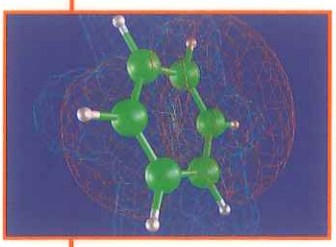
Joint Information Systems Committee

Networks and Innovative Services for Higher Education

NEW TECHNOLOGIES INITIATIVE

NTI Final Report



HIGH PERFORMANCE AND CLUSTER COMPUTING

MULTIMEDIA

INTELLIGENT KNOWLEDGE-BASED SYSTEMS

TEACHING TOOLS

DATASET TOOLS

NETWORK APPLICATIONS

The geographic spread of the NTI projects

Introduction

The JISC's New Technologies Initiative (NTI) was an imaginative leading edge development programme in higher education in the UK, designed to explore the opportunities offered by emerging Communications and Information Technologies (C&IT) by funding projects and initiatives within higher education. The NTI's goals were:

- To examine which C&IT developments were critical in a higher education environment
- To find out how best to exploit their potential
- To fund projects and initiatives to explore the opportunities they offered higher education, and
- To make the results of the projects widely available to the higher education community

The NTI identified three technologies and three application areas as having the greatest potential to higher education. All were largely untried when the initiative was first established. The NTI funded 62 projects across the UK, ranging across these technologies and application areas, to investigate what they could offer. The projects produced a large number of reports, results and recommendations which are now in widespread use throughout UK higher education.

The NTI addressed a broad range of issues and had an enormous impact. The results of the NTI are probably being used in at least one department in every university in the UK!

John Porter

Professor John Porter
Chair of TASC (Technology Applications Sub-Committee of the JISC)
and Deputy Vice-Chancellor, University of Glamorgan

This report includes brief highlights from some of the NTI projects. Further details on all the NTI projects are available from the JISC Technology Applications Programme (JTAP), the successor to the New Technologies Initiative. The JTAP web site is at http://www.jtap.ac.uk/

Key Technologies

A large number of emerging technologies were considered at the inception of the NTI, with the key criteria that they were likely to be widely available in 3-5 years and to be important in the transformations in higher education by improving the teaching and learning process. The three selected technologies were: high performance and cluster computing (HPCC); multimedia; and intelligent knowledge-based systems (IKBS). They were among the most promising technologies and central investigation of the issues involved in their use in higher education proved to be highly cost-effective.

HIGH PERFORMANCE AND CLUSTER COMPUTING (HPCC)

Cluster computing allows a group (cluster) of workstations, or even PCs, to be used as a powerful supercomputer, allowing the user to study much larger problems, in more detail and faster. A cluster is much cheaper than a supercomputer of equivalent power. Cluster computing allows the use of a group of workstations or PCs in a teaching laboratory as a research tool when they would otherwise be idle, such as overnight and in the vacations. At the time the NTI was set up it was not clear whether this would be practical; several of the leading experts had voiced significant doubts. The NTI demonstrated the practicality and cost-effectiveness of this approach and successfully promoted its widespread use in higher education.

What the NTI funded

The NTI took a dual approach to the question of cluster computing. It funded six regional centres to develop high performance and cluster computing (HPCC) training and education materials and to promote their use throughout higher education. Two of these centres (at the universities of Edinburgh and Manchester) continue to be funded under the JISC Technology Applications Programme (JTAP), the successor programme to NTI, to keep the materials up to date and to continue to promote their use.

The NTI also funded 13 projects looking specifically at cluster computing and exploring some of the options available at the time. These ranged from the use of clusters of workstations dedicated to high performance cluster computing at one end, to "stealing spare cycles" on any machine at the other, which means making use of small amounts of time when any particular machine happens not to be in use, including overnight. Projects included:

Electro-Magnetic Utility (EMU)

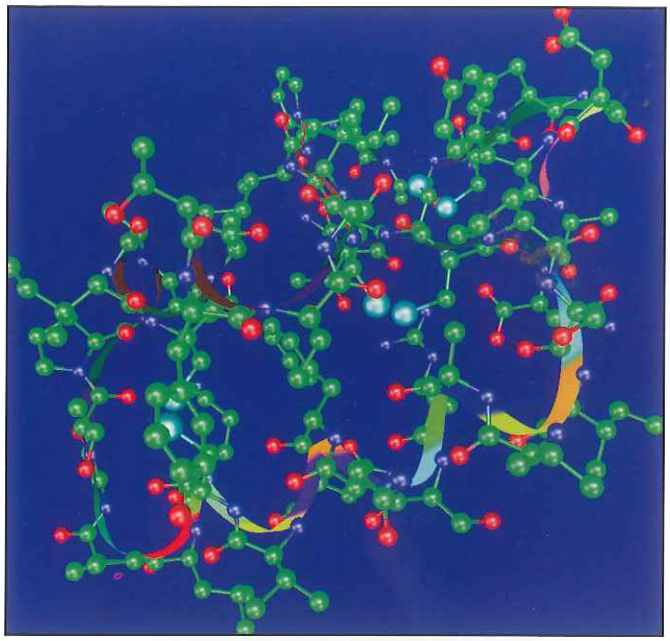
At Brunel University an engineering application to simulate electromagnetic field effects (such as those generated by mobile phones) was developed to run automatically on a cluster of workstations. This program allows students to look at much larger, and hence more realistic, problems than they had been able to. They now gain a better understanding of the issues, without having to understand the complexities of cluster computing. The program was designed to make use of a shared laboratory, using spare cycles, and is considered to be a particularly good example of the use of cluster computing in teaching.

HPC on a Network of Workstations (HNW)

In the Department of Aeronautics at the University of Glasgow, the NTI project group linked together a number of dedicated workstations to use as a supercomputer. They were able to achieve results more quickly on some of their research problems using this cluster than by using their allocation on the largest research machine available, the Cray T3D at Edinburgh, and at a fraction of the cost.

Edinburgh Parallel Computing Centre (EPCC)

The Edinburgh Parallel Computing Centre (EPCC) at the University of Edinburgh hosted one of the six HPCC regional training and education centres. EPCC developed a variety of courses, ranging from introductory to specialist, such as HPCC for business or computer simulation for engineers, and made the material available to anyone in UK higher education wishing to teach HPCC. With its regional responsibility for Scotland and the North East of England, EPCC taught these courses both at the University of Edinburgh and at other institutions. EPCC also developed innovative training materials allowing users to run sample codes on parallel systems from the web.



Cluster computing allows a group of workstations to be used as a supercomputer. Here, the extra power allowed complex modelling of a protein

MULTIMEDIA

At the launch of the NTI, multimedia was only just becoming widely available and it was not clear what its potential would be, especially for networked applications. With the exponential growth of the web over this period, multimedia has now become an everyday part of higher education. The expertise developed and disseminated under the NTI has played a significant part in the success of this new technology.

What the NTI funded

Multimedia is a very large field and a wide variety of projects were funded. NTI projects looked at developing collections of digital images and addressing the issues this raises, from technical issues to the more general, such as how images should be indexed (metadata) and made available (networks), and how copyright can be cleared. The field is still developing and so answers were not found in all areas, but a very important lead was taken in promoting an understanding of the full range of issues associated with using multimedia.

Projects were also funded which looked at the pedagogic opportunities offered by multimedia and how they would affect current practice. These projects included:

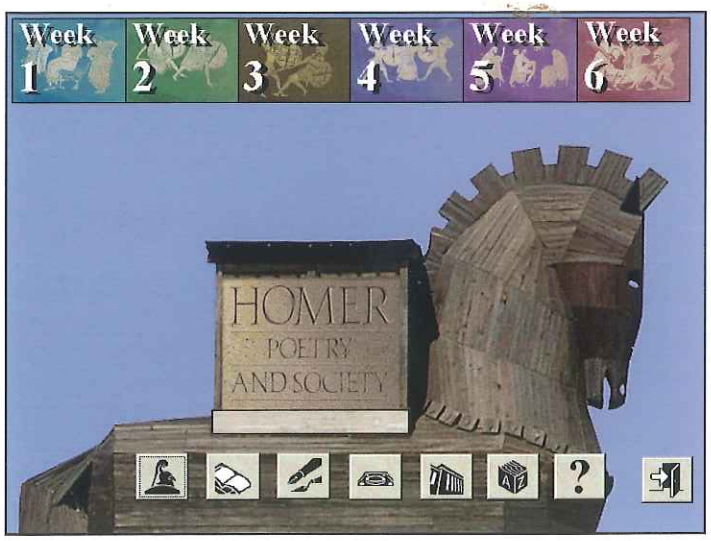
Support Initiative for Multimedia Applications (SIMA)

The Support Initiative for Multimedia Applications (SIMA), based at Loughborough University, funded a multimedia support officer who acted as a central clearing agent for information on multimedia systems and applications. Sima also funded a series of workshops and the production of 30 reports in a broad range of areas including videoconferencing, multimedia data formats, virtual reality and running web services. These have been widely distributed and have had a significant impact by promoting best practice and the use of the most suitable standards.

The Homer Project

The Homer Project at the Open University looked at how a multimedia package could be put together to demonstrate the relationships between Homer's writings and the archaeology of some of the sites described in the poems. This project created novel and effective ways of using and linking the various media to demonstrate the relationships that do, and do not, exist.

Screen shot from the Homer Project



Medi-CAL won a European Academic Software Award (below)

Medi-CAL

At the University of Aberdeen the Medi-CAL project developed several CAL packages using digital moving images and specifically designed to work over Local Area Networks (LANS). At the time of the development of these packages it was not clear how feasible this form of delivery would be, and what the issues involved in scaling would be. The CAL packages demonstrated the viability of delivering teaching materials (including moving images) over LANs (a vital step before MANs can be considered). They are now in use in medical schools around the country. The Medi-CAL project won a European Academic Software Award.

National Video Services

The NTI funded the development of a national video facility at the University of Manchester. The National Video Services, available to all, can be used to convert video images between the various digital (e.g. MPEG, M-JPEG, AVI) and analogue formats (e.g. from videotape to digital, or the digital output from simulations to analogue). The service is currently available through volunteer effort at Manchester.

INTELLIGENT KNOWLEDGE-BASED SYSTEMS (IKBS)

Intelligent knowledge-based systems (IKBS) combine the reasoning and decision-making methods developed in artificial intelligence with modern representations of data to allow powerful decision support tools to be developed. Or at least that is the theory. When the NTI was launched it looked as though these technologies were coming together and would provide a wide variety of important applications in higher education, ranging from intelligent tutoring through student counselling to planning and time-tabling.

The NTI funded projects to investigate some of these applications and the results clearly demonstrated that, with the exception of planning, IKBS is in fact not a viable technology. In doing so the NTI has saved other groups from trying these technologies and so wasting money and it has demonstrated that a centralised development programme of this type is the most cost-effective way the community has for assessing the value of emerging technologies.

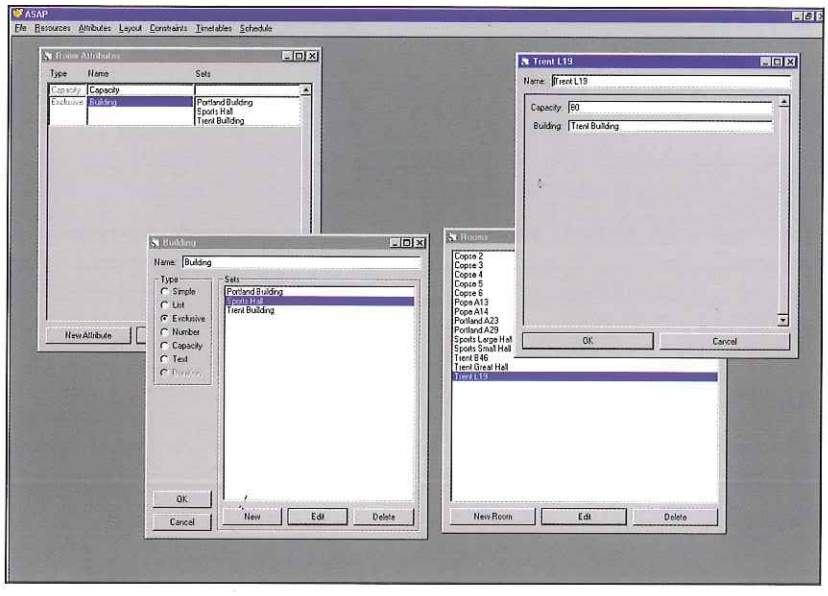
What the NTI funded

The NTI funded a variety of applications in this area. In the end, with the exception of time-tabling, projects either made serious attempts to use IKBS and failed in their objectives, or dropped the IKBS element of the project and used other techniques to deliver something approximating to the original goals.

One project developed an intelligent tutoring system to teach law at an undergraduate level. Early versions included IKBS elements, but the tutors and the students who trialled the system liked the application except for the "intelligent" elements, which were therefore dropped. The most successful IKBS project was:

Automated Scheduling and Planning (ASAP)

A project at the University of Nottingham developed a time-tabling system based on IKBS techniques, including the use of so called "genetic algorithms". Acknowledging that such a system cannot produce the ideal result, they called it "Time-tabling to please most of the staff most of the time". The system can be used to time-table an entire university's teaching programme, maximising the number of choices available to students by minimising the number of clashes, as well as taking into account staff preferences. Under JTAP the team is currently developing a space allocation system to work with the time-tabling one.



Timetabling using the ASAP system

Application Areas

The remaining three strands of the NTI under which projects were funded were application areas rather than technologies: teaching tools; dataset tools; and network applications.

TEACHING TOOLS

Early applications of technology to teaching were largely limited to what may be termed on-line text books. The NTI explored some of the other ways in which technology can be used to support the teaching and learning processes by providing richer data, more complex resources and more sophisticated data-handling facilities. Both high performance and cluster computing (HPCC) and some of the multimedia work discussed as technologies could also be seen as teaching tools.

What the NTI funded

The teaching tools projects covered a very broad range of applications, technologies and disciplines, ranging from poetry and archaeology through dental and medical teaching to engineering and computing applications. The technologies ranged from multimedia through web-based interactive material and demonstrator applications to tools and methods for using existing resources more effectively.

One of the most important principles which these projects demonstrated is that it is essential to produce flexible resources that can be used in any way the lecturer wants, and not to produce monolithic resources. Among the most successful projects were:

Hypermedia Image Processing Reference (HIPR)

At the University of Edinburgh, the HIPR project produced a series of electronic worksheets for use in teaching computer vision. Each sheet describes the functions for which computer vision is useful and includes before and after images and access to the relevant algorithms. They also allow the students to experiment with the functions, to use them in different combinations or orders, and to vary the parameters. Around 100 of these functions are described in the original set, which is available free from HENSA; these have now been extended and the complete set published by Wiley.

Axiom/NAg Numerical Analyst (ANNA)

Engineering and science students often have difficulty selecting the most suitable numerical methods to compute a solution, even when they have developed a mathematical model of it. At the University of Bath a system was developed which can transform an equation into a computable form and write a program to execute it, allowing the student to concentrate on the problem. ANNA has now been incorporated with the Numerical Algorithms Group (NAg) libraries and so is widely available across higher education.

DERWEB

The University of Sheffield created a library of dental resources, including images, on the web, with teaching materials showing how they can be used by tutors in higher education. One great advantage of this library is that students are able to review images which before they may have only seen projected on the screen for a few moments during a lecture. DERWEB has now become a JISC service and will shortly become financially self-sufficient.

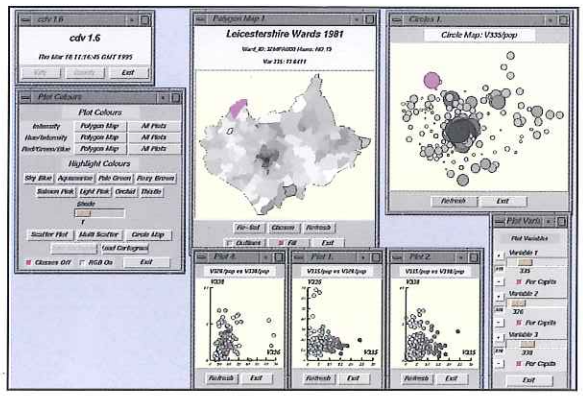
There has been an exponential growth in the quantity and variety of data available in electronic form since the NTI started. The JISC Committee for Electronic Information (CEI) provides the higher education community with a wide range of data, from commercial datasets to the developments undertaken by the Electronic Libraries Programme (eLib). The datasets have opened up new opportunities for teaching and research, but the necessary tools were not always available, so the NTI funded projects to develop them.

What the NTI funded

The NTI funded a number of projects which either aimed at providing tools to assist with access to datasets or demonstrated the potential of new datasets, including:

Knowledge-based Interface for National Datasets (KINDS)

At Manchester Metropolitan University the KINDS project developed a front-end to the MIDAS datasets. MIDAS, also funded by the JISC, holds a variety of datasets, including geographic and social science data. These are not easy to use, and considerable experience is needed to find exactly the data required. The KINDS project developed tools to assist the user, helping researchers and making the datasets available to a much wider audience, extending their use to undergraduate teaching. The KINDS tools have been incorporated into the MIDAS service and are being further developed under JTAP, as a valuable addition to the JISC datasets.



Screen shots from KINDS (far left) and the Cartographic Data Viewer

Cartographic Data Viewer

The Cartographic Data Viewer allows users to view spatial data (i.e. geographically referenced data such as the Census data) in novel ways. Developed at Birkbeck College and the University of Leicester, this tool has opened up new areas of research by allowing users to explore data visually, providing insights not previously available. It also aids students' learning by enabling them to visualise easily the data under discussion. This tool has also been incorporated into the MIDAS service.

Networked Delivery of Multimedia Resources

This project at the University of Bristol investigated the issues involved in making images available over the web. It looked at standards, formats and other technical issues; how to make the images available securely over the web, including watermarking and other access and copyright issues; and the broad range of issues relating to converting existing analogue material. The project produced guidelines in these areas as well as a number of medical and veterinary datasets, including the Bristol Biomedical Archive, and it formed the basis of the new JISC-funded national service, the Technical Advisory Service for Images (TASI).

NETWORK APPLICATIONS

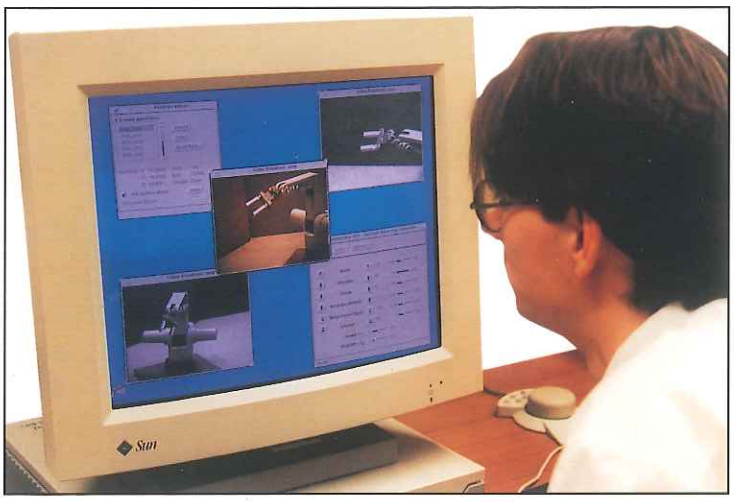
The JISC provides the academic communities with the JANET and SuperJANET high-speed network infrastructure. This is used across higher education for email, sending and copying files and access to the web, videoconferencing and so on. The NTI explored some of the other services which it is possible to deliver over networks, and the use of ISDN services.

What the NTI funded

Projects funded in this category included one which looked at using JANET for distributing multimedia to a wide audience, one which looked at how videoconferencing can be used to support remote teaching and one which looked at remotely controlling laboratory equipment.

Networked Robotics Laboratory (Netrolab)

Based at the University of Nottingham, Netrolab investigated the issues around controlling a robot and robot arm remotely over JANET, with the robot and arm physically located at Reading. Students at the University of Nottingham were able to control the robot arm from Nottingham and view the results of the commands sent to it. While there are still many technical problems to be addressed, the project clearly demonstrated the viability of such an approach. This type of use of networks will become very important both in allowing HEIs to share expensive equipment, the cost of which cannot be justified at each, and in allowing remote access to sophisticated equipment for distance learning.



A student in Nottingham controls a robot arm in Reading

Multimedia Teaching over JANET and ISDN

A project at the University of Exeter, together with the universities of Reading and Central Lancashire and Liverpool Hope University College, demonstrated the use of videoconferencing over JANET and ISDN to support trainee teachers on placement. This looked at both the pedagogic and technical issues and produced a number of reports. Multimedia resources were created for tutors to support their on-line teaching sessions on Cell Biology, Earth Science, the Internet, Student Teacher School Placement Support and Educational Multimedia. This project was an important early demonstration of the use of desktop videoconferencing to support and enhance distance learning. A series of informative case studies with supporting materials is available.

Evaluating the New Technologies Initiative

Two independent evaluations were undertaken at the end of the NTI, one general and one specifically on the high performance and cluster computing (HPCC) projects.

Overall, the evaluation report for the HPCC projects concluded that:

"The JISC NTI programme was successful measured in terms of both national value and international quality. One can make a strong case to exploit the projects and people in the programme with a focused follow-on activity which can have a significantly lower cost than the original effort."

A Review of the New Technologies Initiative (NTI)
High Performance and Cluster Computing Projects
by Geoffrey Fox, Syracuse University, NY (December 1996)

The general evaluation report concluded that:

"Clearly, the most important impacts are access to new tools enabling courses to be taught more effectively (e.g. multimedia and WWW tools), and access to a wider range of teaching materials ... [while] the impact of the NTI on students, both undergraduates and postgraduates, is more diverse."

An Evaluation of the New Technologies Initiative (NTI)
by Dr KJ Bradshaw, Dr SH Brindle, PM Brucciani,
Smith's Systems Engineering (December 1996)

Conclusion

The New Technologies Initiative succeeded in anticipating important developments in Communications and Information Technology (C&IT) and in developing projects and services to assist the higher education community to make use of them.

There has been a very wide take up of the results of many of the NTI projects, notably in the areas of high performance and cluster computing (HPCC) and multimedia. The results of the NTI have had an impact in almost every HEI in the UK and will greatly assist individual institutions with the implementation of the C&IT recommendations in the Dearing Report.

The NTI has given tremendous value for money by preventing unnecessary duplication of effort across the community; it has financed more cutting edge development work than any consortium of HEIs could, so keeping the UK well ahead in the global community in the use of C&IT; and its dissemination of results has proved extremely influential in promoting the effective using of C&IT in higher education within the UK.