- AVS Developers Guide
- AVS Module Reference
- AVS Technical Overview
- AVS Tutorial Guide
- AVS5 Update manual
- AVS Users Guide

On-line Information

AVS 5.02 has online reference information for all the modules in the system and a series of pages for various topics within AVS. The next version of AVS (AVS6) will have online, context-sensitive, hypertext help system based on the Bristol Hyperhelp for Unix and Winhelp for Windows.

Module Repository

The International AVS Center at the North Carolina Supercomputing Center (NCSC) was established to provide support for AVS. One of the functions the center provides is a repository of AVS modules supplied by users which are available via anonymous FTP `avs.ncsc.org`. Manchester Computing Centre (MCC) provides a shadow of the repository of modules on `ftp.mcc.ac.uk`. The repository contains well over 600 public domain modules available in source code form and a number of sample datasets.

Frequently Asked Questions

This can be accessed by:

```
http://www.mcnc.org:80/HTML/ITD/IAC/faq.html
```

There is also the Usenet newsgroup `comp.graphics.avs`

8.2.4 User groups

UK AVS User Group

There is a UK AVS User Group which meets approximately twice a year in the UK. The current charge is £25 per year for individual membership and £125 per year for organizations. The chairman is Julian Gallop, Rutherford Appleton Laboratory (email: `jrg@inf.rl.ac.uk`).

International AVS Center User Group

You can join the International AVS Users Group for a yearly fee of $100.00 which includes subscription to the AVS magazine, the yearly AVS electronic catalog of modules (user donated and commercial), a $50.00 reduction on attending the yearly International AVS Users Group conference and have special rates for additional services as they become available. To join, send check or money order for $100.00 (add $10.00 if out of continental USA) to:

The International AVS Center PO Box 12889 3021 Cornwallis Road RTP, NC 27709

8.3 IBM Data Explorer

8.3.1 Availability

On WWW access to general information on DX can be found at:

```
http://www-i.almaden.ibm.com/dx/
```

This also links to the ftp repository at Cornell, or can be accessed directly as:

```
http://www.tc.cornell.edu/DX/dx.html/
```

Supplier

DX is from IBM or any IBM Dealer. In the UK the contact is:

Andy Hey
IBM AIX Scientific & Technical Solutions,
1, New Square,
Bedfont Lakes,
Feltham,
Middlesex, TW14 8HB.

Tel: 0171 202 5266
email: `ahey@vnet.ibm.com`

Platforms

DX is currently available on the following (colour) platforms:

- IBM RISC System/6000 all models platforms IBM SP1 & SP2
- Multiprocessor systems Silicon Graphics: Indigo, Crimson, Onyx, and Challenge, On Symmetric Multiprocessor machines DX supports intra module parallelism i.e. most DX modules are written to run in parallel
- Sun: SPARC 2 & 10, including SMP (see SGI)
- Digital Alpha models 351
- Hewlett Packard: 9000/700 Series, (all models) 800 Series: 817,827, 837, 847, 857, 867
- Data General AViiON

Costs

- Node locked license (multiple instances on one CPU) List price £4,700.
- Floating license (up to n instances on any of the supported platforms in the user's network) List price £5,895

- Generally IBM Academic discounts can be as much as 80%

8.3.2 Support

The UK based product specialists in IBM Hursley at no additional cost.

Training

IBM run training courses as required, cost depends on student numbers location, length of and type of course (overview or detailed). Typically a 3 day course would cost approximately £250 per day.

8.3.3 Information

Manuals

There are 3 manuals: The Users Guide, Users Reference and Programmers Reference [25], [26] and [27].

The Users Guide includes how to use DX, its data types and the data importer. The tutorial to get new users started with DX is in Appendix A.

The Users Reference lists and describes the modules available.

The Programmers Guide describes how to write your own DX modules and includes how to use the module builder to automatically generate the template for new tools.

On-line Information

The on-line help for DX is very good. Help can be accessed on all aspects - including the modules, on using DX but also to get help on complete networks too. The help system uses hypertext so the user can navigate by selecting keywords from one item to the next until they find what they want (it automatically saves a history so the user can reverse the route back step by step). This was found extremely useful since looking at the entry for one module may require the user to follow links to related modules.

Network Information Services

Apart from the IBM and Cornell Theory Centre WWW pages, location given at the beginning of this section, Cornell also acts as a repository for news (see the directory `ftp:ftp.tc.cornell.edu:/pub/Data.Explorer/news` or equivalent from the WWW) where up to date information can be obtained on various aspects of DX, this includes a Frequently Asked Questions file.

The Usenet group exists in `comp.graphics.data-explorer`.

8.3.4 User groups

No formal user group exists but Birds of a Feather sessions occur at appropriate conferences, e.g. Visualization '94, and the usenet group gives a route to contact users in similar areas of work.

8.4 IRIS Explorer

8.4.1 Availability

General information on availability can be found on:

```
http://www.nag.co.uk:70/1h/Welcome_IEC.html
```

Supplier

IRIS Explorer was originally developed by Silicon Graphics Inc, but it is now developed, distributed and supported by NAG Ltd.

The software can be ordered from:

IRIS Explorer Center
PO Box 50
OXFORD OX2 8DR
United Kingdom

Tel: 01865 516377
Fax: 01865 516388
Email: `helpdesk@iec.co.uk`

Platforms

A list of platforms on which IRIS Explorer is available can be found on:

```
http://www.nag.co.uk:70/1h/Welcome_IEC.html
```

A brief summary at time of writing is given here, but please see the above URL for current information.

Workstation platforms supported are:

- Hewlett Packard Workstations
- IBM RS6000
- SUN (SunOS and Solaris)
- Silicon Graphics
- Cray Y-MP

The platforms for SUN (Solaris), Hewlett-Packard HP9000/700 and DEC Alpha are under development.

Costs

Please note that for current pricing structure users should contact their nearest IRIS Explorer Centre (which are run by NAG Ltd.).

```
http://www.nag.co.uk:70/0h/visual/IE/iecbb/contact
```

Prices for educational users is normally a 50% discount on the industrial price.

A preferential rate for is offered to Silicon Graphics users until Release 3.0 of IRIS Explorer is available. After that, NAG's standard pricing will apply.

8.4.2 Support

Provision

Support is provided through a IRIS Explorer Center help desk which can be accessed by the telephone, fax or email addresses given earlier.

8.4.3 Information

Manuals

- IRIS Explorer User's Guide: contains a "Getting Started" chapter;
- IRIS Explorer Module Writer's Guide: provides information on how to build your own modules with the Module Builder; introduces the Explorer datatypes; and shows how to use the shape language to prototype modules;
- IRIS Explorer Module Definitions: lists all the modules available with Explorer;

On-line Information

There is on-line help for each module, and man pages for the API routines.

Network Information Services

Details of all NAG products and services, including IRIS Explorer, are available from the NAG WWW server. Information is updated regularly and includes Technical Reports, Product Availability Details and Free Software.

Connection details:

```
http://www.nag.co.uk:70/
```

There is an FTP site at Edinburgh Parallel Computing Centre which maintains a repository of modules and an FAQ list. This can be accessed via the NAG WWW server, at the URL:

```
http://www.nag.co.uk:70/1/visual/IE/iecbb/archive
```

Other IRIS Explorer files are available at other sites, e.g.

```
ftp.ncsa.uiuc.edu:/SGI/PATHFINDER/Explorer

pdb.pdb.bnl.gov
```

To subscribe to the IRIS Explorer mailing list send mail to

```
explorer-request@castle.ed.ac.uk
```

There is an active Usenet group for IRIS Explorer: `comp.graphics.explorer`

Repositories of examples

In the UK, NAG provide a bulletin board called the IRIS Explorer Center which can be accessed using mosaic (a WWW interface) or gopher. This homepage provides links, via an Explorer map looking point and click interface, to FTP sites in the UK (`ftp://ftp.epcc.ed.ac.uk/pub/explorer`) and in the US (`ftp://swedishchef.lerc.nasa.gov/`), User Group Info and FAQ, Documentation and Announcements.

The FTP sites have a mixture of binaries and source code for a variety of modules that can be downloaded. There are currently binaries for SGI and SUN systems. Also documents are available.

8.4.4 User groups

There is an IRIS Explorer User Group. Meetings are held in conjunction with the SIGGRAPH and Eurographics conferences. Details from the IRIS Explorer Center, address above, or from the WWW home page for IRIS Explorer.

8.5 Khoros

8.5.1 Availability

General information on availability can be found on WWW at:

```
http://www.khoros.unm.edu
```

There are currently two version of Khoros available, Khoros 2.0 Developer Release and Khoros 1.0.5. The Khoros 2.0 Developer Release is available via FTP only. The Khoros 2.0 book and CD-ROM will be distributed by Prentice Hall, and should be in local book stores by the second quarter of 1995. Khoros 1.0.5 is available via both anonymous FTP and CD-ROM.

Supplier

The supplier is Khoral Research, Inc (KRI).

Platforms

KRI is developing on and has ported the Khoros 2.0 Developer Release to the following architectures:

Architecture	OS	Compiler	Widget Set
SPARCStations	SunOS 4.1.3	SunC 2.0.1	Motif 1.1.5
SPARCStations	SunOS 5.3	SunC 2.0.1	Athena
Alpha	OSF 1.3	Native ANSI cc	Motif 1.1.3
SPARCStations	SunOS 5.3	SunC 2.0.1	Motif 1.2.2
SGI	Irix 4.0.4	Native ANSI cc	Motif 1.1
RS6000	AIX 3.2	xlc 1.3	Motif 1.2.2
Data General	DG/UX 5.4R2.01	Native ANSI cc	Motif 1.2.1
Cray EL92	UNICOS 8.0.2	Native ANSI cc	Athena
486	Linux 1.1	gcc 2.5.8	Athena
486	BSDI 1.1	gcc 2.5.8	Athena
SPARCStations	SunOS 4.1.3	gcc 2.5.8	Athena
SPARCStations	SunOS 5.3	Centerline clcc	Olit

Khoros 1.0.5 runs on these architectures:

Vendor	Name	Configuration
Apollo	DN10000	OS 10.3, Fortran 10.8, cc 6.8
CRAY	XMP, YMP	UNICOS 6.1
DEC	5000/3100	Ultrix 4.2, mips cc 2.0, DEC f77 V3.0-2
DEC	Vax 3600	Ultrix 4.1, cc1.37.1
HP	HP9000/7xx	HP-UX 7.05/8.05
IBM	RS/6000	AIX v3.1, 3.2
SGI	All	OS 3.3.2, OS 4.0, X11 1.2, f77
SUN	SPARCstations, SUN4	SUN OS 4.1.1/4.1.2/4.1.3, f77 1.4.5
SUN	SUN3	SUN OS 4.1.1, f77 1.3.1, gcc 1.39/2.0
PC	486	BSD386, ISC 3.2, Linux

Costs

Khoros 1.0.5 and Khoros 2.0 are distributed via the Internet as free access software; that is, Khoros is available throughout the world, free of charge, via Unix File Transfer Protocol (FTP). In addition, Khoros 1.0.5 is also available for low-cost on CD-ROM. Although there is free access to Khoros, it is not in the public domain. The software is owned by KRI, and does carry a License and Copyright. While Khoros may be used by any organization free of charge, it can not be distributed without a license. Consult the Khoros Free Access License for additional information on use and distribution. KRI is committed to maintaining the Free Access Distribution of Khoros.

The Khoros 2.0 Developer Release is available from the following anonymous ftp sites:

Where	Address	Internet Address	Directory
USA	ftp.khoros.unm.edu	198.59.155.28	/pub/khoros2.0
USA	ftp.sdsc.edu	198.17.47.33	/pub/other/khoros/khoros-2
SWEDEN	ftp.luth.se	130.240.18.2	/pub/cscw/khoros2
ITALY	ftp.unipi.it	131.114.21.10	/pub/khoros2.0
BRAZIL	ftp.unicamp.br	143.106.10.54	/pub/khoros2.0
GERMANY	ftp.hrz.uni-kassel.de	141.51.12.12	/pub/khoros/khoros_2.0
GERMANY	ftp.e20.physik.tu-muenchen.de	129.187.217.5	/pub/khoros/K2
UK	ftp.mcc.ac.uk	130.88.203.12	/pub/cgu/khoros

Pull back the file `$KHOROS_FTP/release/install` and read it first. Please use the site closest to you.

Khoros 1.0.5 is available from the following anonymous ftp sites:

Where	Address	Internet Address	Directory
USA	ftp.khoros.unm.edu	198.59.155.28	/pub/khoros/khoros1.0.5
USA	ftp.sdsc.edu	198.17.47.33	/pub/other/khoros/khoros-1
USA	ftp.uu.net	192.48.96.9	/pub/window-sys/khoros
BRAZIL	ftp.unicamp.br	143.106.10.54	/pub/khoros
CANADA	popeye.genie.uottawa.ca	137.122.20.3	/pub/khoros
GERMANY	ftp.rrz.Uni-Koeln.DE	134.95.80.5	/graph/khoros
GERMANY	ftp.lrz-muenchen.de	129.187.10.35	/local/khoros

Where	Address	Internet Address	Directory
ITALY	ipifidpt.difi.unipi.it	131.114.8.130	/pub/khoros
JAPAN	ftp.waseda.ac.jp	133.9.1.32	/pub/khoros
UK	unix.hensa.ac.uk	129.12.21.7	/pub/uunet/window-sys/khoros

Pull back the file `$KHOROS_FTP/release/install.ftp` and read it first. Please use the site closest to you.

A CD-ROM and manual set of Khoros 1.0.5 may be purchased for $375 USD from KRI. Contact `khoros-request@khoros.unm.edu` for more information.

Licensing Costs

There are three standard Khoros distribution licenses; Free Access, System Integrator, and Developer. Rights in addition to those provided by the standard licenses are negotiated on a case-by-case basis. The Terms and Conditions of each license are summarized below:

Type	Annual Fee	Distribution Rights	Distribution of Derivative works	Updates
Free Access	$0 USD	limited	internal use	Internet
System Integrator	$5,000 USD	world-wide, non-exclusive, royalty-free, non-transferable, no sublicensing	distribution of minor modifications upon approval	CD ROM Internet
Developer	$50,000 USD	world-wide, non-exclusive, royalty-free, non-transferable, no sublicensing	yes	CD ROM Internet
Negotiated	royalty	world-wide, non-exclusive, right to sublicense	yes	Negotiated

8.5.2 Support

Provision

No cost email support is available over the Khoros mailing list and comp.soft-sys.khoros usenet group.

KRI offers monthly training courses for both developers and users. In addition, KRI can arrange for on-site training.

KRI also offers specialized consulting arrangements.

Costs

E-mail support is free.

The Developer's Training Course runs $1600 USD per person and the user training course runs $1200 USD per person.

The cost of on-site training and consulting agreements are negotiated.

8.5.3 Information

Manuals

Khoros 2.0 manuals are available via anonymous ftp from `ftp.khoros.unm.edu` in the `/pub/khoros2.0/manual` directory.

Note that the khoros_manual/ subdirectory contains the combined manuals for the bootstrap, design, and dataserv toolboxes, which together comprise the core Khoros system. Thus, in this directory you will find:

- Installation Guide [34]
- Getting Started Manual [33]
- Toolbox Programmer's Manual [38]
- Visual Programming Manual [39]
- Introduction to Application Toolboxes [32]
- Programming Services Volume I: Foundation Services [35]
- Programming Services Volume II: Data Services [36]
- Programming Services Volume III: GUI & Visualization Services [37]

Then, there is a different subdirectory for each additional toolbox that is distributed with the Khoros system. Thus, the datamanip/ directory contains the manual for the datamanip toolbox, the envision/ directory contains the manual for the envision/ toolbox, and so on.

KRI distributes printed Khoros 2.0 manuals only to Licensees and Khoros Consortium members. We are currently working on a Book and CD release; KRI has made an agreement with Manning Publications to produce the Khoros 2.0 manual set which will include a CD ROM of the Khoros 2.0 distribution. The manual set will be distributed by Prentice Hall in the summer of 1995.

On-line Information

All Khoros programs have complete man pages available on-line as well as help pages which can be browsed with an interactive viewer. HTML converters are available for the documentation if local hypertext versions are desired.

Network Information Services

Khoral Research, Inc. has a home page on the world-wide-web at

```
http://www.khoros.unm.edu
```

KRI maintains up to date information on the Web Site. In addition to information on Khoral Research and Khoros there are pointers to many other home pages that may be of interest.

For additional information on Khoros, training, licensing, and support, users can mail to

```
khoros-request@khoros.unm.edu
```

Repositories of examples

The Khoros system comes with complete source code so programming examples are always available. Contributed toolboxes containing source are also available.

8.5.4 User groups

There are two ways to get questions answered and to interact with other Khoros users: The Khoros mailing list and the Khoros USENET group. The Khoros mailing list and USENET group are bi-directionally gatewayed to each other (all messages are cross posted). That way you only need to participate on either the mailing list or the USENET group.

To be added to, or removed from, the Khoros Mailing List, send e-mail to `khoros-request@khoros.unm.edu` with your request. To participate on the Khoros USENET group, subscribe to `comp.soft-sys.khoros`.

Khoral Research also provides a digestifed version of the Khoros mailing list. Once a day you will receive a single email message with a digest of the previous 24 hours' worth of articles. This message includes a list of topics discussed. To be added to, or removed from the digestified list, send e-mail to `khoros-request@khoros.unm.edu` with your request.

When you become a System Integrator or Developer Licensee of Khoros, you automatically become a member of the Khoros Consortium. The Consortium began in 1991 to facilitate the free access distribution of Khoros and to further the research and development of software development environments. Today the Consortium focuses on the rapid advancement of the Khoros software infrastructure.

8.6 PV-WAVE

8.6.1 Availability

General information on availability can be found on WWW at:

```
http://www.vni.com
```

Supplier

The UK Academic contact is Nigel Brown:

Visual Numerics International Ltd.
New Tithe Court
23 Datchet Road
Slough SL3 7LL

Tel: 01753 790600
Fax: 01753 790601

Email: `nigel.brown@vniuk.co.uk`

Platforms

PV-WAVE CL is available as part of the Visual Numerics Ltd. CHEST agreement and is available for the following platforms:

- Convex Unix
- DEC VMS (VAX, Alpha)
- DEC Ultrix
- DEC OSF
- HP 9000/700 HP UX
- IBM RS/6000 AIX
- SGI Irix
- SUN (SunOS, Solaris)
- Microsoft Windows NT (DEC Alpha, MIPS, Intel)
- Microsoft Windows 3.1 (PV-WAVE Personal Edition)

PV-WAVE “Personal Edition” is available for the PC under Windows 3.1 but is not included in the CHEST agreement. The full terms and conditions of the PV-WAVE CL CHEST agreement are detailed below, including costs.

Costs

This is a 5 year CHEST Agreement which commenced on the 23rd March 1994 and terminates on the 22nd March 1999. Institutions may participate at any time during the period; however they will be bound until the end of the Agreement. The Agreement covers both the PV-WAVE family of products and the IMSL C and FORTRAN numerical and graphical libraries. New platforms will be provided within the charges if and when commercially available from Visual Numerics.

The Options for pricing are as follows:

1. £5550 per year for 5 years (Total cost of 5 years £27,750)
2. £7500 in the 1st year and £3500 for the next 4 years (Total cost of 5 years £21,500)
3. For existing customers who have purchased licences prior to 1st January, 1994, Visual Numerics offers a *Transfer Programme* to options 1 or 2.

Please note that this information was correct at the time of printing.

8.6.2 Support

Provision

Visual Numerics in the UK offer full-range of technical support. The telephone is the preferred first point of contact for problems with Email access for transferring code and data etc. Visual Numerics are a subsidiary of VNI Inc., so they have direct access to engineering and product development teams.

Costs

8.6.3 Information

Manuals for PV-WAVE Command Language

- PV-WAVE CL Applications Guide - Free Code and Sample Applications: Describes the online application examples provided with PV-WAVE and provides sample code in the book for other examples. Also contains a useful worked interactive session example which is a useful way of getting started.
- PV-WAVE Command Language Guide to Advanced Rendering Library: Provides description and reference guide to the Advanced Rendering Library, which is a group of procedures and functions that provide additional data visualization capabilities for the PV-WAVE Command Language, of which it assumes an existing knowledge.
- PV-WAVE Command Language Overview: Describes the basic features of the Command Language with many examples.
- PV-WAVE Command Language Reference: Consists of a Reference Guide to all the functions, procedures, keywords and system variables in the Command Language. Approx 650 pages.

- PV-WAVE Command Language User's Guide: Description of all the facilities in the Command Language. Similar size to the Reference Manual.
- PV-WAVE Command Language Unix Installation Guide: For the person who has to install the PV-WAVE Command Language product, this describes how to do it on the Unix operating system.

Manuals on the PV-WAVE Point & Click product

- Getting Started with PV-WAVE Point & Click Motif Version: Introduces the Motif version of the PV-WAVE Point & Click product.
- Getting Started with PV-WAVE Point & Click OPENLOOK version: Introduces the OPENLOOK version of the PV-WAVE Point & Click product.
- PV-WAVE Point & Click User's Guide: Provides a detailed description of PV-WAVE Point & Click.
- Installing PV-WAVE Point & Click: Provides instructions on installing PV-WAVE Point & Click on Unix workstations.

PV-WAVE Advantage

- PV-WAVE Advantage is an integration of PV-WAVE Command Language and the IMSL C/Math and C/Stat Libraries.

PV Software Licensing

For the person installing Precision Visuals software, this guide is concerned with unlocking the software.

Training Courses

A training course is available which covers PV-WAVE basics through to programming in PV-WAVE Command language and WAVEwidgets.

On-line Information

On-line help is provided within PV-WAVE CL in the form of a procedure called INFO which starts the FrameViewer on-line help.

The help procedure can be used with a number of command line parameters to return status information with regards to the current session and variables in use. The help system can be accessed to obtain on-line information with regards the functions and procedures available both within PV-WAVE CL and outside via a help utility.

Network Information Services

There is a WWW site for VNI Inc.,:

```
http://www.vni.com
```

Information Email: `info@vniuk.co.uk`

There are two Mailbase lists:

```
chest-pvwave@mailbase
chest-imsl@mailbase
```

8.6.4 User groups

There is not a formal PV-WAVE User Group but occasional user meetings are arranged by Visual Numerics.

Chapter 9: Strengths Weaknesses Opportunities Threats (SWOT)

9.1 Introduction

This Chapter incorporates SWOT analyses (Strengths, Weaknesses, Opportunities, Threats) for PV-WAVE, AVS, Khoros and IRIS Explorer. The intention of the analysis is to predict how each system will fare in view of anticipated changes in usage patterns which have been judged important by the evaluation group. The analysis is intended to be forward looking and thus where appropriate has been extended to cover features of systems which will become available soon. In the case of Khoros, the analysis refers to Version 2 which at the time of analysis was not generally released yet and was carried out from the documentation available.

9.1.1 What is SWOT Analysis?

SWOT analysis [31] is a technique commonly used in business circles to assist in identifying strategic issues for a company or organisation. If the analysis is to be applied to visualization products some modifications to the technique will be required, however, potentially it will yield useful information about the future viability of various systems. The predictive capabilities of the technique come about from the consideration of each system's strengths and weaknesses in the context of the environment which is seen to present opportunities and threats. The intention is to determine how each system will fare in the light of changes taking place around it.

9.1.2 Strengths and Weaknesses

In business, SWOT analysis is usually applied to one company in order to determine its own strategic direction. When applied to many systems it will be necessary to adopt some model of visualization products which captures all important issues regardless of which product is being analysed. It is then up to the analyst to measure the particular strengths and weaknesses of each product using this model. For instance, if one model parameter is Documentation, the analyst will record this as a strength if this is known to be comprehensive and easy to follow for the system under consideration, and as a weakness if it is poor or non-existent.

For convenience the model has been constructed under a number of sub-headings; Availability, Input/Output, Basic Usage and Advanced Usage. Figure 16 shows the complete model in broad terms. The section describing the *SWOT kit* issued to each analyst goes into more detail about what is required under each sub-heading.

9.1.3 Opportunities and Threats

The next stage is to analyse the environment and this also is done under sub-headings for convenience. An important difference though from the determination of strengths and weaknesses is that the environment is fixed for each visualization system. The sub-headings are Economic Vari-

ations, Changing User Population and Changing Hardware and Software Environment, under each of which there are a number of factors against which to consider each system's strengths and weaknesses.

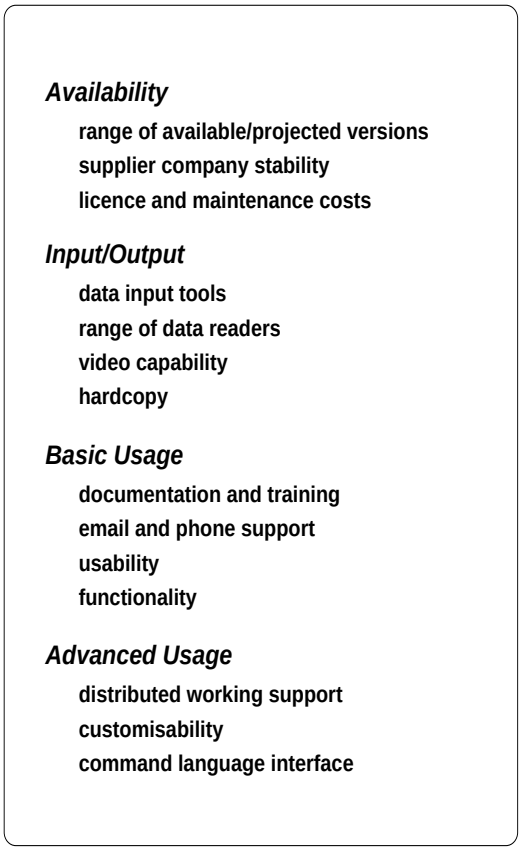

Figure 16: The Complete Model

Economic Variations

- *Purchasing ability* of users and their representatives will remain the same for some years
- *Vendors of visualization systems* will generally experience growth in the coming years. This situation is not to be confused with the stability of an individual company which is assessed as a strength or a weakness
- *Competition* in the visualization field will narrow but become increasingly fierce

Changing User Population

- *Size* of the user population will increase, opening up new areas of interest
- *Skill range* of users will widen, the existing population becoming more competent whilst at the same time novices join the field
- *Use* of visualization systems will increase

- *Rising expectations* amongst users will be the norm
- *Problem sizes* will increase

Changing Hardware and Software Environment

- *Desktop* equipment will become more common
- *Network bandwidths* will continue to increase
- *De facto standards* will have widening support
- *New algorithms and techniques* for visualization will emerge

9.1.4 Analysis

Having classified each feature from the model as a strength or weakness for the particular system under study, these are written down the left hand side of a table as in Figure 17. Along the top are put the environmental factors.

	Economic Variations	static purchasing power	vendors' growth	increasing competition	**Changing Users**	increasing population size	widening skill range	increasing use	rising expectations	problem sizes increasing	**Changing H/w and S/w**	move to desktop	increasing bandwidth	de facto standards	new algorithms
Strengths															
range				+				+	+			-		+	
company stability		+	+	+											
costs		+		+		+		+				+			
data input				+		+		+							+
data readers		+													
video capability									+	+					
hardcopy									+			-			
documentation		+					+	+							
Weaknesses															
support				-		-		+	-					+	
usability				-		-	+						+		
functionality				-					-	-					
distributed support												-	+		
customisability		-		-					-						-
command language							-		-	-					

Figure 17: An example of a SWOT table

The analyst then examines the rows against the columns, putting "+" or "-" as follows:

1. Put a plus if there will be a benefit to the system

either because a strength enables the system to take advantage of or benefit from an environmental change
or because a weakness will be offset by an environmental change

2. Put a minus if there will be an adverse effect on the system

either because a strength will be reduced by the environmental change

or a weakness would prevent the system overcoming a difficulty associated with a change.

The prevalence of "+" and "-" indicate which qualities will have the most marked effect in the context of the environment and conversely which aspects of the environment will provide the greatest opportunities or threats. Note that features originally thought to be major strengths or weaknesses might register as fairly neutral in the final reckoning.

9.1.5 SWOT Kit

This section describes the SWOT kit issued to each analyst.

Model details

Figure 16 gives a broad view of the features of systems which are of interest. More specifically the following features were considered for each system:

- *range of versions*: the supplier and operating system combinations
- *company stability*: is it stable, viable and in a tenable market position
- *costs*: the capital and recurrent costs, the availability of deals. Consider the difference if any between runtime and development licences
- *data input tools*: any limitations and their ease of use
- *data readers*: pre-written readers for other packages/systems
- *video*: facilities for animation and playback
- *hardcopy*: how easy/difficult is it to produce, what formats are available
- *documentation:* the costs, availability, quality. Include on-line information sources and training
- *support:* include both email and telephone support. Consider the presence of a bulletin board or email list - are facilities free
- *usability:* how easy to use or flexible is the system. How does the performance scale with increasing problem size
- *functionality*: what types of visualization are supported. Are there limitations on the number of independent or dependent variables
- *distributed working*: both remote process execution and via X windows
- *customisability:* is it easy to add new features, what are the tools provided to assist

• *command language:* the facilities for running scripts of commands, batch working, audit.

Preparing the table

Each of the model features were then considered in turn to decide whether it represented a strength or weakness for the system being analysed. The feature was placed in the appropriate section of the table, remembering that no feature can appear in both sections.

Filling in the table

Returning to the first feature for the system being analysed, consideration was given to each predicted environmental change in turn. Any warranting a "+" or "-" were filled in, with comments to justify the entry. It was not intended to fill in every box on every row, only those features of special note. Comments had to be as specific as possible, since any statement which is true in every context has no value in differentiating between systems. The process was repeated for each feature of the model in turn and a summary given commenting upon noteworthy features which had emerged.

9.1.6 Mediation

The SWOT analyses represent the considered views of individuals or small groups working on each system. The results were discussed by all the authors together at an evaluation meeting held at the University of Manchester on 19 and 20 July 1994, where changes were agreed to try to ensure consistency between the analyses. Subsequently each analysis was made available to the system supplier in order to check for factual correctness. The results are presented in good faith, however, it must be recognised that the nature of the technique precludes any claim to absolute certainty in respect of the future of the systems considered. Tables summarising the results for each system can be found in figures 18, 19, 20 and 21.

9.2 Application Visualization System (AVS)

9.2.1 SWOT analysis

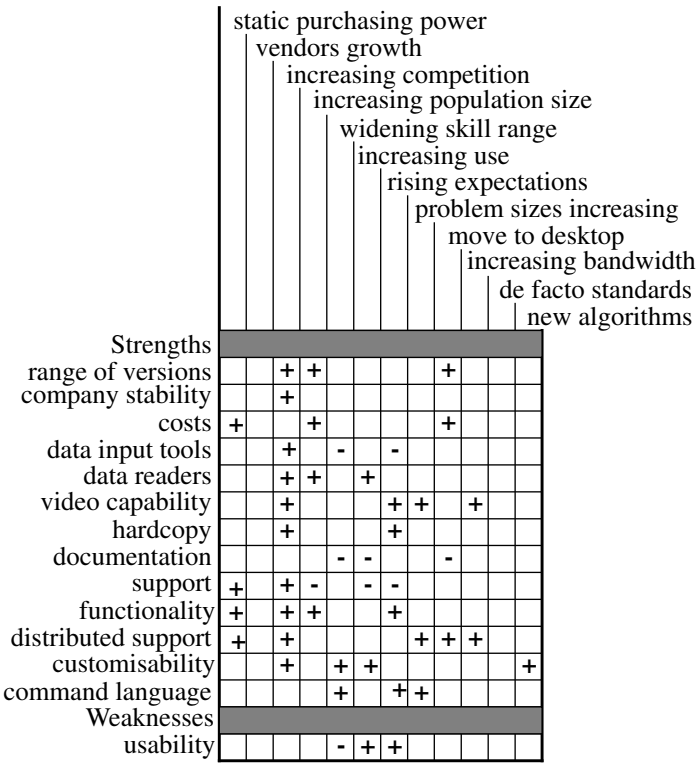

Figure 18: AVS SWOT Table

9.2.2 Comments

Range of versions: Strength

AVS appears on a wide range of UNIX workstations (but needs colour), and on Dec VMS, Cray, and Convex. It has also been ported to the KSR by University of Manchester. A version for powerful PCs (Windows NT and Windows 95) will appear with AVS6 next year.

- Increasing Competition: AVS has the advantage of having been in use on commonly available platforms for several releases and as such is a mature product
- Increasing Population size: AVS is likely to support hardware platforms available to the new user
- Moving to the Desktop: AVS is available on a wide range of platforms, including typical desktop machines, such as colour Suns, SG Indigos, HPs, DECs and PCs (next year) and has been tailored to take advantage of special hardware features and local graphics libraries

Company stability: Strength

- Increasing Competition: Although AVS are reliant on just two products (i.e. AVS and UNIRAS) they appear to have a strong position in the general visualization market. They were the first to market such a product and have held on to their early customers. Their proven track-record continues to attract new customers from a wide range of application areas. The development team grows every year and is now in the 20s, with the company apparently committed to vigorous and continuing improvement of their software.

  AVS/UNIRAS Ltd., is the UK subsidiary of Advanced Visual Systems Inc. and currently has eight full time employees with an expected increase in 1995.

Costs: Strength

- Static Purchasing Power: A CHEST deal (2.5 years remaining) is available whereby a single fixed charge each year allows academic sites unlimited use of the base software on a wide range of platforms. The current CHEST deal does not include the Chemistry or UCD viewers but example networks are provided. It is also possible if there is enough interest in a particular *add-on* that it can be added to the CHEST deal, e.g. the Animator is obtained at an additional but reasonable cost.
- Increasing Population Size: The CHEST deal makes AVS attractive to a growing population
- Move to the Desktop: With the CHEST deal no further costs are involved in moving to a desktop system. It is not necessary to buy additional licences or new versions as common desktop platforms are included in the site-wide deal.

Data input tools: Strength

- Widening Skill Range / Rising Expectations: AVS has an interactive facility, the AVS Data Interchange Application (ADIA), to import data into AVS fields. To access this use the field descriptor module from the network editor. Having saved the data format as a template it is then possible to re-use this for other datafiles with the data dictionary module. These tools only allows the user to import field data and not polygonal or UCD (e.g. Finite element) data, so it may prove limiting in view of users' rising expectations. It can cause problems to novice users too that may need to specify offsets in the data file by number of bytes (a graphical interface where the user can select with the mouse where new data starts would be easier to use).
- Increasing Competition: Although the data input tool will not handle all data and may cause problems for novice users, it is considered an asset to have an interactive tool to import data.

Data readers: Strength

- Increasing Competition: AVS have a large number of data readers, both in the public domain and from commercial sources (e.g. AVS, Tessella)
- Increasing Population size: With the large amount of example code available, developing a new reader can be a relatively easy task for a new user.

- Increasing Use: As the user uses AVS for more data visualization, there is a good chance that a data reader will already be available for the new tasks.

Video capability: Strength

- Increasing Competition / Rising Expectations: There are a number of ways to create animation and video with AVS. For simple animations modules such as animated integer can step through a range of values, which can be used to change parameters. For more complicated animations the Animator tool is of great benefit, and can be used to control changes in parameters, data input, camera positions and even networks. The Animator is a key-frame animator, and has 2 levels of control panels, one for newer users or less complicated animations, the other for advanced use. The simpler panel shows a small subset of fairly simple functionality, such as add/delete keyframes and play. The full panel gives greater control over the time between each keyframe. Although the Animator is probably beyond absolute novices, slightly more experienced users will find this of great benefit.

  In addition it is possible to generate an MPEG movie from an animation (i.e. sequence of images) using a public domain module from the International AVS Centre (IAC). This module can be found in avs modules/data output/Create MPEG, but note this does not generate MPEG directly but calls the standard mpeg encoder.
- Problem size increasing: The ability to create quality animations stored to video is an advantage in the case of increasing problem sizes since it is not always possible to view the visualization in real time
- Increasing Bandwidth: Increased bandwidths will make the strong animation facilities even more attractive

Hardcopy: Strength

- Increasing Competition / Rising Expectations: Support for PostScript for hardcopy output is good. It is also possible to convert an image to CGM. The expected addition of UNIRAS functionality in AVS6 will improve hardcopy support to cover many more devices and formats. Advanced facilities are available, for example, views which have a mixture of shaded rendering and line drawing can be saved as a mixture of lines and image in PostScript so as to make best use of hardcopy devices.

Documentation: Strength

- Widening Skill Range / Increasing Use: The documentation can prove difficult for novice users (e.g. no Getting Started guide) and as a reference source can be missing necessary information. However it is readable and for many users it is possible to find the required information and so on balance the documentation is considered a strength.
- Move to the Desktop: The user will probably have to purchase a paper copy of all of the documentation as it seems unlikely they could manage with the small amount of on-line information available

  The next version of AVS (AVS6) though will have online, context-sensitive, hypertext help

system based on the Bristol Hyperhelp for Unix and Winhelp for Windows.

Support: Strength

- Static Purchasing Power: The support of AVS is included in the CHEST licence arrangements
- Increasing Competition: AVS currently provides good technical support in the UK and access to the larger support team in the US when necessary.
- Increasing Population Size and Use / Rising Expectations: Could overstretch the resources of the support team.

Usability: Weakness

- Widening Skill Range: Novices often find the system difficult to use, for example, where several modules appear to do the same thing, such as isosurface and ucd iso. In the next release of AVS, 6.0, expected next year, an object oriented approach and improved general data types means a single isosurface module will be available.
- Increasing Use: Poor usability becomes less noticeable once the user understands which modules to choose and why.
- Rising Expectations: Apart from the many example visualizations available in the form of networks, some of which are packaged into a menu-driven viewer (dataviewer), it is also possible to purchase customised data viewers (e.g. for UCD, and chemistry). Therefore it may be possible to visualize new data without the development of new code.

Functionality: Strength

- Static Purchasing Power: With strong functionality the need for alternative systems is reduced
- Increasing Competition: A large number of modules are available in the Public Domain (IAC) and within AVS itself.
- Rising Expectations/Increasing population size: As the users' expectations rise there is a good chance with the large number of modules available that they can find what they need

Distributed support: Strength

- Static Purchasing Power: AVS has good support for distributing modules across a number of platforms to share the workload for an application, allowing the user to make better use of the available resources
- Increasing Competition: The ability to distribute modules is considered an asset.
- Problem size increasing: As the problem size increases it is possible to distribute the task across a number of platforms, either by taking advantage of larger, more powerful machines or splitting the task so each part can be processed separately.
- Move to the Desktop: When a user moves to a desktop system they can take advantage of

the distributed support in AVS to farm out difficult and large problems.

- Increasing Bandwidth: With increased bandwidth the transfer of data will improve. Since distributing applications often involves transferring data from one system to another greater benefits in speed can be expected from distributing large, complex problems.

Customisability: Strength

- Widening Skill Range: A user with relatively little experience can expect to be able to customise AVS. With a small amount of experience users can produce an application to process simple data. The user interface can be modified to some extent without any programming (e.g. by using the mouse the user can switch between typed in values and dials or sliders). For more experienced users it becomes possible to add new tools. For advanced users with access to the developers' kit it is possible to tailor all AVS modules or produce an application that just uses the required parts of AVS (e.g. a scaled-down geometry viewer). This will become easier with the next developers' kit (Express) which is the underlying system for AVS6.
- Increasing Competition/Increasing Use: The ability to customise applications to end-users' needs is of great benefit. With AVS6 there will be even more control for the expert, including the ability to modify Motif-type interfaces too.
- New Algorithms: Since AVS can be customised it is possible for new algorithms to be incorporated as modules into AVS. There is also a large amount of example source code in the public domain (e.g. IAC) which may be tailored to include new algorithms.

Command language: Strength

- Widening Skill Range: Although not considered suitable for novices the command language, CLI, is extremely useful for scripting applications and demonstrations. Less experienced users can rely on AVS itself to record scripts, which can then be tailored. CLI scripts can be used to build and change networks as well as to change parameters. It is possible to journal a sequence of events by starting AVS with the `-cli` option and opening a script for saving events with `script -open file` - this does not record all events (e.g. geometry animations) but they can be added in afterwards by hand. It is also possible to develop modules that call CLI commands so networks can change to handle different events/data.

  V, the replacement for CLI in AVS6, will have even more powerful commands and should be easy to master for those already familiar with Unix shell scripts.
- Rising expectations: For the reasons above (in Widening Skill Range) CLI can be a powerful facility. In AVS6 the command language will be even more powerful with programming type control and expression evaluation.
- Problem size increasing: With increasing problem sizes it is often useful to be able to produce a batch of commands which can be left unattended to produce a visualization (although this does require the use of a graphics screen for display).

9.2.3 Summary

The AVS product is a system which allows users to visualise their data by constructing applications from a series of software components called modules. Each module performs a specific task and some of these include:

- importing data
- processing and filtering data
- mapping data onto geometric primitives or an image representation.
- rendering the geometry or images

Some of the features of the software allow the system to be extended by users integrating application and visualization code into AVS by writing new modules. The system also allows the user to change and edit the user interface and layout to customise the application. This makes it a very powerful tool for prototyping.

The maturity of the AVS product is one of its strengths. The first version of AVS (AVS1) was released in April 1989 and it is now currently in its fifth version (AVS5). The new development environment AVS/Express was released during 1994 and the summer of 1995 will see AVS6 which will be based upon the new architecture of AVS/Express bringing many new improvements.

There is also a very good infrastructure in place for the AVS system in the public domain with the International AVS Center's activities in the US collecting and porting user contributed modules.

One of the disadvantages, as with most of the application builders, is the complexity of the system for the first time user. This leads to an initial steep learning curve which can be an obstacle for novices. Improvements in on-line help and tutorial facilities would alleviate this and the releases of AVS6 may address these.

9.3 IRIS Explorer

9.3.1 SWOT analysis

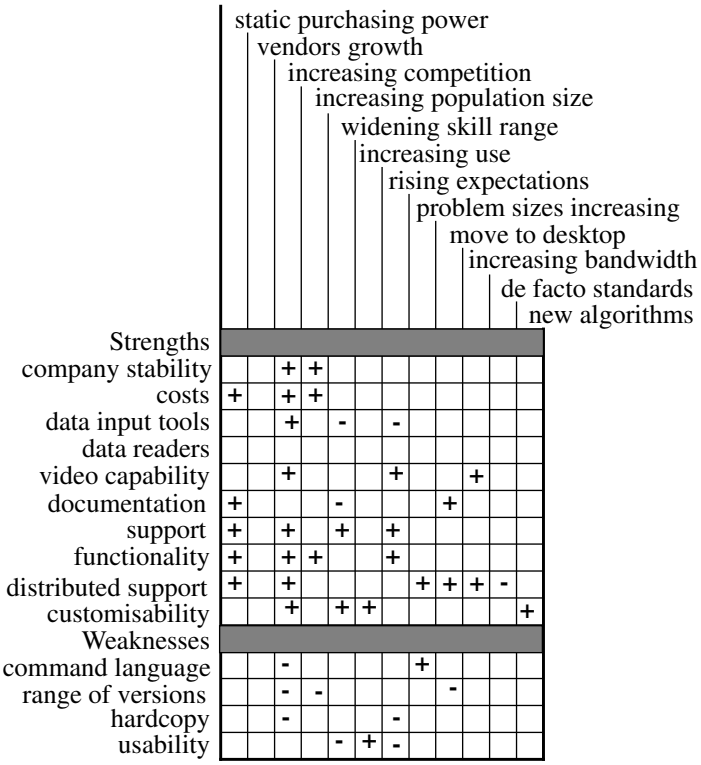

Figure 19: IRIS Explorer SWOT Table

9.3.2 Comments

Version

The version of Explorer used for this analysis was 2.0 running on Silicon Graphics equipment. All comments are based on this version unless otherwise stated.

Range of versions: Weakness

This is only a temporary weakness - SGI, SUN (SunOS) and IBM RS/6000 are available now, HP 9000/700 and SUN (Solaris) are promised by the end of the summer and DEC Alpha sometime after that. There is also a Cray version, and other supercomputer versions are being discussed.

- Increasing Competition/Increasing Population Size: A weakness since the range of machines currently supported is less than the competition.
- Move to Desk Top: Some notable workstation vendors missing, and no PC version.

Company stability: Strength

NAG have been in existence for over 20 years; their turnover is steadily increasing; their staff complement has been stable over the recent difficult period in the economy. It is not-for-profit so surpluses are fed back to the benefit of the company.

- Increasing Competition: Should do well since NAG has a high professional reputation built over many years to trade on.
- Increasing Population Size: The company are well experienced in the support of a large user community and thus we can expect them to be able to scale their activities to match an increasing user base.

Costs: Strength

It is currently bundled with SGI workstations. This will change, but NAG Ltd. have publicly committed to a non-expensive pricing strategy. Educational sites will receive a 50% discount on both the one-time fee & the support service. Support costs will be approximately 15% of the one-time fee. Current SGI users, who up to now have received it free, will be offered support and maintenance for an unlimited number of users for the price of the 4-user support service up to Release 3.0. For the period of probably a year after Release 3.0, these sites will be offered the opportunity to increase the scope of their licence to include more users for the difference in support charge only. Those who do not take up the offer before Release 3.0, and new sites wishing to receive IRIS Explorer, will have to pay the one-time payment which ranges from £1000 for a single user licence to £20,000 for an unlimited user licence. These costs refer only to 1 implementation; an additional fee of £500 (licence) and £75 per annum (support) is charged per extra implementation.

- Static Purchasing Power: Once the one time fee is paid for one version, there is only a very small additional fee for additional implementations. Also, it is possible to pay a one time unlimited user fee.
- Increasing Population Size/Increasing Competition: Relatively low price product will attract new customers.

Data input tools: Strength

DataScribe is a flexible, visual programming tool. It allows the user to easily create a data reader that will convert from any data file format to an Explorer data type. This does require, however, knowledge of the data file format and some knowledge of Explorer data types and their uses. DataScribe can also be used in *reverse* to output data from IRIS Explorer according to any desired format. Indeed, it can be used as a general data conversion tool between two external formats.

- Increasing Competition: Having good input tools and the ability to create data readers is a plus, but at present, as with other similar systems, the tools provided are less than ideal. This is due mainly to the fact that they only support Lattice datatypes, not Pyramids, and can be difficult for novice users.
- Widening Skill Range: Data input is rarely easy, and DataScribe would be difficult for novice users.

- Rising Expectations: Users expect tools that cover everything, but DataScribe does not handle some of Explorer's data types.

Data readers: Strength

A range of readers are provided (e.g. AVS types, HDF, PDB, Plot3D). Others (e.g. ReadMarc, ReadMesh1, ReadMultiPlot3D, ReadNastran, ReadSEGY) are available as either unsupported (they come on the installation disk, but are user donated modules) in version 2.2 or available through Explorer ftp sites (e.g. netCDF).

Video capability: Strength

Facilities to animate the viewing position are provided; and there are loop controls in the visual programming language. There are modules to control a video recorder; and a module to interface to MovieMaker on SGI.

- Increasing Competition / Rising Expectations: This is increasingly important in scientific visualization. Linking them into existing software is a plus.
- Increasing Bandwidth: Distributed multimedia become technically feasible, and IRIS Explorer has tools to exploit them.

Hardcopy: Weakness

At present, it does not seem possible to generate CGM. Postscript is only available through the Render module: it will generate colour Postscript with options to set an output size in inches and setting the DPI; it can be sent direct to a printer or into a file. It is also possible to output GIF.

- Increasing Competition / Rising Expectations: to be able to produce output which can be sent directly to a hardcopy device should be standard. The only method of doing this is from the Render module. Others such as Graph, DisplayImg and Histogram do not support this.
- A new module, available soon from NAG, NAGGraph will be able to output postscript.

Documentation: Strength

Detailed manuals (in the form of a User's Guide, Module Reference Manual and a Module Writer's Guide), plus on-line help (UNIX man pages) for Explorer subroutines and on-line help pages with each module.

- Static Purchasing Power: The documentation is to be found on line, hence no need to buy large quantities of manuals.
- Widening Skill Range: It should have a "Getting Started" guide as this is increasingly important.
- Move To Desk Top: On-line documentation becomes more important as we move to large numbers of desk-top users and the cost of hardcopy documentation becomes prohibitive.

Support: Strength

IRIS Explorer Centres have been established in the UK and Japan, and there is support in the US. These act as one-stop shops for the product. The support service licence also includes phone/fax/ E-mail support, Users Newsletter and regular CDs containing tested and implemented modules. Also NAG Bulletin Board is a source of up-to-date information with an IRIS Explorer section; this is available on WWW with mosaic at: http://www.nag.co.uk:70/1/visual/IE/iecbb

- Static Purchasing: Support comes in the package at present, but after Release 3.0 comes at 15% of the one-time fee.
- Increasing Competition / Rising Expectations: Support is well organised and is an important selling point.
- Widening Skill: Naive users and expert users can use same query mechanism.

Usability: Weakness

IRIS Explorer (for the naive user) needs some time to learn, and is not suitable for the occasional user (who would be better with a menu driven system). Conversely its flexibility makes it highly usable by the expert. It needs a workstation of reasonable processor power and memory for worthwhile use.

- Rising Expectations: This is an obvious weakness as users expect to be able to “turn it on and go”.
- Widening Skill Range: Naive users will be exposed to the steep learning curve.
- Increasing Use: Familiarity makes the system easier to use. Its flexibility means that experts cannot easily outgrow the system.

Functionality: Strength

- Static Purchasing Power: With strong functionality the need for alternative systems is reduced.
- Increasing Competition: Explorer provides a large range of modules and more may be found on public ftp sites.
- Increasing Population: Rich functionality should enable it to be used throughout the community.
- Rising Expectations: As user expectations rise there is a good chance that with the large numbers of modules around they will find what they need.

Distributed support: Strength

The design of IRIS Explorer is focussed on a distributed execution model. It is easy to place computationally intensive modules on separate compute engines. The Render Remote module explicitly provides for rendering to be carried out on a separate workstation. At present, on SGI, it uses GL rather than X so remote execution with local viewing can be a problem. Version 2.2 and above uses OpenGL so remote viewing is no longer a problem (with IRIX5 and above).

- Static Purchasing Power: As the range of versions increases it will be possible to run modules on a variety of platforms so distributing the load.
- Increasing Competition: To be able to distribute the load is what future users will expect so is an obvious strength.
- Problem Size Increasing / Move To Desk Top / Increased Bandwidth: Can use remote high performance computer to *number crunch* but display locally.
- De Facto Standard: Does not as yet adhere to X standard.

Customisability: Strength

IRIS Explorer has two important customisation features:- (1) Module Builder is a visual programming tool that allows the user to write their own code and then compile it into a new module. (2) Modules can be grouped to provide simpler interfaces for novice users (cf turnkey).

- Increasing Competition / Increasing Use: It is an obvious strength to be able to produce your own modules to do tasks related to your specific area of interest.
- Widening Skill Range: At one extreme it can be customized for the naive user by grouping modules and providing a simplified interface; at other extreme, the advanced user can write their own modules
- New Algorithms: Can add new algorithms as modules as they become available.

Command language: Weakness

IRIS Explorer provides a command language called SKm (scheme) which can be run interactively or from a script file. The language allows the functionality of the map editor with the launching/ destroying of modules, connection/disconnection of ports, the setting of parameter values and loading/saving maps etc. It is also possible to define procedures involving modules and values. The system allows a limited form of batch working.

- Increasing Competition: There is no facility present to script an interactive session so that it can be played back.
- Problem Size Increasing: The production of scripts for limited batch working allows large problems to be worked on without interaction, viewing only the end result.

Summary

A state of the art visualization system from a UK company with a long history of supplying the higher education community with high quality software. IRIS Explorer is an application builder which makes it highly flexible as a visualization tool. It uses a visual programming interface to build networks of modules to form visualization maps, it allows the incorporation of new/user written modules to extend the functionality if the need arises and it supplies tools to aid the generation of these new modules.

There are options to extensively customise the appearance of maps by grouping the modules together and allowing the user to define their own control panel by selecting and re-arranging

widgets. This customisability is extended by allowing these groups to be saved and used by other, more novice, users as turnkey applications.

One of the strengths of the IRIS Explorer software is that the system architecture was explicitly designed to ensure its application across hardware platforms in heterogeneous network environments. This, combined with NAG's expertise in porting software, will ensure that the user is able to fully exploit the easy to use remote module execution system of Explorer for distributed working.

Explorer provides a good graphical user interface, DataScribe, for writing data import modules. Although it is difficult for novice users and applies only to Lattices it is still a powerful tool with many useful features. These features should allow Explorer to do well with respect to the increase in competition.

The down side, as with most other flexible systems, is the rather steep learning curve. Also a lack of good hardcopy output, this being a screen dump only available from the render module in encapsulated postscript format, and a poor command language do not do it justice.

9.4 Khoros

The analysis for the SWOT was performed from Beta release versions of the manuals. At the time of compilation of the results there was no access to information on the Data Input Tools and Data Readers.

9.4.1 SWOT analysis

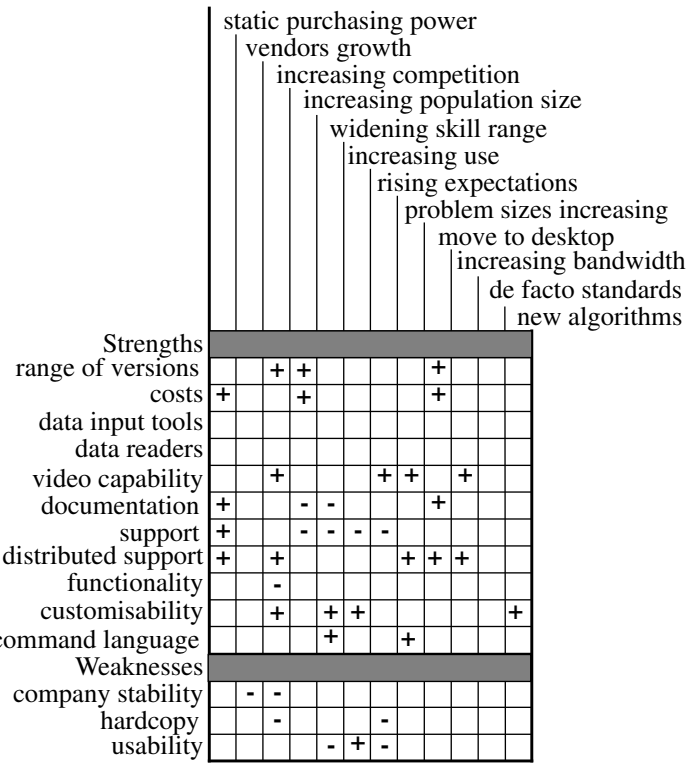

Figure 20: Khoros SWOT Table

9.4.2 Comments

Range of versions: Strength

- Increasing Competition: Khoros is available on a wide range of machines which increases its appeal in the face of competition. All versions are directly supported by Khoral Research, Inc.
- Increasing Population Size: likely to be supported on hardware platforms available to the new user
- Move to Desktop: some desktop machines are supported

Company stability: Weakness

- Vendors' Growth / Increasing Competition: revenue for Khoral Research, Inc. comes from

government contracts, training, product sales, support, and licensing. KRI is a startup company, and does not yet have all the resources that other, more-established vendors have.

Costs: Strength

- Static Purchasing Power: users will always be able to afford the software because it is free, distributed via the Internet as source code and binaries
- Increasing Population Size: being freely available it is attractive to a growing population
- Move to Desktop: no further costs are involved in moving to a desktop system

Video capability: Strength

- Increasing Competition / Rising Expectations: the Animate program is an interactive image sequence display tool which allows the user to either input a sequence of images or supply a basename that describes a set of images contained within a number of files. The user is presented with a video recorder style interface with which to move through the image sequence. Using this program together with the tools to annotate images and control within the visual programming language such as do-loops and if-then-else constructs provides strong support for video
- Problem Size Increasing: strong video capabilities are an advantage in the case of increasing problem sizes since it is not always possible to view the visualization in real time
- Increasing Bandwidth: increased bandwidths make the strong video capabilities even more attractive

Hardcopy: Weakness

- Increasing Competition / Rising Expectations: weak provision for hardcopy will detract from the system's attractiveness in the face of competition and users' rising expectations

Documentation: Strength

- Static Purchasing Power: documentation is freely available in PostScript by FTP for printing locally in desired amounts. The Khoros 2.0 manual set will be available for at low-cost from bookstores world-wide in the second quarter of 1995.
- Move to Desktop: it is also available on-line
- Widening Skill Range / Increasing population size: there is a lack of documentation at the novice and expert ends of the spectrum

Support: Strength

- Static Purchasing Power: support is via email, from users and the Khoral Research, Inc. who also maintain extensive FAQ (Frequently Asked Questions) files. This service is free and response is normally very good.
- Increasing Population Size / Use: could overload newsgroups and email lists

- Rising Expectations / Widening Skill Range: users will expect more than just email and newsgroup support; technical queries will be increasingly difficult to handle in this way

Khoral Research, Inc. offers monthly training courses and various consulting contracts.

Usability: Weakness

The Khoros 2.0 version of Cantata contains something called a Finder, which allows for module searches based on keywords.

- Widening Skill Range / Increasing Use: the systems comprising Khoros all support the data flow model, but it can be difficult to find the appropriate module for a certain task or data. This will be more marked for novices, but poor usability becomes less noticeable once the user understands which modules to choose and why
- Rising expectations: users would not expect to learn about specific data types onto which they must map their data; they would rather have the system import the data

Functionality: Strength

- Increasing Competition: Khoros has strong functionality but there are gaps in respect of Finite Element analysis. There is however a contributed toolbox from LBL is available which contains basic FEA functionality.

Distributed support: Strength

- Static Purchasing Power: distributed support exists in the form of a daemon which handles remote task execution and data transfer. Users can make best use of existing hardware, e.g. to share the workload of an application
- Increasing competition: these facilities will prove to be an advantage when comparing to other systems
- Problem Size Increasing: jobs can be distributed across a number of platforms
- Move to Desktop: local processing can be carried out on the desktop with compute-intensive parts carried out remotely
- Increasing Bandwidth: benefits in speed can be expected when distributing processing

Customisability: Strength

- Increasing Use / New Algorithms: Khoros is customisable at a number of levels. New functionality can be added or existing functions can be altered to suit users needs
- Widening skill range: can customise the system for novice users

Command language: Strength

- Problem Size Increasing: all programs in Khoros can be activated and controlled from the command line using the command line user interface (CLUI). This provides *true* batch facilities to produce a visualization unattended Furthermore, the encapsulated workspace func-

tionality of Cantata makes the creation of a batch process automatic. Users can collapse a workspace down into a command line program.

- Widening Skill Range: The journalling capabilities in the Khoros 2.0 Developers Release were not robust across the different widget sets and have been disabled. This functionality may be re-enabled in the future.

9.4.3 Summary

Khoros is an integrated software development environment that allows users to compose and perform a variety of tasks related to image and signal processing, medical imaging, remote sensing, ecological research, data exploration, scientific visualization, X-window application development and other application specific domains.

Khoros includes a visual programming language, a suite of software development tools that extend the visual language and help you create new applications, an interactive user interface editor, an interactive image display package, 2D/3D plotting, and an extensive suite of image processing, data manipulation, scientific visualization, geometry and matrix operators.

9.5 PV-WAVE

9.5.1 SWOT analysis

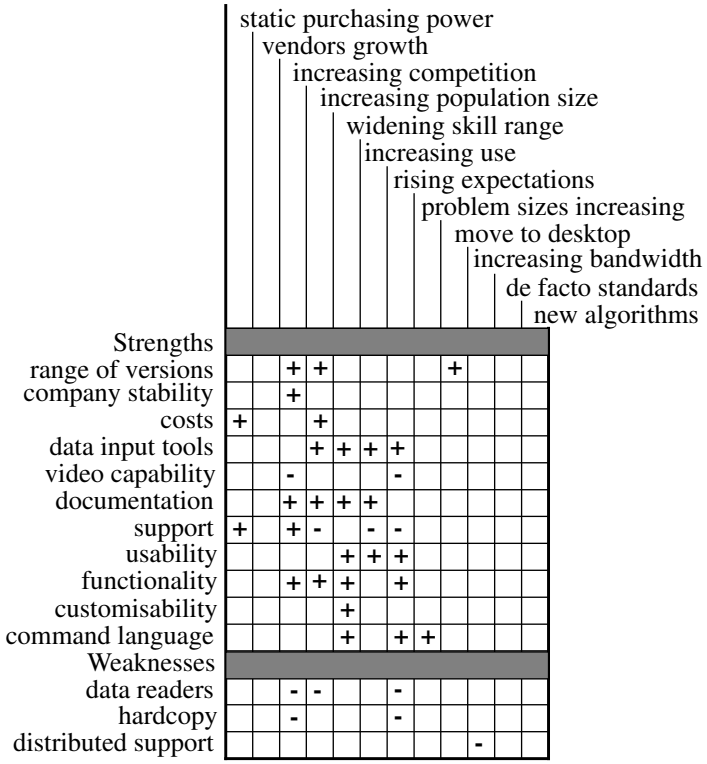

Figure 21: PV-WAVE SWOT Table

9.5.2 Comments

Range of versions: Strength

- increasing competition: the software is available on a wide range of platforms, from PC to Super Computer, more readily than some of the competition
- increasing population: readily available and usable on commonly available H/W in the community
- move to desktop: MS Windows 3.1 version available. Development taking place under Windows NT

Company stability: Strength

- increasing competition: Visual Numerics Inc formed in 1993 through merger of Precision Visuals and IMSL means the new company should have greater stability and increased product range

Costs: Strength

- increasing population / static purchasing power: due to be announced as a CHEST deal in the very near future, ensure pricing is competitive.

Data input tools: Strength

- changing users (all factors): data input facility is flexible and easy to use, suiting all user environment factors.

Distributed support: Weakness

- increasing bandwidth: Graphics based on X11 only, no true distributed support as with AVS, Explorer etc.

Data readers: Weakness

- increasing competition: data readers for data from other applications not readily available, leaves package susceptible to competition
- increasing population: lack of data readers may mean the package is less attractive given an environment change.
- rising expectations: data readers might not meet rising expectations

Video capability: Strength

- increasing competition / rising expectation: animation sequences can be built facilitating flip book animation.

Hardcopy: Weakness

- increasing competition / rising expectations: limited H/C facilities likely to mean package is susceptible to competition, unlikely to attract increasing use and not meet expectations

Documentation: Strength

- increasing competition: existing documentation is very good with compact easy to follow manuals
- increasing use / widening skill range: manuals are structured, from overview, getting started, users guide to comprehensive reference guide
- increasing population: overview and getting started documentation is very good

Support: Strength

- static purchasing power / increasing competition: technical support in the UK is very good; responses are prompt and support staff are very knowledgeable - problems can be referred to US if required although the UK office does appear self sufficient in many ways
- increasing population / use / rising expectations: limited number of support staff in the UK could mean problems with these factors e.g. softkeys are currently generated in the US only

Usability: Strength

- widening skill range: Command Language is both easy to use and is extensible for the competent / computer literate user
- increasing use: Command Language is easy to use, particularly for anyone with programming skills
- rising expectations: extensibility of the Command Language environment should fulfill rising expectations

Functionality: Strength

In addition to the standard functionality the Advantage product has the full IMSL C library routines integrated into it.

- increasing competition: functionality is comprehensive. Should enable PV-WAVE to remain at the forefront
- widening skill range: functionality suited to technical and non-technical users
- increasing population: rich functionality should enable PV-WAVE to be useful throughout the community
- rising expectations: rich functionality should match rising expectations

Customisability: Strength

- widening skill range: extensibility is attractive to competent technical users

Command language: Strength

- widening skill range: command language is usable across a wide skill range, readily suited to the novice and specialist alike.
- rising expectations: command language likely to meet rising expectations, given the available programming constructs.
- problem size increasing: ability to use in batch mode
- New functions and procedures are added to most releases of PV-WAVE reflecting new functionality.

9.5.3 Summary

A very good general purpose package, providing rich functionality suited to a wide skill range of users, although more particularly those with programming experience. PV-WAVE is complementary to Uniras and AVS in the community, and not in competition with them.

Strengths which will carry the system forward are its data input tools and functionality. Some aspects of support will require attention by the suppliers in view of anticipated environmental changes. Ready-made data readers, and hardcopy facilities, represent the most significant weaknesses. The expected widening skill range of users is the chief environmental factor showing advantage for this system.

Annex to Chapter 9: Strengths Weaknesses Opportunities Threats

9.6 IBM Data Explorer

9.6.1 Introduction

During the review of the visualization systems an in-depth SWOT analysis was not performed for IBM Data Explorer. This omission should *not* be taken as a reflection on the features provided by the IBM Data Explorer system. This annex will provide similar information for IBM Data Explorer that can be found in chapter 9 for other visualization systems. This annex will either provide that information under the equivalent section headings or references to other areas in this report where that information can be found.

The final section of this annex contains some information on the powerful data manipulation facilities available in IBM Data Explorer.

9.6.2 Additional Information for IBM Data Explorer

Range of versions

IBM Data Explorer is available on a range of Unix workstations and the complete range of versions can be found in section 8.3.1 on page 111.

Company stability

International Business Machines Corporation (IBM) has a long history in the computing industry and is involved in almost every area of computing hardware and software. For more specific information on the company and products you can access the IBM WWW home page:

```
http://www.ibm.com
```

Costs

Price information can be found in section 8.3.1 on page 111.

Data input tools

Information concerning importing data into IBM Data Explorer can be found in section 3.2.3 on page 24 and section 4.3 on page 66.

Data readers

Information on data readers and their location can be found in section 4.3 on page 66

Hardcopy and Animation Facilities

These features are detailed in section 5.2 on page 80.

Documentation

The full range of manuals are listed in section 8.3.3 on page 112.

Support

Contact addresses and arrangements for support are in section 8.3.2 on page 112.

Functionality

A review of the functionality in IBM Data Explorer can be found in section 3.2.3 on page 24 and some information on data manipulation is contained in section 9.6.3.

Distributed working

Details of these facilities can be found in section 7.2 on page 103.

Customisability

Information on incorporating application code into the IBM Data Explorer system can be found in section 6.3 on page 92.

Command language

IBM Data Explorer has an extensive scripting language. To execute IBM DX in script mode you simply type:

```
dx -script
```

More details on the scripting language can be found in the IBM Data Explorer User Guide [26].

9.6.3 Data Manipulation

Sometimes the scientist using the visualization system wishes to select a subset of the data to process or wants to apply an expression to the dataset to produce a resultant data component e.g., vector magnitude from a vector field. Most of the visualization systems provide support in the form of modules to slice and crop the data and other modules to apply simple mathematical expressions to data components.

If the scientist however wants to select specific data components from a dataset based on some conditional expression then there is only minor support through modules in the various systems. The user must resort to coding the task in the form of an additional module if any extensive manipulation is required for example see [64].

IBM Data Explorer provides extensive support for both of the above cases through the Compute module. This module applies an expression point-by-point to the input data producing an output dataset. The module also allows multiple input fields to be combined via the expression supplied and individual data components within a dataset can be referenced in the expression. Some of the operations available in the Compute module are:

- Trigonometric, Hyperbolic and Logarithmic functions
- Unary, Binary and Vector functions
- Type conversion
- Logical and Conditional expressions
- Bitwise operations

The user can construct complex expressions for example, `Field1` is a vector field, `Field2` and `Field3` are scalar fields. The expression evaluates on a point-by-point basis an output field which is the magnitude of `Field1` added to the quantity `Field2` divided by 4.5 times `Field3`:

```
output_field=Compute("mag($0) + $1/($2*4.5)", Field1, Field2, Field3);
```

More information on the Compute module can be found in [27].

Chapter 10: Conclusions and Summary

10.1 Conclusions

We set out to review a number of visualization software packages that are available for use in the UK higher education community. We also required that the software we reviewed met certain minimal requirements - which we described in Chapter 1: Overview.

Conventionally, the conclusions would be our summing up of the comparative performance of the systems. In this report, we have taken a different approach. Following the basic factual information in chapters 2 to 8, we have made a detailed SWOT study, in Chapter 9, which in effect stand as our conclusions.

One could make an overall general comment, that, since AGOCG published the previous visualization software evaluation, the visualization software on the market has been comparatively stable - the changes have taken place in the companies, but not the products.

We offer this report in the hope that it may be useful to potential users deciding what to buy and to new users trying to put their chosen system in context.

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