data for the deep structure of the Japan subduction zone, *Eos, 80*, F724, 1999.

Babuska, V., and J. Plomerova, Seismic anisotropy and large-scale fabric of the continental lithosphere, *IUGG99 Abstracts*, B144, 1999.

Benouar, D., A methodology for the re-evaluation of the seismicity in the Maghreb countries -- Algeria, Morocco, Tunisia, *Euro. Earthq. Engr.*, *13* (3), 62-73, 1999.

Bijwaard, H., and W. Spakman, *Ear. Planet. Sci. Lett.*, *166*, 121-126, 1999.

Boschi, L., and A.M. Dziewonski, High- and low-resolution images of the Earth's mantle: Implications of different approaches to tomographic modeling, *J. Geophys. Res.*, *104*, 25567-25594, 1999.

Dziewonski, A.M., L. Boschi, Y. Gu, G. Masters, and G. Laske, Feasibility of construction of a 3-D reference earth model, *Eos*, 1999.

Goes, S., and W. Spakman, A lower mantle source for European volcanism, *Eos*, *80*, F730, 1999.

Goes, S., W. Spakman, and H. Bijwaard, A lower mantle stource for central European volcanism, *Science, 286*, 1928-1931, 1999.

Gu, Y.J., and A.M. Dziewonski, Mantle discontinuities and 3-D tomographic models, *Eos*, 1999.

van der Hilst, R.D., and H. Karason, Compositional heterogeneity in the bottom 1000 kilometers of earth's mantle: toward a hybrid convection model, *Science, 283*, 1885-1888, 1999.

van der Hilst, R.D., H. Karason, and R. Saltzer, Tomographic constraints on the depth of slab penetration ans the scale of convection, *Eos*, 1999.

Johnson, L.R., and D.W. Vasco, Whole earthq structure estimated from seismic travel time data, *IUGG 99 Abstracts*, B197, 1999.

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Status of Earlier Plans

The table at right, derived from plans in the 1998 Director's report, shows that the ISC successfully carried out most of its plans for 1999. Fourteen months of Bulletin were edited in just over a year and editing experience held stable. The CD and web site were enhanced, and ISC and NEIC agreed a new standard for data exchange. Modernisation of the computer hardware was concluded and, even though important software projects were not quite completed, we made substantial progress in each area. Income and spending were in line with plans and further development funding was obtained.

JAN 1999 STATUS	PLANS FOR 1999		JAN 2000 STATUS
Data Analysis			
• Seven months behind	• Edit 14 months	☑	• Five months behind
• Three full-time editors	• Extend or replace Bird	☑	• Banganan hired
• Two experienced editors	• Prototype on-line editing	☒	• Two experienced editors
• Long-term plans unc.	• Solicit community input	☑	• IASPEI working group
Data Exchange			
• CDs through 1995	• CD7 with PDF & HTML	☑	• CD7 replacement near
• On-line queries limited	• Flexible on-line queries	☑	• Reliable on-line service
	• IMS 1.0 extension	☑	• ISF1.0 draft in prep.
Computing			
• Workstations throughou	• Purchase & install server	☑	• Hardware reqs. met
• NSF-funded developer	• New association algorithm	☒	• Expected in March
• Oracle being installed	• Collect data to database	☒	• Auto. data capture
Finances			
• Surplus from 1997-98	• Match spending to income	☑	• General reserve stable
	• Seek develop. funding	☑	• NSF grant in hand
	• Free lien on reserves	☑	• Improved liquidity

The concentration of unfinished tasks in software development results from setting ambitious goals, and does not reflect substantial progress actually made. Regarding specific targets:

On-line Editing Prototype: This goal was not pursued due to lack of resources. The departure of Mrs Surguy reduced the number and experience of computer development staff, and we decided to continue projects already underway to improve automated processing. The ISC made plans, however, for a joint project with Reading University to develop on-line editing, and plans to apply for partial support from the UK Department of Trade and Industry.

New Association Algorithm: A new algorithm was yet to be tested in operations, but the code changes were nearly complete. We are hopeful of completing configuration in the near future, and confident of implementing a program sufficiently flexible to continue improving.

Collect Data to Database: The ISC has made great progress in using a relational database. We completed installation of the management system, designed and implemented a schema, inserted all published ISC data in the database, and began using the database for on-line services. Only the last of all database plans for the year, using the database in collection, remained undone. Even in this area, significant progress was made in automating data capture and certain editing tasks.

Plans for Bulletin Content

The ISC has received a grant from the NSF to integrate the Engdahl, van der Hilst and Buland (EHB) catalogue and procedures at the ISC and to recover unassociated readings from WTF files as far back to 1964 as possible. By late 2000, we anticipate that locations from the EHB "century catalogue" will be inserted in the ISC database and grouped with ISC events. By late 2001 we anticipate that the EHB statistical phase identification will be implemented as an automatic process run after editing is completed for each month. We plan to post the EHB hypocentres as non-prime hypocentres in the on-line Bulletin and eventually to include them in computer disks published by the ISC.

The NSF grant also includes funding to recover unassociated readings from WTF files. By early 2001 we anticipate that readings at least back to 1980 will be inserted in the database. We plan to post unassociated readings in the on-line Bulletin and eventually to include them in computer disks published by the ISC.

Over the course of 2000 we plan to begin parsing some of the collected bulletins into the database. Based on this, we plan to post at least a portion of collected hypocentres and readings in the on-line Bulletin before the ISC's own analysis is undertaken.

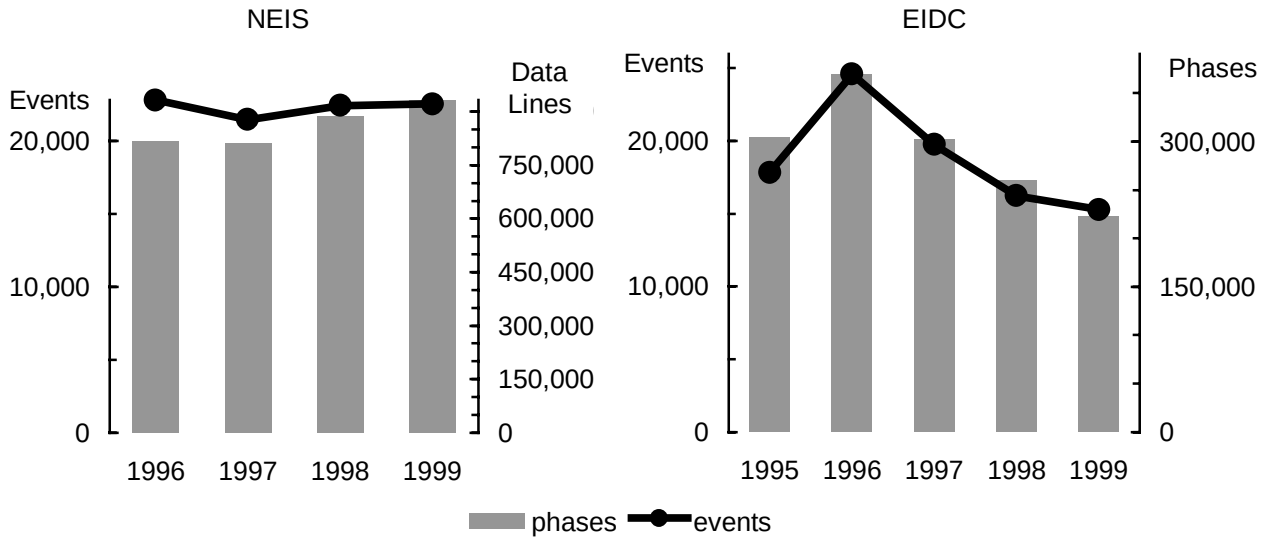
We have talked with the IRIS DMC about the possibility of becoming a node of the FDSN "NetDC". The advantage to the ISC would be receipt of inventories from on-line waveform distribution centres. Using these inventories, we hope no later than late 2001 to begin supplementing the on-line Bulletin with information about waveform data availability for individual earthquakes or phase readings, and perhaps to compose waveform requests on behalf of ISC bulletin users.

The Director is chairing an IASPEI working group on the content of seismic bulletins and plans to convene a workshop at the 2001 IASPEI Assembly on new types of waveform measurements or source parameters that might be catalogued.

Plans for Data Analysis

The Centre has obtained a four-year extension of the UK work permit for Dr Dmitry Storchak. Mr Mamy Andrianirina is contracted to work at the ISC through November 2000, but may legally work for the ISC through November 2001. The ISC is likely to offer Mr Andrianirina an extension, and he would likely accept. Ms Esmeralda Banganan joined the ISC in mid-January 2000. She is contracted to work at the ISC through January 2002, and is legally permitted to work in the UK for the ISC through January 2003. During 2000 the ISC editing staff may be slightly less productive than during 2000 since Ms Banganan joined us 13½ months after Mr Andrianirina, rather than 12.

Two of the most important data sources to the ISC through the late 1990's are the NEIS, which sends ISC late-arriving data as well as the "Monthly PDE", and the prototype IDC, which has sent the "REB". The importance of these sources arises from their aim at worldwide coverage, rather than the number of data alone. Nevertheless, the number of data is an important indicator of how comprehensively each is achieving its goal, and thus how much work remains for the ISC.



Apart from 1997, the number of events in the PDE each year has grown gradually while the number of phase arrivals has remained steady. The stable number of phases from NEIS may indicate that the total number of data to be analysed at the ISC will not differ much during the next two years from what it has been over the last two. The increasing ratio of events to phase arrivals may result partly from NEIS holding more events to locally-determined epicentres when their own location algorithm does not converge. Regardless of the reason, the ISC's job will be slightly easier if we start from a more complete set of initial hypocentres.

At its peak in 1996, the REB provided hypocentres for more events than the PDE, even though it included less than half as many phase arrivals. But the volume for the REB has been declining for several years and the REBs that will be analysed by the ISC this year have 15% fewer events and 20% fewer phases than the 1997 REBs analysed in 1999. One of the most important impacts of the REB was to reduce the number of "SEARCH" events in mid-oceanic regions; ISC seismologists may need to renew efforts to scrutinise the "SEARCH" pass in the coming year to limit deterioration of thresholds in sparsely instrumented regions.

We anticipate using a new association algorithm for March or April 1998 earthquakes. Preliminary tests have achieved only marginal apparent reductions in the number of misassociated readings, but we remain hopeful that network-specific configuration will be more helpful. With three seismologists, data input sometimes cannot keep pace. Seismologists key their own edits when this happens, which gets the job done but reduces the "seismologist days" available for editing.

In summary, operations may be more challenging in 2000 than 1999 because of a slightly less experienced staff and potentially a need for more "SEARCH" analysis, but easier due to more completely analysed data from NEIS and, we hope, more accurate initial associations. On balance, we will be challenged to again edit 14 months in the year, leaving the ISC approximately 3 months behind its target publication schedule.

Plans for Data Exchange

NEIC has agreed to begin developing software for supplying data to the ISC in IMS1.0 format, with appropriate extensions. The extensions are a provisional standard that the ISC Director has suggested to the IASPEI Commission on Practice after consulting with NEIC, the CTBT Provisional Technical Secretariat, developers at the prototype IDC, and other seismologists. We plan to encourage agencies reporting to the ISC to use this format and to incrementally introduce the extensions in the ISC on-line bulletin. For example, we plan to begin posting moment tensors computed by Harvard University and NEIC as "formatted comments" during 2000.

We plan to implement an AutoDRM system during 2000, which will allow users to send e-mail to the ISC with selection criteria and receive an appropriate selection from the on-line Bulletin by return e-mail.

The ISC has continued to expand the sources of data that are received as e-mail rather than printed bulletins. During 2000 we expect to begin analysing data from e-mails sent by Pretoria, New Delhi, and GSN data collection centres. These are in addition to e-mail data used for the first time in 1999 from the Kamchatka Regional Seismic Centre, Sakhalin, and the CTBT National Data Centres of Indonesia and Portugal. In addition, we expect to begin receiving focal mechanisms by ftp from JMA during 2000.

Plans for Computing

Computing and Networking Hardware

All work stations are planned to be in use during the second half of 2000, and any further growth would require additional computer purchases.

The ISC has experienced some difficulty with overloading of its 10 Mbit/s LAN, partly due to frequent re-writing of blocks from the Data Collection File and due to reading and writing of complete data, index and listing files for a month data being analysed. The cost of 100 Mbit/s LAN hardware is now low enough that we will probably upgrade during 2000. We are confident that this will be sufficient for some time because we are arranging activities to reduce the network load, and anticipate further reductions in the load as growing use of the database helps us to limit I/O of data unrelated to each task.

The ISC's 56 kbit/s Internet connection is slow enough to require consideration in certain decisions. But we anticipate the possibility of both much greater requirements and lower costs in the future, and we have decided on a one-year extension of our existing contract with Rutherford-Appleton Laboratory.

Software Development

Implementation of a new association algorithm was incomplete at the end of 1999. Dr Noureddine Beghoul, who has developed the program so far, plans to leave the ISC at the end of February 2000. Much of the work for configuring the new algorithm will remain, and be a high priority task during the second quarter of 2000.

Implementation of a program to translate from the database to WTF format was incomplete at the end of 1999. The primary purpose of this program is to facilitate use of yet-to-be-developed other programs to process data in the database. Thus, the impact of delay in completing this project is to limit Dr. Dawson's contribution to other development.

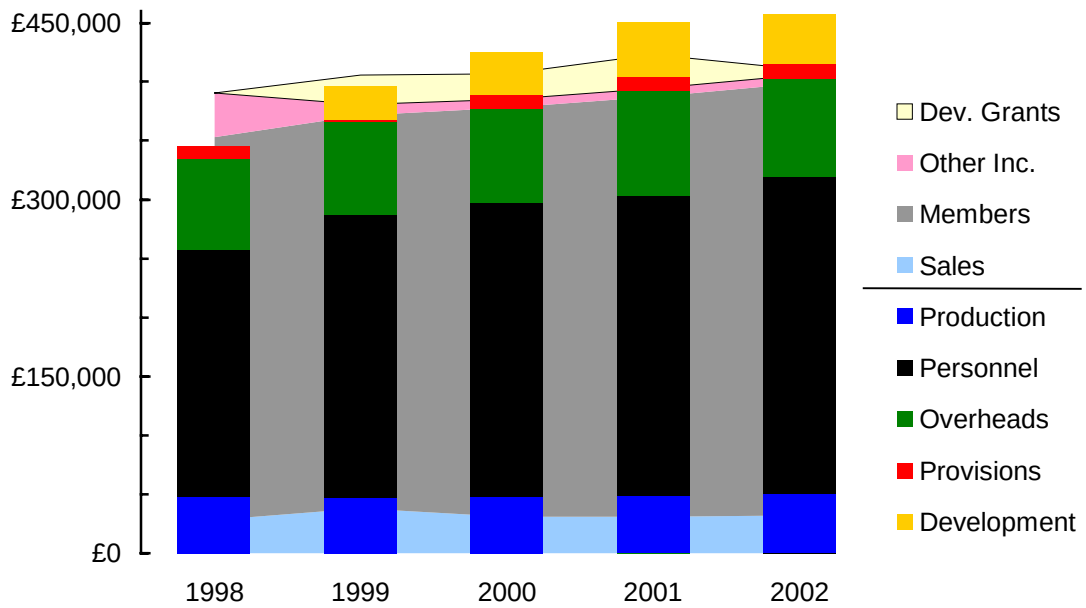
ISC plans to hire an additional seismologist/developer who will undertake collection of data directly to the Oracle database. As this task progresses, we will be able to consider implementing grouping of hypocentres and association of readings in the database, followed by use of the database-to-WTF program.

During 2000 the ISC plans to begin implementation of an on-line editing system. We plan to apply jointly with Reading University for a Department of Trade and Industry grant for partial support of a recent computer science graduate employed by the University but working at the ISC. The work is planned to be underway from mid-year, but an initial prototype is not expected to be ready until sometime during 2001, and refinement is expected to continue into 2002.

Modification of the ISC location algorithm to make use of 3-dimensional earth models has been undertaken by Dr Chen Qi-fu on a one-year Royal Society fellowship. We hope that these modifications can eventually be used in operations and that they will aid in modification of the algorithm to also make use of S and PKP travel times.

Plans for Finances

The budget projection figure below illustrates the evolution of the ISC's income and expenditures over the last two years and projected for this year and the next two years. Grant-funded capital spending is excluded. The projections are based on the membership rates agreed by the Governing Council in 1999 and write-offs estimated at £12,000 annually. Details of planned expenditures are given in the appendix.



Income apart from development grants grows as the result of annual indexing of member contributions. The actual and projected increases of member contributions are slightly less than the agreed rate of increase in the unit rate because

- Following its review in early 1998, the UK Royal Society decided to continue its contribution at the 1997 level without indexing.
- A few members are invoiced in native currencies, compared with which the British pound has steadily strengthened.
- While 3 organisations joined the ISC during 1999, 2 single-unit members withdrew during the same year.

Expenditure grows principally as the result of salary rises, based partly on a presumed annual indexing of 4%. West Berkshire unemployment fell to 0.8% at the end of 1999 and the number of positions available significantly exceeds the number of people seeking work. It is unsurprising that the average rise in salaries in the UK significantly exceeded retail price inflation, reaching nearly 5%. Even in the public sector, the British government has recognised the necessity of salary rises above inflation among education and health care workers in order to maintain high standards. Housing prices in the area rose by 20% during 1999, which is a burden ISC staff renting or looking to buy homes and job candidates considering relocating from elsewhere. The ISC is unlikely to be able to attract and retain outstanding employees if salary rises fail to keep pace with UK university salary scales.

As the ISC invests a portion of the accumulated surpluses from 1997-1999, a modest shortfall of income is projected for 2001, and a somewhat larger deficit for 2001. Even though this represents investment less than 40% of cumulative excess income during 1997 to 1999, it is clear that the staffing level during 1999, which enabled significant progress in development, requires ongoing efforts to obtain support beyond member contributions.

The ISC will continue to seek grants for development projects, but it is important that funding for operations does not decline in real terms. Even development projects undertaken by staff hired with supplementary funding require time from both the Director and the Senior Seismologist, who are necessarily involved in projects with a potential to affect the Bulletin. As shown at right, the ISC has applied or intends to apply for special grants from agencies of the governments of the US, the UK, the European Union and Japan. If all were successful, the ISC would be challenged to implement each of them with full effect. As in the past, however, it is likely that some of them will succeed only if re-submitted in the future.

ISC Development Support

NSF: Partially funded two-year computer replacement programme concluding in 1999.

NSF: Supplemented operations grant to support a development seismologist for 1 year during 1999.

NSF: Separate grant during 2000-2002 to support an extra staff member for nearly 2 years to make more data available from ISC.

DTRA: ISC's proposal to automatically re-process unassociated readings was unsuccessful.

RS: Funded computer purchases during 1999 including a server.

RS: Funded a fellowship for Dr Chen Qi-fu of the CSB to investigate earthquake locations using 3-D earth models at the ISC during 2000.

NERC: ISC intends a joint proposal with Bristol or Leeds University to develop procedures for routinely measuring shear wave splitting.

DTI: ISC intends a joint proposal with Reading University to develop interactive Bulletin editing.

EC: ISC's application with EMSC was unsuccessful, but we have been invited to join an EC-funded project as an evaluator of EuroBull.

INTAS: No proposal was submitted during 1999, in anticipation of refining objectives.

STA: Request for ¥100,000,000 over five years to support development of new products is pending, but prospects remain uncertain.