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The 2nd Annual Report of the EASE Visualization Community Club

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January - December 1993

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Foreword

Visualization as a discipline has now reached a certain maturity. Its importance in engineering and scientific computation is widely accepted; there are a number of excellent software products available; and the use of visualization as a presentation tool is common in journals and at conferences.

However there remains an excitement about the subject which personally I find very stimulating. Two experiences in the past year highlight this for me - in one I was the teacher, in the other I was the learner. The first was a course in "Graphics and Visualization", held in January, when a number of us tried to pass on our skills and experiences to a group of young researchers taken from a variety of disciplines - from chemical engineering to architecture, and from geography to mathematics. It was a thrill to see the students progress from little or no experience, to being able to make a scientific visualization video - all within a week.

The second was attending, for the first time, the annual IEEE Visualization conference in the US. The keynote speaker was Fred Brooks, once of IBM (and "Mythical Man Month" fame) and now a father figure of visualization and virtual environments at University of North Carolina. Brooks gave a brilliant lecture, full of punchy advice, of equal value to the young student as the established researcher. He pointed out the obligation on the visualization scientist to "tell the truth": we trust them to construct an "honest" representation of the data. This contrasts with the graphics researcher, whose faithfulness to visual realism is open to any scrutiny. A quote to remember is:

Visualization is to inform, not to impress; if you inform, then you will impress.

1993 was a good year for the Community Club. Four meetings were held, all well-attended with more than 50 delegates. A particular success was the meeting on "Visualization in Electromechanical Engineering Research", with 89 attendees. The overall membership rose to over 250.

The visualization team at Rutherford Appleton Laboratory worked hard on a variety of support activities for the Club, as you can see in the later sections of the report - including helping with the "Graphics and Visualization" course mentioned earlier. A new activity has been a number of case studies where particular problems are worked through to a solution; the benefits are high of course to the problem owner, but the spin-off to the community is useful also through new software, and the final write-up.

The Steering Group continues to seek new ways of having the Club serve its Community. Next year we aim to build on a questionnaire and survey of Engineering Board grant holders, in order to construct a useful programme of events. For example, it was clear from the survey that flow visualization is especially of interest, and we hope to address this perhaps with a tutorial.

Finally let me thank the visualization team at RAL for their excellent work over the past year in support of the Club; and let me thank also my fellow Steering Group members for their help and contributions over the year.

KWB

Summary

This is the 2nd annual report of the SERC Visualization Community Club, set up with funding from the Engineering Research Commission (ERC)as part of the EASE programme. The report covers 1993.

Achievements in this period include:

- The Community Club held 4 technical events in 1993. One was on the application of visualization to a specific engineering discipline, corresponding to one of the ERC committees - Visualization in Electromechanical Engineering Research.The Club also held seminars where more general visualization subjects were presented:3D Visualization in Engineering Research; Visualization in Engineering Teaching; and Parallel Processing for Visualization.This approach will continue in 1994.

- More emphasis is now placed on application case studies in cooperation with SERC funded engineering researchers.A case study using data from wind tunnel testing was completed in cooperation with the Engineering Department at the University of Oxford.Further case studies will be worked on in 1994.

- Technical support priorities have been identified at Community Club events, from case studies, and using surveys. In 1993, attention was focused on improving the quality and fidelity of colour hardcopy; the use of animation and video; and (in cooperation with the CFD Community Club) the interfaces between CFD and visualization software.

- A week-long, hands-on course on "Graphics and Visualization: Methods and Tools" was held in January 1993 at the University of Leeds by the UK Advisory Group on Computer Graphics (AGOCG) and supported by the Visualization Community Club. Over 30 postgraduate researchers attended and the course was held again in January 1994.

- A hands-on course on the integration of user interface software (based on OSF/Motif) with graphics software was given three times in 1993.

- The EASE programme has continued to support the technical activities of AGOCG, whose objectives are to raise the general level of computer graphics use in the UK Higher Education Community.

- The Community Club now has over 250 members.

1. Introduction

This is the second annual report of the SERC Visualization Community Club set up under the auspices of the Engineering Research Commission (ERC) and covers the period from January to December 1993. The Club is one of three such Clubs run within EASE. The Club has now over 250 registered members and held four events during this period. It is also involved in directing visualization technical activities carried out at RAL. The Visualization Community Club provides an effective mechanism for engineering researchers using visualization techniques to collaborate and disseminate knowledge and results of their work and also to promote the wider use of these techniques within engineering research.

2. Organisation of the Visualization Community Club

2.1 The Role of the Visualization Community Club

The role of the Visualization Community Club is to help researchers, developers and users interested in visualization by:

- providing a forum in which to present and discuss their requirements;
- guiding activities within EASE to meet these requirements;
- increasing awareness through exchange of views and information;
- assisting the emergence and use of relevant standards;
- promoting exchange of visualization software and data;
- providing a mechanism for disseminating information to the visualization community through seminars, meetings, workshops and courses.

2.2 Membership

The registered membership of the Visualization Community Club has grown steadily from around 90 at the time it was founded, to over 250 as it stands now. Approximately 90% of the membership is from the academic community and the remainder is from industry and other government bodies, individuals and foreign country representatives. The membership reflects the wide range of subject areas using visualization: electromechanical, process and civil engineering, CFD, medical imaging, geography, maths, remote sensing, image processing, biology and more.

2.3 The Steering Group

At the formation of the Club it was agreed that a Steering Group should be formed. The Group forms a regular point of contact between the community and EASE technical staff at RAL. Its role can best be described through the Terms of Reference of the Steering Group which are given in Appendix I.

The Steering Group has the important functions of focusing the needs of the committees of the ERC in order to direct the work of RAL staff and of feeding back the results of the Community Club's activities to these committees.

The current Steering Group members are drawn from the academic world. The membership of the Steering Group represents three Engineering Research Commission committees, engineering researchers and some members also sit on the Advisory Group on Computer Graphics (AGOCG). Below is the list of the current members:

- Dr R. W. Ainsworth — University of Oxford
Electromechanical Engineering Committee

• Prof N. T. Bowman	De Montfort University (at Leicester) Construction Committee
• Dr K. W. Brodlie (Chairman)	University of Leeds AGOCG representative
• Dr T. David	University of Leeds
• Mr J. R. Gallop	Rutherford Appleton Laboratory
• Mr W. T. Hewitt	University of Manchester
• Mr S. Larkin	University of Manchester AGOCG Visualization Support Officer
• Mrs R. Popovic (Secretary)	Rutherford Appleton Laboratory
• Dr N. Pratt	SERC Central Office
• Prof J Swithenbank	University of Sheffield, Process Engineering Committee

The Steering Group has agreed to expand its membership by inviting representatives from other Engineering Research Commission committees that are not currently represented. In addition to this, the Steering Group has decided to invite an industrial engineering researcher in order to deepen membership.

The Steering Group meets approximately quarterly to discuss and plan activities of the Club.

2.4 RAL Support Staff

ERC approved funding for 4 technical staff at RAL in 1993/94 to provide visualization facilities for engineers including the necessary graphics and user interface support. This effort is provided from within the Visualization Group of Computational Modelling Division in Informatics Department.

The leader of the group is Mr. J. R. Gallop and its members are Miss J. Haswell, Mr. R. J. May, Dr. R. Maybury, Mrs. R. Popovic and Dr. L. Sastry.

3. Review of activities during 1993

3.1 Community Club Events

During this period four major events have been organised by the Club. Details of these are given in Appendix II. Only a short account of the events is included here, however full reports and proceedings have been prepared and are listed in Appendix III. There are also video records of the "Visualization in 3D Engineering Research" meeting (see Appendix IV). Attendance for academics is normally free, but industry delegates pay a meeting fee. Any costs not covered by meeting fees are borne by the EASE programme.

3.1.1 3D Visualization in Engineering Research

The seminar was held at RAL on 24 March 1993 and chaired by Mr. J R Gallop (RAL) and Mr W T Hewitt (University of Manchester). Over 50 people attended. The purpose of the seminar was to demonstrate 3D input techniques and producing 3D output with today's technology.

The speakers of the day (listed in Appendix II) painted a rich picture of current methods and

technology used for 3D input and output. Novel hardware for true 3D input was presented (3D Scanners). A large part of the seminar was devoted to displays, going from what additional information is needed to give a 3D impression from a 2D image, to presenting methods that are producing a 3D image on a flat screen (use of stereo effect in order to produce 3D output on a 2D screen and hardcopy output in the forms of holograms). From 3D display technologies the seminar went on to making a physical copy of 3D computer generated objects - the method known as stereo lithography. With this the circle was closed: going from real 3D objects that are scanned and coordinates of the points on their surfaces entered in computer, via ways of representing 3D scenes on 2D displays using extra information, stereo and holography we arrived at producing real 3D objects via 3D computer representations.

Attendees were able to see demonstrations of almost all 3D examples mentioned during presentations: on display were various holograms, a Cambridge Autostereo Display rendering pictures and animations, and a selection of objects generated by stereo lithography.

3.1.2 Visualization in Engineering Teaching

Other Community Club seminars have shown the importance of visualization in research. This seminar was held at the University of Sheffield on 26 May 1993 and 50 people attended. The seminar showed how visualization can be used in teaching. The joint chairs, Prof Ron Smith and Prof Jim Swithenbank, both of the University of Sheffield, summarised the challenge as being to teach engineers to strengthen their engineering instincts by using visualization. During the day, many aspects were covered:

The seminar gave good examples of the different ways visualization can support teaching.

- Teaching can take place by examining real problems and Prof Swithenbank described what can be done with combined heat and flow problems on PCs (an example is a burner in a power station).
- Teaching can be enhanced by a video of the phenomena being studied.This emerged from talks from the Audio-Visual Department at Sheffield, who can produce presentation quality videos in cooperation with lecturers from the university;
- Teaching can proceed by encouraging design skills and stimulating the engineer to use computer sketching software to visualize initial design ideas.

Although most speakers were concerned with undergraduate teaching, it was also emphasised (by Prof Peter Muller, UCL) that visualization can also help with educating the public. He is concerned with communicating the results of Earth observing missions to the widest possible audience. His team can now offer videos and interactive discs on the Earth. To compose these products needs the fusion of several satellite missions, each of which tells only a part of the story. With the fine resolution now available (SPOT has a resolution of 20 metres in colour), the data processing requirements are enormous, selecting from datasets of 5 TB/day.

The one industrial speaker (Dr J Miles, Ove Arup) emphasised the use of animation with many examples - it is now useful and affordable. However an engineer (in most cases) is not going to develop the technical visualization skills needed and will need to call upon a source of expertise.

With the use of images and animation, it is not surprising that multimedia is gaining in importance and that was the topic of one of the presentations (Prof T. Williams, Keele) and most of the end of seminar discussion.

3.1.3 Visualization in Electromechanical Engineering Research

The Community Club organised a seminar on "Visualization in Electromechanical Research" which was held at the Engineering Department of the University of Oxford on the 29 September 1993. The seminar was chaired by Dr R. W. Ainsworth and had a record number of attendees (89). The aim of the seminar was to present the techniques which electromechanical engineers use to visualize data. The seminar covered both experimental and computational visualization techniques and data.

The speakers presented talks on the following subjects:

- pre and post processing of computation for aircraft design - Dr M. Fearon (British Aerospace, Warton);
- use of crystals in thermofluid visualization, experimental visualization - Dr P Ireland (University of Oxford);
- numerical modelling of the interaction of waves with offshore structures and visualization of the results - Professor R Eatock Taylor (University of Oxford);
- virtual reality and its application in engineering - Dr R. Stone (ARRL, University of Salford);
- presentation of Visual3 software - Dr M. Giles (University of Oxford);
- use of visualization in DRA for unsteady aerodynamic measurements in turbomachinery - Mr M. Cherrett (Defence Research Agency);
- AIDE, An Integrated Design Environment that will fully integrate processes of geometry generation, fluid flow solution and visualization and its application in heart valve design - Dr T David (University of Leeds). See also Figures 1 and 2 that illustrate this work.

3.1.4 Parallel Processing for Visualization

The seminar was held at University of Manchester on 17 November 1993 and around 50 people attended. The chair of the seminar, Dr. Roger Hubbold, outlined the key assumption of the meeting, which is why use parallel processing for visualization. Many techniques in visualization are time-consuming. Applications would benefit from completing the image creation in a reasonable time, and in some cases parallel processing can make the difference and lead to an application being run at interactive speeds.

One talk was about architectural issues (Dr Derek Paddon, University of Bristol) and made some statements of general application. One conclusion is that although solutions that are scalable to large problems and large numbers of processors are needed, most published versions are not truly scalable. When the application data base becomes large, it is not possible to assume that every processor can hold a copy of all the objects and scalability breaks down. Another is that a parallel algorithm that is optimal for some problem sizes and images sizes, is not optimal for other sizes. There are many possible ways of partitioning the data (one study suggests 22) and the penalty of using an approach that is not optimal for the problem size can be high.

Several speakers (Dr Daniele Marini, University of Milano; Dr Brian Collins, IBM Winchester; Dr Alex Del Pino, Fraunhofer Computer Graphics Institute, Darmstadt) presented performance results of particular algorithms. These demonstrated the dependence on the number of processors, the size of the image and the size of the image tile allocated to each processor. These algorithms were based on classic methods for generating images: ray-tracing, radiosity and volume-rendering.

Brian Collins' described application was the use of graphics and visualization to model, in

as much detail as possible, old buildings that no longer exist. His examples included Cluny Abbey in France, Roman baths in Paris and, to support the ambitious rebuilding plans, the Frauenkirche in Dresden. For his clients, high quality, detailed videos are recorded. 3-5 million polygons are typical in the model and it is clear that parallel processing is necessary.

With increasing interest being shown in MIMD parallel processing systems (where each processor can execute a different program), it was useful to have a speaker (Dr George Cameron, University of Aberdeen) who asserted the value of the SIMD approach (where the same instruction is obeyed across all processors in lockstep). His application was the manipulation of 3D images in medical research.

Andrew Grant (University of Manchester) described how AVS has been installed at Manchester on a vector processor, a distributed memory system and (in progress) on a scalable shared memory system. AVS has the flexibility to do this, but some performance problems, mainly associated with broadcasting the data, need to be solved. In most cases, AVS is divided between a computational part, installed on the parallel system, and a graphical part, running on a workstation.

In summary:

- For some large problem sizes and for some algorithms, parallel processing is necessary to get the work done in the right time.
- Beyond a certain problem size, complexities are introduced which defeat scalability and are not adequately solved.
- AVS has a modular data-flow architecture which (like other such systems) encourages its use on parallel architectures.
- Performance measurement was mainly focused on classic image generation problems - ray tracing, radiosity and volume rendering. Large visualization problems, such as analysing a large unstructured fluid flow data set, are also computationally demanding and could usefully be the subject of distributed and parallel processing studies in the future.

3.2 Application Case Studies

Following on the experience of the case studies used in the 1991/92 evaluation of visualisation software, the Steering Group has placed great importance on building up and disseminating a set of case studies which would be of direct benefit to others. They are developed through close contact with specific engineering research projects funded by the SERC and depending on the need, ranged from a simple initial advice on how to get started, to helping the researcher adapt or develop techniques that are not already available. As a result of each case study, the software (such as AVS modules and networks, or stand alone programs) has been developed, colour images and video produced and the final report on the study written. The software together with the datasets supplied by researchers for the case study and reports are made available to community through Visualization Community Club Mailshots and HENSA. In addition to the paper copy of the reports, hypermedia/multimedia reports will be made and will be accessible on CD-ROMs and via networks.

The following set of case studies were done in 1993:

- ***electromagnetic field data*** - the electromagnetic, field analysis package, ELEKTRA (Vector Fields Ltd), can generate large amounts of 3D vector and scalar data on an unstructured grid.This case study has been updated to explore transient solutions too, where real-time interaction proved impossible. Use was made of both the Animator and standard AVS facilities to generate animations both for the screen and for video production.

- ***scatter data*** - to enhance the viewing of scatter data (provided by Space Science Department at RAL) an enhanced *3D axes* module was developed at RAL.This can automatically generate sensible ranges for the axes, and can display a background grid (either at the minimum or maximum for x, y and z). Converting scatter data to a convex hull then reinforces the minimum and maximum ranges in 3D-space. To further reinforce the location of data points, a filter was developed at RAL to remove points that do not fall within a selected ranges for: data value, x, y, and z.

- ***data from wind tunnel testing of a 45 degree semi-angle pyramid probe*** - (provided by Dr R W Ainsworth's group, Engineering Department, University of Oxford) there were two test configurations: one where incidence of the probe to the flow was zero, and the other where the incidence was varying. The data was provided as sets of pressure readings over four frontal faces of the probe. Figures 3, 4, 5, and 6 illustrates some of the visualization techniques applied to these data. In addition to this, an animation sequence was produced in order to visualize pressure changes when incidence of the probe to the flow was varied (see Appendix IV for the video and Appendix V for the report).

3.3 Software Support

AVS - a data flow visualization system with wide application - is available in HEIs through CHEST site deals following the AGOCG/Community Club evaluation the previous year. With this and other visualization software available in the community, the situation is improving. It is our practical experience with case studies that a new visualization problem can be partially solved with already existing software, but that an important remaining part needs more experienced attention in each case.

In addition to meeting more general requirements that have arisen from Community Club requests, software has been produced in response to these practical issues. This can be used without change for data similar to that used in the case studies and can be tailored for other situations.

Data In and Data Out (Data Import/Export)

There is much overlap of interests between the CFD and Visualization Community Clubs. There is clearly a need to ensure that data from the major codes of interest to the CFD Community Club (FLUENT, FLOW-3D, PHOENICS, STAR-CD, FEAT) can be accepted by visualization software in the community (initially AVS). The plan is to ensure that these CFD packages are represented by readers which are working and up to date (not satisfied by most of the public domain readers we are aware of). This is being achieved by arrangements with suppliers or by additional work at RAL. Members of the Steering Group have offered assistance with Iris Explorer and Data Visualizer.

Other data import software has been produced. In the visualization case study for testing wind tunnel equipment, the geometry (the shape of the probe) was a common basis for many datasets. It was therefore necessary to produce modules which associate a dataset with a geometrical definition in a form that AVS can easily accept. This was done for AVS meshes (read_mesh) and for AVS UCD data (gen_ucd).

Data Filtering and Mapping

In a visualization problem, data is often associated with some geometrical definition and AVS accepts a variety of geometrical primitives. It has been found in case studies that structure often exists in the geometry that needs to be exploited to avoid unnecessary (and potentially error prone) duplication. Software has been produced to take advantage of this inherent structure: data can defined on a number of planes and the planes then combined to form a more com-

plex 3D object (set matrix, combine_UCD). Simulation code often takes advantage of symmetry if present - to allow the researcher to visualize the true situation it is necessary to replicate the data and geometry (mirror).

Visualization software often automatically sets a range of colours to fit the range of values actually present in a particular set of data. AVS maps the minimum and maximum colour indexes to the minimum and maximum values found in the data. This is usually incorrect, particularly when the currently displayed dataset is only one of many. The mapping from a data value to a colour would therefore vary from one data set to another, which is generally misleading to the user. Software to override these automatic settings with a user- defined minimum and maximum has been produced.

Use of Colour

The work on colour matching, begun the previous year, resulted in a number of tools released in 1993. This work is designed to improve the quality and fidelity of colour printers. Stage 1 was released on the HENSA software archive at the University of Kent under the name RAL-col_match and Stage 2 will improve the quality and fidelity further. The announcement was carried in ECN 46 "Announcing the Release of a Colour Matching Package".

3.4 Animation and Video Facilities Support

Animation is a useful tool that can be used in conjunction with other visualization technique in order to achieve better understanding of underlying data. Video is a natural medium for storing animation sequences used either for presentation or exploration of data or indeed for disseminating of information about visualization. This is why the Club was involved in the following work:

- ***evaluation of animation software for use with AVS*** - (jointly with AGOCG) the AVS modules *Animator*, *KeyFrame* and *fast animate* were evaluated. The report on the results was submitted to AGOCG and made available to the community (see Appendix V).

- ***production of animation sequences for various visualization projects using AVS*** - see Appendix IV for more details.

- ***provision of video facilities*** - the Visualization Group at RAL has purchased a video output board and connected it to the Silicon Graphics Crimson. This board records the output from the screen directly onto video tape in real-time. There is also the Atlas Centre Video Facility at RAL. This facility allows single frame accurate video recording. A report was written on use of Atlas Centre for video production and submitted to AGOCG and the community (see Appendix V).

3.5 Awareness, Training and Dissemination

The Community Club has initiated or participated in many activities during the year aimed at increasing awareness, training and exploitation of visualisation.

- Dr K. W. Brodlie of the University of Leeds (Chairman of the Community Club Steering Group) organised and prepared a week-long AGOCG Postgraduate course on "Graphics and Visualization: Techniques and Tools" at Leeds in January 1993. The course resulted from the efforts of a large number of people from Universities of Leeds, Bath and Manchester, RAL and the AFRC Computing Centre. The course was extremely successful, which is the reason for the course to be repeated at Leeds University in January 1994. See Figures 7, 8, 9, and 10 that students produced at the "Graphics and Visualization: Techniques and Tools" course in January 1994.

- The Eurographics Workshop on Scientific Visualization was organised jointly by RAL and NAG and the Proceedings are going to be published in 1994 (see section 4.3).
- A multimedia workshop was organised jointly with AGOCG in November 1993 (see section 4.1);
- Mr J R Gallop participated in the USA Office of Naval Research (ONR) workshop on Scientific Visualization at Darmstadt in July 1993, and in the publications resulting from it.
- A video collection has been established out of case study video records and video proceedings of the Visualization Community Club seminars (see Appendix IV).
- Two types of survey were carried out in 1993: one by sending a questionnaire to all ERC grant holders, and the other by extracting the information out of ERC RG2 Grant Applications submitted in May 1993 (see section 3.6).
- A programme of visits to visualisation users sites by RAL staff was continued (see section 3.6).
- Although useful publications on visualisation are now available, the Steering Group identified a gap, namely a simple, rapidly updatable guide for the UK academic community which provides information on how to get started. For this purpose "Getting Started in Visualisation" has been produced by RAL.
- A mailshot has been produced during the year. Its contents are listed in Appendix V.
- Several articles on the activities of the Club have appeared in the Engineering Computing Newsletter and in the Graphics and Visualization newsletter (see Appendix V).
- It is also possible to direct queries on visualisation or send information about visualisation by electronic mail to *chest-visual@uk.ac.mailbase* and about the Club to *vcc@uk.ac.rl.inf*

3.6 Survey, Questionnaire and Visits

During the year, the Community Club Steering Group decided that, in order to plan future work, it needed to find out more about engineering researchers' needs for visualization and their computing environment.

Two methods were chosen. One was to survey the information provided on grant application RG2s - this includes all applications, not just the successful ones. A sample (close to 50%) of the RG2s submitted to two of the ERC committees (Electromechanical Engineering and Process Engineering) were analysed. The information extracted included the computing equipment and software and the intended use. Because these are not fundamental to a grant application, particularly where existing equipment is being used, the level of detail varied and some care needed to be used. One question that has interested the steering group is the balance of PCs and workstations in the community. It has become clear from the results that this varies quite strongly from one committee to another and also depends strongly on the type of work being carried out with the equipment.

The other method was to distribute a questionnaire to all holders of grants funded by committees of the ERC, which was done in second quarter 1993. It was made clear that the questionnaire was only to be returned by people with an interest in visualization. The over 50 replies therefore are mainly engineering researchers who were not previously in the Community Club, with an interest in using or developing (primarily the former) visualization. Several ERC committees were represented in the replies, but the most prolific was "not specified". There were strong requests for visualization courses, which are now being planned. All respondents gave

a thumbnail sketch of their applications and needs and this information is already being used by the Steering Group.

We are also using the information in the replies to plan a series of visits, two of which have taken place so far. The visits are intended: to help us understand better the visualization needs of engineering researchers; to provide information on visualization if needed; to identify possible further joint case studies and other areas of possible cooperation.

3.7 Graphics and User Interfaces

Some effort was given to graphics and user interface support. The hands-on PHIGS / Motif course was run three times in 1993. Funding was obtained from the UK Higher Education Funding Councils (HEFCs) to investigate cross platform user interface development tools. These allow a single user interface specification to be developed across Unix workstations, PCs and Apple Macintoshes. This complements the existing EASE funded work to evaluate graphical user interface tools on Unix workstations.

4. Relationship with Other Complementary Groups

4.1 AGOCG

AGOCG - the Advisory Group On Computer Graphics - coordinates computer graphics activities for the benefit of users in UK universities and other HEI's. It is financially supported by the Higher Education Funding Councils (HEFCs) and co-operates with the Research Councils. In particular support is provided for a full time coordinator for AGOCG - Dr. A. M. Mumford of Loughborough University.

AGOCG is responsible for ensuring that appropriate graphics products are available as widely as possible in the UK academic community. Since 1991, AGOCG has developed a programme on visualisation in cooperation with technical staff at RAL. During 1993 AGOCG has continued to support the appointment of Mr S. Larkin based at University of Manchester as the AGOCG Visualization Support Officer. His activities are helping to increase awareness of visualization products and methods in the community. Mr. Larkin is a member of the Visualization Community Club Steering Group.

RAL provides the chair of AGOCG, Dr. D. R. S. Boyd, and the secretary of AGOCG, Dr. Sastry.

In November 1993, a "Multimedia Workshop" was organized by AGOCG and RAL and hosted at Cosener's House in Abingdon. The purpose of the workshop was to bring together experts in multimedia in the UK higher education community. Those present included people involved in using multimedia for teaching and others in providing information resources using multimedia. It is hoped that there will be an AGOCG support programme for multimedia in UK higher education, but the success of the proposal is unknown at present.

More information about AGOCG's work can be found in the bi-monthly Graphics and Visualization newsletter (contact is Rachel Miles at RAL, e-mail: *rym@uk.ac.rl.inf*).

By coordinating the work of AGOCG and the EASE programme at RAL, the quality of the underlying provision of computer graphics in the UK is increased and benefits accrue to the engineering research community. As this general provision improves, the EASE effort at RAL can then focus more on developing advanced support for engineering researchers.

4.2 UK AVS User Groups

A UK user group for AVS (the UK AVS User Group) was constituted in May 1993 and has held one meeting (in November at RAL) since then. Liaison is maintained with this group as Mr J.R.Gallop is chair of the User Group and Mr W.T.Hewitt is secretary (both are on the Steering Group of the Community Club).

4.3 Visualization in Europe

Eurographics is the Association for Computer Graphics in Europe. There are several working groups which hold regular (usually yearly) workshops. One of these is on Visualization in Scientific Computing. Mr. J. R. Gallop (RAL) was co-chair and local organiser of the 1993 workshop which was held in April at the Cosener's House in Abingdon.

4.4 IRIS Explorer User Group

Dr K W Brodlie, chair of the Steering Group, chairs the European section of the IRIS Explorer User Group. Its first meeting was held at Eurographics 93 in Barcelona.

5. The Future Programme

The Forward Look for the EASE programme contains a reduction in the technical staff funded at RAL for visualization, computer graphics and user interfaces to 2.5 people in 1994/95, 2.0 in 1995/96 to 1997/98 and to 1.5 person in 1998/99 While this will inevitably reduce the scope of the work, the Steering Group will attempt to produce a balanced programme within the available resource.

5.1 Programme of Events

Below is the table of events planned for 1994:

Event	Type	Date	Chairman
Visualization in Built Environment Engineering Research	seminar	May	Prof Bowman
Introductory Course in Flow Visualization	course	early July	
Multimedia			
Extremes/Reference Model	workshop		Mr W T Hewitt and Mr S Larkin
Visualization of Experimental Data	seminar	mid/end November	Dr David

5.2 Technical Support

The following technical activities are planned:

- Further case studies will be undertaken in cooperation with engineering research groups. These will continue to be brief segments of work intended to be of value to the research group, but also to be made available - with data and examples - to other Community Club

members. It is our aim that the topics chosen should be representative of ERC committees with an interest in visualization.

- Evaluation of visualization software will be revisited as there have been changes since the last evaluation in 1991/92.
- One of the problems that commonly occurred in the postal survey of engineering grant holders could be described as pushing the extremes of current capability - visualization of many variables and of complex data. A technical workshop is planned by the Community Club for 1994 and if time permits it would be useful to precede that event with a deeper analysis of the visualization problems that engineering researchers are having in this area.
- Results of visualization are difficult to convey in a paper report. The Community Club will begin to make information and resources available with multimedia, using CD-ROM or networking where appropriate.
- Some effort will be given to graphics and user interface support in 1994. and the work already started funded by HEFCs (see 3.7) will result in two workshops in April. However from April 1994 onwards, the amount of staff time, within that allocated to Visualization Community Club support, that it will be possible to devote to this will be very small.
- The Steering Group identified the two topics, where work would be required beyond what was possible within the existing programme. These topics are graphical user interfaces and multimedia.The goal would be to make effective use of these technologies in supporting engineering research.

6. Conclusion

In its second full year, the Visualization Community Club has run a number of successful events, approximately once every three months, on visualization in engineering or on wider visualization topics.

Resources of proceedings, software, reports and videos have been built up. Because of the nature of visualization, the Club will investigate the multimedia to make information available.

By means of surveys and meetings, some topics of future importance have been identified in relation to visualization, including multidimensional data, experimental data, with CFD continuing to be important.

While the resources available to support the Community Club are reducing, the need has been identified for new work to be done on the effective use of graphical user interfaces and multimedia in engineering research.

Appendix I - Terms of Reference of the Visualization Community Club Steering Group

- To advise the Rutherford Appleton Laboratory on running an EASE Community Club in Visualization.
- To make recommendations on a programme of activities to benefit all those involved in Visualization in the academic research community.
- To maintain knowledge of methods and techniques in visualization and of their implementation in hardware and software.
- To identify requirements and make recommendations for the provision of new visualization facilities.
- To encourage interchange of ideas and methodologies between engineers and visualization providers.
- To liaise with the Advisory Group On Computer Graphics (AGOCG) and appropriate national and international groups.
- To report to the Visualization Community Club at least annually.
- To report through relevant subject committees to the Engineering Research Commission on the activities of the community club and the provision and use of existing computing facilities for visualization at least annually.

Appendix II - Visualization Community Club Events

1. 3D Visualization in Engineering Research (seminar)

   Venue: Rutherford Appleton Laboratory
   Date: Wednesday, 24 March 1993
   Chairmen: Mr J R Gallop (RAL) and Mr W T Hewitt (University of Manchester)
   Speakers: Mr J R Gallop (RAL), Mr S Crampton (3D Scanners Ltd), Mr M Prime (RAL), Mr I Sexton (De Montfort University), Mr W T Hewitt (University of Manchester), Prof N J Phillips (Loughborough University of Technology), Dr S Lang and Dr N Dodgson (University of Cambridge), Dr A Graves (3D Systems Inc. Ltd)
   Attendance: 53 (50 Academic, 3 Industrial)

2. Visualization in Engineering Teaching (seminar)

   Venue: University of Sheffield
   Date: Wednesday, 26 May 1993
   Chairmen: Professor J Swithenbank and Professor R Smith (both from University of Sheffield)
   Speakers: Professor J Swithenbank (University of Sheffield), Mr J Webster and Mr G Cowie (University of Sheffield), Dr H Haider (University of Sheffield), Professor I P Muller (University College London), Professor T Williams (Keele University), Dr S H Joseph (University of Sheffield), Dr J Miles (Ove Arup)
   Attendance: 50 (47 Academic, 3 Industrial)

3. Visualization in Electromechanical Engineering Research (seminar)

   Venue: Oxford University
   Date: Wednesday, 29 September 1993
   Chairman: Dr R W Ainsworth (Oxford University)
   Speakers: Dr M Fearon (British Aerospace, Warton), Dr P Ireland (Oxford University), Professor R Eatock Taylor (Oxford University), Dr R Stone (ARRL, Salford University), Dr M Giles (Oxford University), M M Cherrett (Defence Research Agency), Dr T David (University of Leeds)
   Attendance: 89 (83 Academic, 6 Industrial)

4. Parallel Processing for Visualization (seminar)

   Venue: University of Manchester
   Date: Wednesday, 17 November 1993
   Chairman: Dr R J Hubbold (University of Manchester)
   Speakers: Dr R J Hubbold (University of Manchester), Dr D Paddon (Computer Science, Bristol), Mr A Grant (University of Manchester), Dr A Del Pino (Fraunhofer Computer Graphics Institute, Darmstadt, Germany), Dr G G Cameron (Biomedical Physics, University of Aberdeen), Dr D Marini (Informatics Sciences Department, University of Milan, Italy), Dr B Colloins (IBM UKSC, Hursley)
   Attendance: 51 (48 Academic, 3 Industrial)

Appendix III - Seminar Proceedings

For each of the seminars listed, the papers and view graphs have been collected under a single cover. A full report on the event is attached to the event proceedings. The "3D Visualization in Engineering Research" seminar was recorded on video. For information on edited version of the video see Appendix IV.

These materials are available free to all members of the academic community and for a fee to industrialists.

1. 3D Visualization in Engineering Research, Proceedings 6, 24 March 1993

2. Visualization in Engineering Teaching, Proceedings 7, 26 May 1993

3. Visualization in Electromechanical Engineering Research, Proceedings 8, 29 September 1993

4. Parallel Processing for Visualization, Proceedings 9, 17 November 1993

The copies of Proceedings can be obtained by sending a request to ***vcc@uk.ac.rl.inf*** or by contacting ***Mrs. Virginia Jones***:

- **phone**: 0235 445121 (attended a.m. - answerphone p.m.)
- **letter**: Rutherford Appleton Laboratory
  Informatics - R1
  Chilton, Didcot
  Oxon OX11 0QX

Appendix IV - Video Records

1. "Visualization Software", Video Proceedings No 2.
2. "3D Visualization in Engineering Research", Video Proceedings No 3.
3. "Visualization of a Storm Cloud over Nigeria".
4. "Visualization of the Results from Wind Tunnel Testing of a 45 Degree Semi-angle Pyramid Probe" - case study.
5. "Visualization of Electromagnetic Field Data" - case study.

The copies of Video Proceedings can be obtained by sending a request on ***vcc@uk.ac.rl.inf*** or by contacting ***Mrs. Virginia Jones***:

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  Oxon OX11 0QX.

Appendix V - Steering Group Reports, Newsletter Articles, Mailshots and Publications

Visualization Community Club Steering Group Reports

VCCSG/P03/93	Report on "3D Visualization in Engineering Research" Seminar, *Mrs R Popovic*, 20 May 1993
VCCSG/P06/93	Postgraduate Course on Graphics and Visualization, *Dr K W Brodlie*, 20 May 1993
VCCSG/P07/93	Report on Current Visualization Community Club Technical Activities, *Mr J R Gallop*, 25 May 1993
VCCSG/P08/93	Report on Ways of Generating a Collection of Robust Visualization Tools, *Mr J R Gallop and Mr S Larkin*, 7 June 1993
VCCSG/P09/93	Report on Grant Holders Survey and the Questionnaire Results, *Mrs R Popovic*, May 1993
VCCSG/P10/93	Report on AGOCG's Visualization Activities, *Mr S Larkin*, June 1993
VCCSG/P11/93	Report on Fourth Eurographics Workshop on Visualization in Scientific Computing, *Mr J R Gallop*, 25 May 1993
VCCSG/P12/93	Report on the UK AVS User Group Meeting, *Mr S Larkin*, June 1993
VCCSG/P13/93	Report on the AVS '93 - 2nd International AVS User Group Conference, *Mrs R Popovic and Mr S Larkin*, 24 February 1993
VCCSG/P15/93	Changes to EASE and the Research Councils and the Implications for the Visualization Community Club, *Mr J R Gallop*, October 1993
VCCSG/P16/93	Report on Questionnaire and Survey Results, *Mr J R Gallop and Mrs R Popovic*, October 1993
VCCSG/P17/93	Future Directions, *Dr K W Brodlie and Mrs R Popovic*, October 1993
VCCSG/P18/93	Report on "Visualization in Electromechanical Engineering Research" Seminar, *Mrs R Popovic*, October 1993
VCCSG/P20/93	Report on "Data in Visualization" Workshop, *Mr S Larkin*, October 1993
VCCSG/P21/93	Review of Visualization Community Club Technical Activities, *Mr J R Gallop*, October 1993
VCCSG/P22/93	Video Facilities Loan-Pool, *Mr J R Gallop*, October 1993
VCCSG/P24/93	Report on AGOCG's Visualization Activities, *Mr S Larkin*, October 1993
VCCSG/M01/93	Minutes, *Mrs. R Popovic*, 28 June 1993
VCCSG/M02/93	Minutes, *Mrs. R Popovic*, November 1993

Visualization Community Club Articles in the EASE Engineering Computing Newsletter

1. Announcing a New Version of RALpage, *Mr R J May*, ECN 42 (January 1993)
2. Introduction to Programming with Graphical User Interface Design Tools, *Dr L Sastry*, ECN 42 (January 1993)
3. Visualization Software Meeting, *Mrs R Popovic*, ECN 42 (January 1993)

4. 3D Visualization in Engineering Research Seminar, *Mrs M V Jones*, ECN 42 (January 1993)
5. Visualization in Engineering Teaching Seminar, *Mrs R Popovic*, ECN 43 (March 1993)
6. 3D Visualization in Engineering Research Seminar, *Mrs R Popovic*, ECN 44 (May 1993)
7. OSF/Motif Course, *A J Keane*, ECN 46 (September 1993)
8. Announcing the Release of a Colour Matching Package, *Mr. R J May*, ECN 46 (September 1993)
9. Novel Input and Output Devices, *Mrs. R Popovic*, ECN 47 (November 1993)

Visualization Community Club Articles in the Graphics and Visualization newsletter

1. 4th Eurographics Workshop "Visualization in Scientific Computing", *Julian Gallop*, Issue No: 27 (February 1993)
2. SERC Visualization Community Club, *Rajka Popovic*, Issue No: 28 (April 1993)
3. Graphics and Visualization - Tools and Techniques, *Ken Brodlie*, Issue No: 28 (April 1993)
4. Integrating Graphical User Interfaces and Graphics, *Lakshmi Sastry*, Issue No: 29 (June 1993)
5. Importing Data into AVS, *Steve Larkin*, Issue No: 29 (June 1993)

Visualization Community Club Mailshot

Mailshot, July 1993

- Summary of the Video Proceedings, IEEE Visualization '92, Boston, Massachusetts, 19-23 October 1992;
- Summary of the "Visualization of Neutron Scattering Data Using AVS" case study report;
- "Getting Started in Scientific Visualization" document;
- Report on Readers for Application Visualization System (AVS);
- The Annual Report of the EASE Visualization Community Club.

Visualization Community Club Publications

1. Evaluation of the AVS Animator, *Mr R J May*, AGOCG Report
2. Report on Experiences of Using the Atlas Video Facility, *Mr R J May*, AGOCG Report
3. Visualization of the Results from Wind Tunnel Testing of a 45 Degree Semi-angle Pyramid Probe, *Mrs R Popovic and Mr R J May*, Case Study Report
4. Brief Survey - Importing CFD Results into AVS, *Miss J Haswell*, CFD Community Club Report No CFDSG/P9/93 Annexe 1.
5. Research Issues in Foundations and Systems, *P Robertson, R Earnshaw, D Thalman, M Grave, J R Gallop, E De Jong*, Research Issues in Scientific Visualization, special section on Research Issues in Scientific Visualization, L Rosenblum (ed.), IEEE Computer Graphics and Applications, to appear March 1994
6. Underlying Data Models and Structures for Visualization, *J R Gallop*, Frontiers of Scientific Visualization, Academic Press, to appear Summer 1994

The copies of most Reports, Articles, Mailshots and Publications can be obtained by sending a request on ***vcc@uk.ac.rl.inf*** or by contacting ***Mrs. Virginia Jones***:

- **phone**: 0235 445121 (attended a.m. - answerphone p.m.)
- **letter**: Rutherford Appleton Laboratory
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AIDE: An Integrated Design Environment
Application to Heart Valve Design

Dr T David, University of Leeds

These two pictures show an Integrated Design Environment implemented in Iris Explorer. This has been used to create and analyse new innovative designs for artificial mechanical heart valves. Changes in geometry produce 'instantaneous' updates in the fluid flow and functionality of the valve.

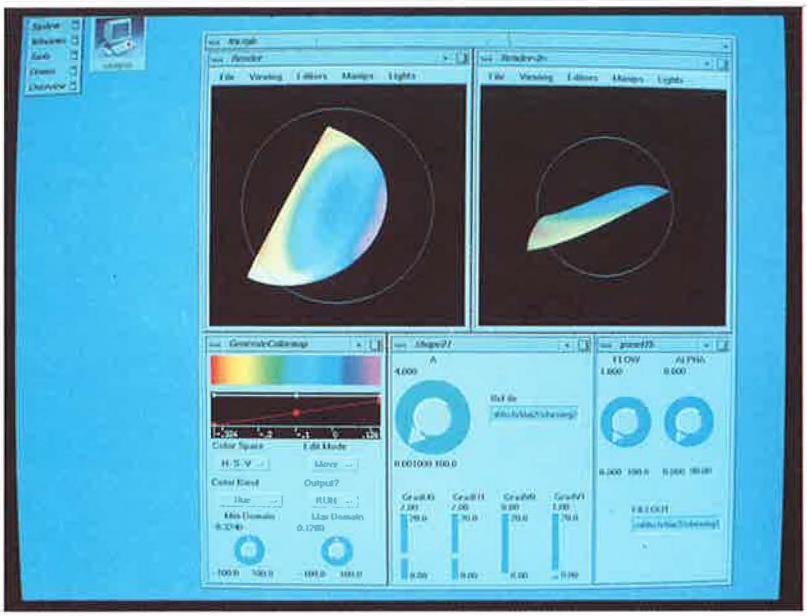

Figure 1

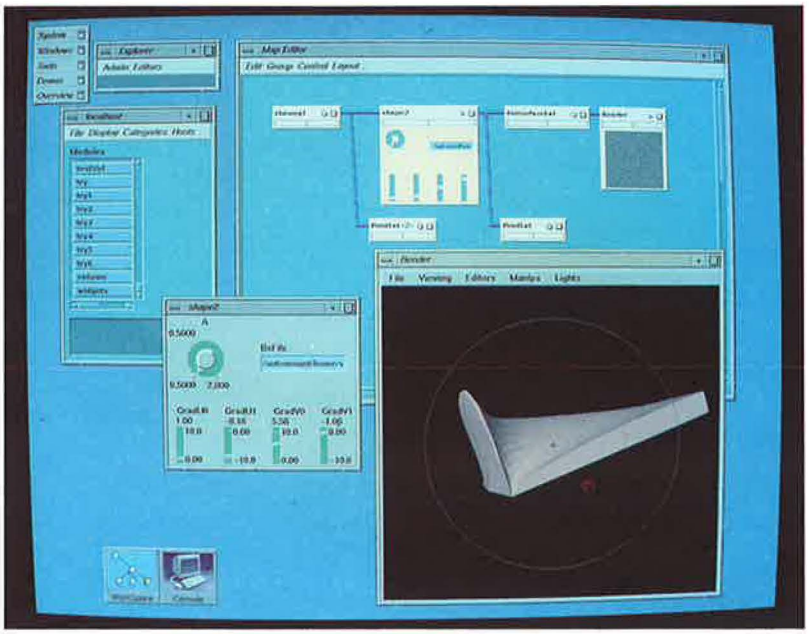

Figure 2

Visualization Case Study:

Data from Wind Tunnel Testing of a 45 Degree Semi-angle Pyramid Probe

These four images resulted from the application case study described in section 3.2. They illustrate some techniques applied to these raw pressure readings. Blue colour represents low and red high values of the raw pressure.

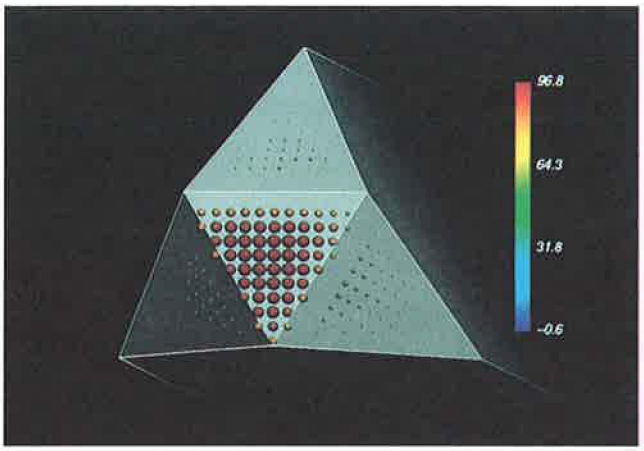

Figure 3: Bubbleviz.

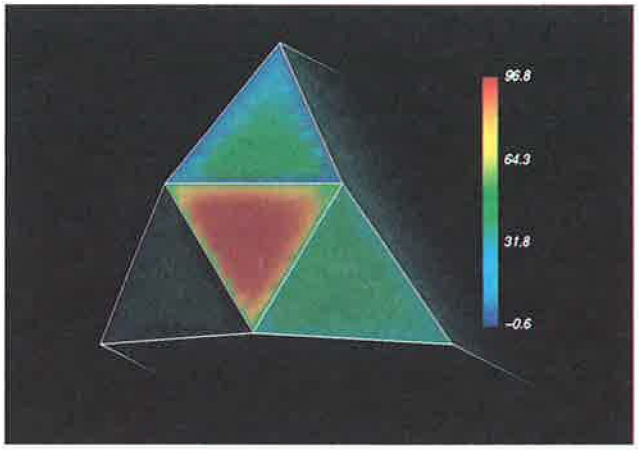

Figure 4: Colour contouring.

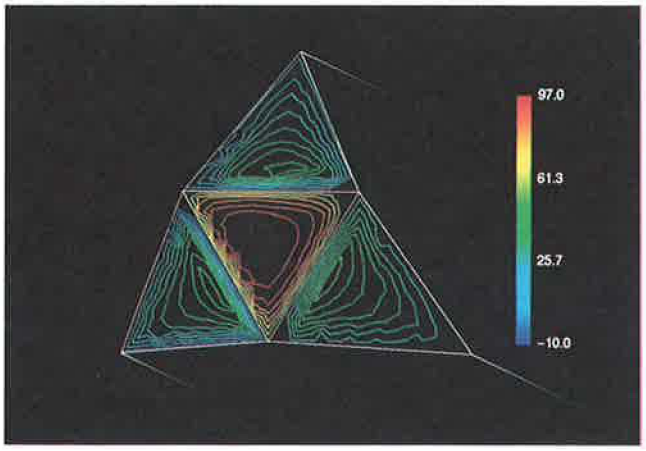

Figure 5: Isolines.

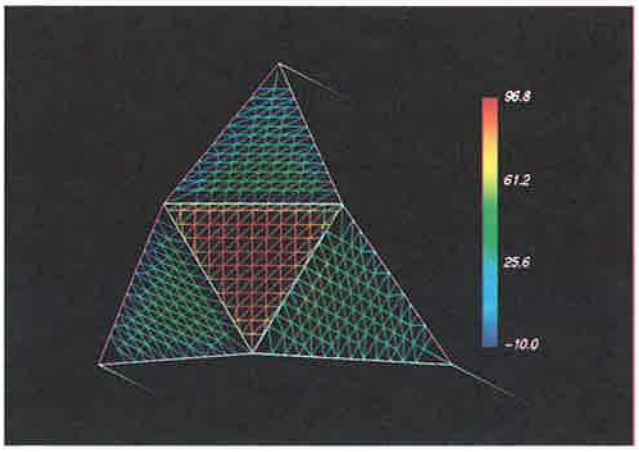

Figure 6: Grid geometry coloured according to the raw pressure.

AGOCG Postgraduate Course on Graphics and Visualization: Methods and Tools

These four images resulted from the five day course held at Leeds University in January 1994 (see chapter 3.5 for more details on course). One of the problems set to the students for exercise was the 3D challenge. The students were given results of a simulation of air flow between two plates, where one plate is cold and the other is warm (situation similar to one with double glazing). Data is positioned on a grid of 18 x 18 x 10 points and consists of velocity (in x, y and z directions), temperature and pressure. They had one and a half day to understand the behaviour of the air in the cavity and present their results as an animation sequence. They used the techniques they were taught during the course, along with AVS as the visualization system.

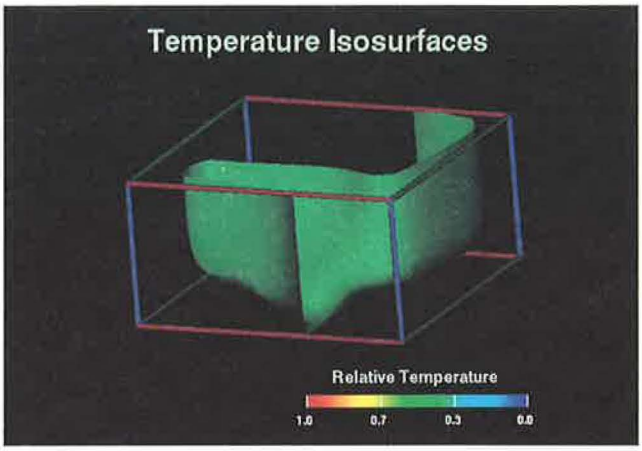

Figure 7: Temperature isosurface.

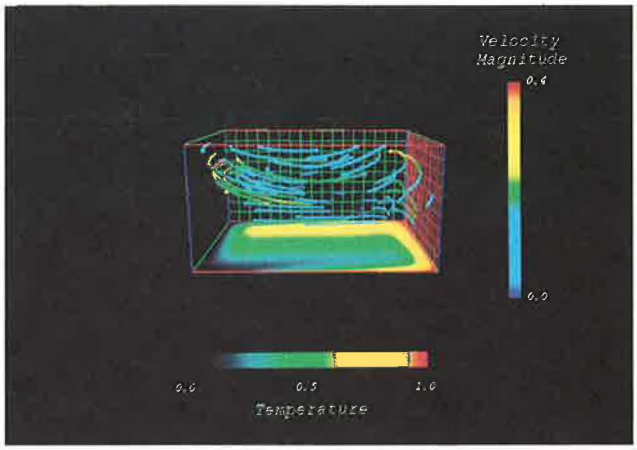

Figure 8: Velocity streamlines coloured according to the velocity magnitude (blue for a low and red for a high magnitude).

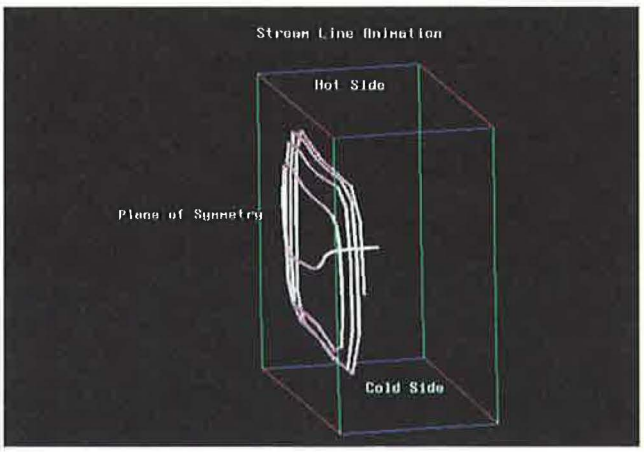

Figure 9: Velocity streamline.

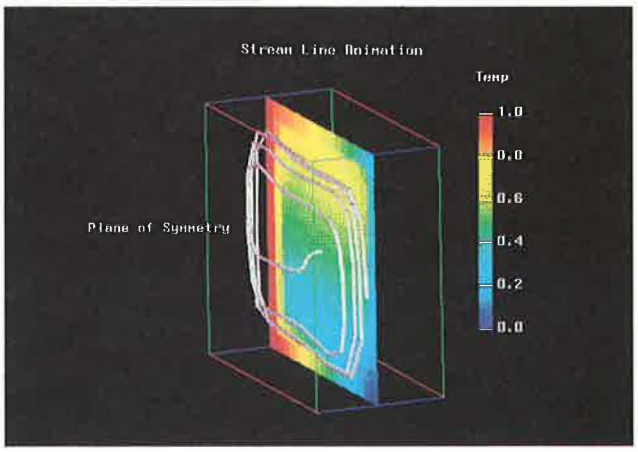

Figure 10: Velocity streamline and an arbitrary slice through the volume. The slice is coloured according to the temperature (blue for a cold and red for a hot temperature).

Visualization of Mixing Using the Network-of-Zones Model

P Ying and Dr R Mann

Department of Chemical Engineering, UMIST

Tracer mixing experiments in closed batch vessel are more difficult to interpret than the classical stimulus response technique applied to steady state continuous flow reactors, because concentrations vary in both space and time as mixing proceeds to completion.

In this work an extension of the 2D Network-of-Zones model, previously used to interpret the mixing of reactive and inert tracers in a single impeller vessel, is now extended to a full 3D arrangement. This extended version of the model when comprised of thousands of zones, gives a good spatial discrimination of internal mixing behaviour.

The Application Visualization System (AVS) is used to visualise the results from the experimental simulation. These computer generated model results can then be compared to experimental mixing of an inert pulse of dye tracer and the mixing of an alkali slug injected into a batch of acid (with suitable pH-indicator) which is recorded and photographic still taken.

The figures show the concentrations over a number of time steps starting from the initial conditions. These are shown as dots at each of the sample points and a slice through the centre of the dataset. The colour is used to indicate the concentration with the blue indicating a low concentration and red a high concentration.

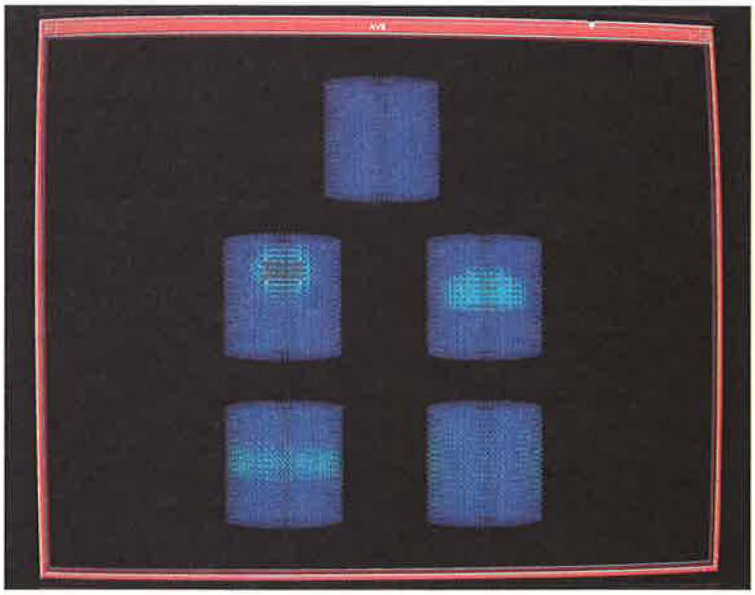

Figure 11: Concentrations shown as dots at each of the sample points.

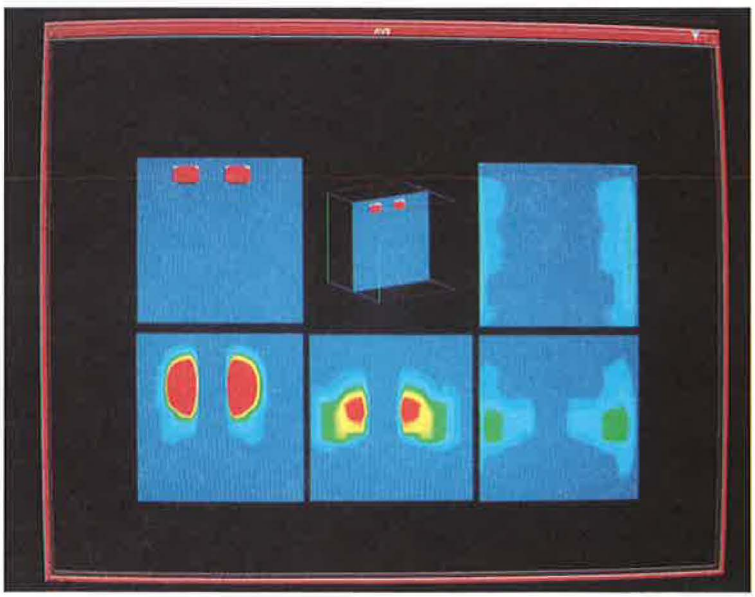

Figure 12: Concentrations shown as a slice through the centre of the dataset.