

Background to The Numerical Algorithms Group (NAG)

The Numerical Algorithms Group Ltd is a not-for-profit company which aims to provide products and services to meet the mathematical software and related needs of computer users especially scientists, engineers, planners and analysts. This document provides a general overview of the company and its products.

1 The Early Years

The NAG project began in 1970 as a collaborative venture between the Universities of Birmingham, Leeds, Manchester, Nottingham and Oxford, and the Atlas Computer Laboratory (now part of the Science and Engineering Research Council's Rutherford Appleton Laboratory). The original aim was to develop a library of numerical and statistical subroutines for use on their ICL 1906A/S machines. Because of the different language emphasis in the centres and the difficulty of mixed-language programming it was decided to develop the library in both Algol 60 and ANSI Fortran. The Mark 1 Library contained 98 user-callable routines and was released on 1st October 1971.

Universities with other types of computer became interested in the activity, and various machine-range implementations were initiated from Mark 2 of the Library onwards. Hence, the early aims of NAG could be summarised as follows:

- (a) to create a balanced, general-purpose library of algorithms meeting the numerical and statistical needs of computer users;
- (b) to support the library with documentation giving advice on problem identification, algorithm selection, and routine usage, together with a comprehensive set of example programs;
- (c) to provide a substantial test suite for certification of the library;
- (d) to implement the Library as widely as user demand required.

In adopting these objectives, NAG committed itself to a long-term programme of library contents development with a strong emphasis on documentation, testing and portability. This emphasis has been maintained throughout the subsequent years of NAG's development, and is reflected in the present-day range of NAG products.

Both the contribution activity and the implementation process were co-ordinated from Nottingham until August 1973. The central office of the project then moved to Oxford University, and at this point the name of the project changed from 'The Nottingham Algorithms Group' to 'The Numerical Algorithms Group'.

2 The Formation of NAG as a Company

Until mid-1975, the distribution of the Library was, for funding reasons, restricted to UK university computing sites and certain related installations. Since the Library and its supporting facilities appeared to be useful to scientific computer users generally, it was decided to make the Library more widely available. A Library Service based on Mark 5 was initiated in 1976.

To facilitate the provision of such a service, NAG became a not-for-profit company, limited by guarantee, in March 1976. This particular company structure was chosen to reflect NAG's continuing commitment to collaborative work in the development of software for the benefit of the scientific and research community. NAG has no shareholders or owners, but about 300 members voluntarily guarantee the company. All financial surpluses can thus be re-invested in resources to enhance development of existing and new products and services.

After the Company was formed, the nature of the resources within NAG continued as before, namely the close collaboration between full-time staff and a large number of specialists in numerical and statistical computing. Originally, these specialists were situated in university departments or government research institutions throughout the United Kingdom, but since then co-operation has been established with a much wider body of specialist expertise worldwide.

To promote the use of the NAG Library Service in North America, an associated company, The Numerical Algorithms Group (USA) Incorporated, was established in 1978. A second subsidiary company, The

Numerical Algorithms Group (Deutschland) GmbH, was created in 1990. The NAG IRIS Explorer Center Japan (IECJ) was set up in 1994 to provide a full range of product sales, services, training, consultancy and support for IRIS Explorer. NAG also has a number of distributors in different countries around the world.

3 Developing and Extending the Product Range

(a) Numerical and Statistical libraries

In keeping with its original objectives, NAG has developed its original product, the NAG Fortran Library, through a succession of major Marks (editions). Seventeen Marks have been released between 1970 and 1995, and Mark 17 contains over 1150 user-callable routines. This active campaign of development will continue both in terms of new contents and implementation on an ever-widening range of computer systems, from personal computers to supercomputers and special architecture systems.

Subset Fortran libraries have also been launched, for use mainly on microcomputers and workstations. The NAG Foundation Library is a recently released subset – it contains over 250 user-callable routines fully compatible with material in the NAG Fortran Library and provides the core functionality required by many scientists and engineers. This Foundation Library is supported by an optional on-line information system providing advice on routine selection and usage, together with an example programming environment.

These libraries have been prepared to use the appropriate current standard Fortran language, e.g., specific Fortran 77 constructs were introduced at Mark 12. The adoption of the Fortran 90 standard now provides further scope for enhanced library facilities. NAG has already implemented both the Fortran Library and the Foundation Library for use with Fortran 90 compilers including the NAGWare f90 Compiler (see below). However, NAG is also developing NAG *f90*, a new Fortran 90 Library which will take advantage of features of the new standard to provide greater flexibility and ease-of-use. The first release, containing the equivalent of about 320 Fortran (77) routines, became available in 1994, and a second release will be completed in 1995.

NAG has also been developing further software for use in parallel computing environments, and issued the first release of the NAG Numerical PVM Library in 1995. This high-level library makes use of PVM to run on distributed memory systems or networks of workstations. Current developments include extending the coverage of routines included as well as work with other systems, e.g., MPI.

Alternative language libraries have also continued to feature in the NAG product range. In 1973, NAG began to develop an Algol 68 Library, Mark 1 of which was released on ICL 1900 machines in March 1976, and for which a total of four Marks were prepared. These developments coincided with reduced interest in Algol 60; Mark 8 of the NAG Algol Library was made available in 1981, but no further Marks have been produced. A Pascal Library was released in 1986. A collaborative project for the creation of an Ada Library was also initiated, and Mark 2 of this library is now available.

Towards the end of the 1980s, a growing interest in the use of C for scientific computing led NAG to start the development of a C Library. Three Marks were released between 1990 and 1994, and Mark 4 containing about 275 user-callable functions will be available early in 1996.

At the same time, a number of specialised topic libraries have been developed jointly by NAG and other organisations. These provide facilities for solution of problems in Control Engineering, Sparse Matrices, Data Approximation and Finite Elements.

For some years NAG has supported the Fortran Library and Graphics Library with the provision of an On-line Information Supplement containing a reduced form of the library manuals. We are now developing a new range of electronic documentation products providing hypertext forms of the manuals, generally called TextWare. NAG *f90* and the Numerical PVM Library are already supported in this way and versions for the Fortran Library and C Library will be available shortly.

(b) Statistical Packages

Because of NAG's expertise in software validation, porting, sales and support, third party software developers often enter into agreements with NAG, whereby the company undertakes the

implementation and distribution of their software products. The first of these were the widely used statistical packages GLIM (developed by the Royal Statistical Society) and Genstat (developed by Rothamsted Experimental Station). Over the years, this collaboration has grown so that NAG and the developers share knowledge for the design of technical contents, graphical facilities, user interface, etc.

(c) Software Tools

Because of NAG's commitment to the production of high quality software which is robust and easily portable, the need for an extensive range of reliable software processing tools was recognised from the beginning. NAG developed a number of tools for its own use, and this activity widened into collaboration with the Toolpack project formed in 1978. This project was supported in the US by the National Science Foundation and the Department of Energy, and in the UK by the Science and Engineering Research Council. The first release of Fortran 77 processing tools was made available as a public domain distribution service in 1985, and a subsequent release was made in 1986.

Over the following years, NAG's use of these tools increased, and new versions were developed which were faster, more robust and able to cope with processing much larger source code. The portability base on which tools were produced was modified to ease implementation and support, and to provide a simpler model of the host environment. These technological developments were then made available to other Fortran programmers when the f77 Tool Suite was released for sale as the first product in the NAGWare range of software support systems, in 1991.

While always making use of a number of programming languages, NAG has recognised the special place of Fortran to serve the requirements of the scientific computing community. To further this support, NAG became closely involved in the discussions concerning future Fortran language standards, which culminated in the approval of the Fortran 90 standard. Within a very short period of time, NAG was able to release the NAGWare f90 compiler, which as a fully standard-conforming compiler has given the Fortran community the chance to take advantage of the new constructs very quickly. This compiler is available for both workstations and personal computers; collaboration with other vendors and the sharing of NAG's Fortran 90 technology expertise will ensure that further compilers become available shortly.

Our work on the compiler and the Fortran 90 library has naturally led to the development of a suite of tools for processing Fortran 90 code. These have also been released, as the NAGWare f90 Tool Suite.

Another aspect of software processing has been the building of links between systems, particularly to provide the power and flexibility of NAG library software to users of other products. This has already led to the development, in collaboration with the National Physical Laboratory, of a system for generating gateways allowing Fortran subroutines to be called from MATLAB by simple MATLAB-style commands. This NAGWare Gateway Generator is now available.

(d) Visualisation and Graphics

Users of the NAG Fortran Library soon expressed a requirement to be able to produce plots of data or results from within their programs. NAG, therefore, developed a Graphics Library to provide this functionality while ensuring that the underlying numerical computations were sufficiently rigorous to give high-quality accurate plots, e.g., of contours, perspective surface views etc. Mark 4 of this library includes facilities for production of 'publication quality' output and has now been released.

While there is continuing demand for this type of graphics subroutine library, the requirement for sophisticated data visualisation systems has grown recently (along with the development of single-user workstations powerful enough to support such work). At the forefront of these products is IRIS Explorer, which was developed by Silicon Graphics Inc as both a data visualisation system and as a visual programming environment. In 1992 Silicon Graphics invited NAG to port IRIS Explorer to a range of other UNIX workstations; again this is evidence of the recognition of NAG's expertise in software portability. In 1995 NAG took over the development, porting and support of IRIS Explorer worldwide and Release 3.0 is now available.

(e) Symbolic Computing

AXIOM is another example of NAG accepting responsibility for material developed elsewhere. The IBM T J Watson Research Centre developed a powerful symbolic computing package, Scratchpad

II, which provides a mathematical approach to problem solving, together with advanced graphical capabilities and hypertext documentation. A number of collaborators around the world had contributed to this work, and wished to continue to do so. NAG, with its extensive experience of co-ordinating such activities, was asked by IBM to develop Scratchpad II into the product AXIOM. Release 2 of AXIOM, including a new compiler and links to NAG numerical software, is now available for a range of UNIX workstations. Development and porting to further platforms is continuing.

To complement this range of products NAG's expertise in mathematical computation and software engineering is available on a consultancy basis and has been used to great effect in a wide range of industries.

4 User Support

NAG continues to place considerable emphasis on all forms of user support. In addition to the comprehensive documentation supplied with each product, a number of other services are available. These include:

(a) Response Centre

This acts as a focal point for all enquiries about any aspect of NAG activities, as well as providing specific technical, servicing and sales support. It can be contacted by telephone, fax, e-mail and letter at NAG Ltd and NAG Inc. All queries are logged and monitored to ensure NAG can identify areas of concern or difficulty for our users.

(b) News publications

"Network" is a quarterly news-sheet distributed to all supported customers to highlight new developments within NAG and topics of general interest.

Specific newsletters for particular products are also available.

(c) Bulletin Board

An electronic Bulletin Board Service is available to provide users with access to news and background information on NAG products and services at any time.

(d) Meetings

NAG organises a variety of seminars, workshops and training courses at suitable locations around the world. These may focus on a particular product, such as Genstat or the NAGWare f90 Compiler, or provide a more general overview of developments in scientific computing.

(e) User Groups

The NAG Users Association (NAGUA) is an independent organisation open to all users of NAG products and services. NAG provides support, mainly by giving presentations at meetings and seminars arranged by NAGUA. Similarly, NAG supports other groups where either hardware or software is the common factor amongst members.

As well as offering these facilities as a service to users, NAG values the feedback on our products which such contacts generate. This information, backed up by surveys on specific topics, e.g., documentation usage, is used to ensure NAG is aware of changing user requirements and can respond accordingly.

For further information about NAG and its existing or planned products, please do not hesitate to contact us.
