TELEMATIC NETWORKS FOR OPEN & DISTANCE LEARNING IN THE TERTIARY SECTOR
Final Report
Volume 1

Final Version

SCENARIOS, COSTINGS AND SURVEY

Authors

Adrian Rawlings	**Open University, UK**
Seamus Fox	**National Distance Education Centre, Eire**
Valerie Hobb	**National Distance Education Centre, Eire**
Nicholas Fox	**European Association of Distance Teaching Universities**
Paul Bacsich	**Open University, UK**
Chris Curran	**National Distance Education Centre, Eire**

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Comments to: Nicholas Fox
EADTU
tel +31 45 76 22 14
fax +31 45 74 14 73

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Executive Summary

This is Volume 1 of our Final Report of the DELTA "CCAM" Study Contract "Telematic Networks in Open and Distance Learning in the Tertiary Sector". In contractual terms, it forms Deliverable 3 of the Study. The summary that follows covers *both* volumes of the Final Report.

Organisation of the Study

The study was carried out by the project office of the European Association of Distance Teaching Universities (EADTU) under the direction of the general project manager Nicholas Fox. The work was primarily undertaken by two member institutions of EADTU:

1 The UK Open University (UKOU) led the survey, scenario and policy aspects.

2 The National Distance Education Centre (NDEC) in Eire undertook the cost analyses.

During the course of the study there was regular consultation with the EADTU Board and with the Media Methods and Technology Working Group of EADTU.

The Report is relevant to so-called "traditional" universities wishing to use telematic networks for teaching as well as to "distance teaching universities". (It should be noted that EADTU contains many traditional universities within its organisation as well as open universities and several dual-mode organisations.)

Deliverables

The project had three Deliverables, produced as a two-volume Final Report:

Volume 1 "Scenarios, costs and survey" covers Deliverables 1 and 2

Volume 2 "Rationale and work programme" covers Deliverable 3.

Work plan

The work plan had six components. In the list below we describe them and give volume and chapter references:

a The specification of hypothetical but potentially realisable scenarios relating to the use of telematic networks in tertiary education (by campus-based or distance universities). [Volume 1 Chapter 2]

b A postal survey of 760 degree-awarding university-level teaching institutions, primarily in the member states of the European Community (but also some in other parts of Europe), and a subsequent telephone survey of selected institutions. The objective of the two surveys was to identify the potential demand for telematic networks in tertiary education. [Volume 1 Chapter 3]

c An economic analysis of the comparative cost of using each of four media within the context of the scenarios (see (a) above), relative to the cost of providing the same programmes through a more conventional mode of teaching. In addition, an estimate was derived of the cost of equipping learning resource centres (Euro Study Centres), based on specifications prepared by EADTU. [Volume 1 Chapter 2]

d An analysis of trends in the use of telematic networks in education and training, drawing on a range of sources and in particular on results from the JANUS project. [Volume 2 Chapter 5]

e The formulation of policy recommendations for the development of European telematic networks to meet tertiary level education and training needs. [Volume 2 Chapters 6 and 7]

f The formulation of proposals for future work both short-term and longer-term. [Volume 2 Chapters 8 and 9]

Conclusions

The conclusions are in three parts:

1 General conclusions

2 Conclusions on particular media

3 Infrastructural conclusions.

General conclusions

1 Our survey work shows interest, but non-specific interest, in the potential of telematic networks

2 Standardisation is required in order to avoid the problems, and associated cost increases, of having to buy different products to fulfil similar requirements. For example:

- having to buy an extra or more complex satellite receiver because education and training channels are on different satellites [as were EUROSTEP and EuroPACE]
- having to buy a different type of microcomputer from that used for administrative tasks [for example if teaching needed a PC but administration was done via dumb terminals on Unix].

3 Media/technologies should be used extensively, if users wish to gain economic benefits from them:

- both for large numbers of students
- and for a large number of study hours.

4 Where telematic networks can be developed on existing infrastructure, the fixed costs can be reduced. For example:

- using mainframe computing power in the evening to support student access [at times when administrative use and staff access is light]
- using a satellite for which many users already have receivers or could be "easily" persuaded to buy them [such as Astra]
- use of existing computer networks cost-justified for other purposes such as research [such as the national academic networks].

5 Even now, little is known about true costs in actual situations.

Conclusions on particular media

Some of our main conclusions are given below. It should be stressed that our conclusions are mostly phrased in terms of *overall* system costs including student costs. The issues of who actually incurs the costs and who notices them raise complex organisational and political questions.

- *Satellite TV* in most cases is less cost-effective than postal delivery of videos; but can become cost-effective as the number of students grows large. In addition, given the under-developed character of postal services in some parts of Europe, and the complexity of working with several national systems, satellite TV offers a single integrated solution to the requirement of Europe-wide delivery of video. The apparent cost-effectiveness of this increases if use is made of domestic satellite TV receivers and overnight transmission time.
- *Computer conferencing* has limited economies of scale because of the need for tutor/student ratios similar to conventional tutorials. It is therefore less cost-effective than commonly believed for large numbers of students. However, if students have home or workplace access to the appropriate hardware, software and telecommunications, it can provide an effective method of extending access and support even for small study programmes.
- *Video conferencing* used for video lectures can be cost-effective at relatively low hours usage per year. At present, however, the initial capital outlays required are substantial. A potentially significant factor affecting costs is the decreasing requirement for bandwidth, opening the way to the use of ISDN in video conferencing and substantially reduced charges. If network bandwidth is apparently free (as on many academic networks) this has a substantial effect on apparent costs.

Infrastructural conclusions

The cost analyses are restricted to a small number of specific scenarios – however, these have been chosen to be typical of operational use in North America and operational, pilot and planned use in Europe. They strongly suggest that the common assumption of the universal cost-effectiveness of telematic networks is unsupported, and that the use of these technologies needs to be carefully focused if resources are to be deployed effectively.

They also suggest that factors tending towards cost-effectiveness include scale of use, both in number of students and number of study hours, and use of existing equipment and services on a marginal cost basis. But one cannot have marginal costs if there is no basic tier of service on which to add marginal costs.

They also bring out that there are many limitations of the analytic method, including the fact that it is in practice impossible to substitute one medium for another (is live television the same as video?) and that there are many factors which are either hard to cost or where users (such as students) make economically unjustified decisions (such as over phone bills, TV costs or car use).

And of course it is well known that there are few reliable studies of the cost of telematic networks in operational use.

This suggests that:

a A number of pilot trials are set up to get better information on the cost factors in the context of educational practice.

b A European Telematics for Education Infrastructure is set up so that real-world trials can be undertaken without getting bogged down in heavy start-up costs and complexity.

Recommendations

In order (a) to make best use of existing infrastructures (run by PTTs, etc.) which fulfil part but not all of the operational requirements for telematic trials and (b) to avoid setting up a new large infrastructure – plus organisation to run it – which may not (yet) be justifiable, we propose that a small infrastructure organisation is set up as a "telematic network broker". This would operate rather like a package holiday company. It would purchase telematic services from PTTs, academic networks, and others, and supply them on an agreed basis to universities who wish to use telematic services for the provision of programmes for credit.

A subsidy for this broker should be available from the EC on the usual matched-funding basis.

The broker would be overseen by a board which would include a substantial representation of those universities making use of its services.

This scheme would give hard information about the demand for such networks. It would also give universities the experience of using telematic networks with the ease of use and low tariffs which market forces would *in the long term* produce if only the market were kick-started.

The broker would provide telematic services for a number of pilot projects but would not be restricted to these. The pilot projects should include the following six:

1. Video lectures (satellite and ISDN) such as for post-graduate courses.
2. Voice mail and audio conferencing such as for language teaching.
3. LAN linking by ISDN such as for support of tutoring in Euro Study Centres.
4. Two-way video conferencing such as for a "virtual summer school".
5. Integration of CD-ROM with networks such as a multi-media courses database allowing on-line registration for courses.
6. User-friendly computer conferencing for home-based users such as with windows-based conferencing software over higher-speed links.

These six applications should provide a good range of trials to satisfy universities both in the distance education area and the area of traditional universities considering distance education methods. They also contain relevant trials for our partners in the other sectoral studies. We believe that the Infrastructure can be set up to service all three sectors studied.

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Deliverables 1 and 2
Scenarios and Costs

1 Introduction

This volume forms Deliverables One and Two of the EADTU's study 'Investigation on Telematic Networks for Distance Education Institutions'. The study was funded by the EC under the aegis of the DG XIII CCAM studies. The primary focus of this study is on the feasibility of using telematic networks to link students and education providers at the tertiary level (whether distance or conventional universities) throughout Europe. There are parallel CCAM studies on the use of telematic networks in vocational training and the production and delivery of specialised courses.

Deliverables One and Two focus on technical scenarios involving *use* of a telematic network and the costings of such scenarios. The third, and final, deliverable of the study will elaborate on recommendations and proposals for the *implementation* of a telematic network for European tertiary education. (See Volume 2.)

The analysis of comparative costs set out in the scenario section of this report have drawn on data from an wide range of sources. It has emerged in the course of the study that prices in relation to key components of the cost estimates (such as telecommunications tariffs, hardware and VAT rates) vary quite significantly from one country to another. In addition, as is to be expected, any one of the scenarios postulated could lend itself to alternative underlying assumptions, for example the range and quality of equipment for video conferencing or staff student ratios in conventional teaching, and are therefore subject to wide variation in practice. For these reasons the results of the analysis should be seen as essentially estimates indicative of a scale difference between one approach and another and not as precise estimates of the cost of adopting a particular approach. Nevertheless none of these qualifications undermine the significant trends emerging from the study or the general thrust of the conclusions.

1.1 Structure of this Report

This report falls into two natural halves. The first half, chapter 2, develops a number of educational scenarios encompassing the use of telematic networks for distance education – such as video or computer conferencing. The second half, chapter 3, outlines the results of a survey carried out on universities and colleges throughout Europe to gauge their current and planned use of telematic networks. While logically distinct the two sections of the report inform and reinforce each other.

Chapter 2 on scenarios starts with a general discussion on the potential uses of telematic networks in tertiary education and the related issue of ensuring that the teaching by telematic networks is accepted and integrated into the educational context. The emphasis is on the pedagogical aspects of using telematic networks in education and the importance of ensuring that their use is student – and not technologically – driven. An outline of the scenarios is given and then each of the scenarios is costed. A conventional means which is as near as is possible to delivering the same educational content is costed for comparison purposes. The

subsequent analysis identifies any emergent critical factors in the use of particular media which in turn informs discussion on the wider implications of the scenarios.

The five scenarios were summarised and sent out as a questionnaire to over 750 institutions. The purpose was twofold: first, it was an effective way of describing the mission of the CCAM Telematics Project concisely and, secondly, it was a means of 'reality testing' the scenarios. There were a total of 113 agencies of which 56 currently conduct distance learning. This survey and the follow-up telephone interview showed broad support for the scenarios and the project as a whole. Further details are given in Chapter 3.

Finally, in Chapter 4, some conclusions are drawn from the report. These form one input into wider discussion on the potential implementation of European telematic networks for open and distance learning, which will be the basis of the Volume 2 of this report.

1.2 Uses of Telematics in Tertiary Education

The last decade has seen the rapid expansion of the educational use of telematic networks, which can carry a variety of traffic including speech, data, video and multimedia. Many forms of teaching via telematics, whether one-way or two-way are currently being exploited in tertiary education. Most of these applications are in North America, but increasingly Europeans are adapting them for their own needs and context.

It should not be assumed that telematic teaching belongs solely to the world of distance education. Because of the difficult economic climate, the changing population to be educated, the greater focus on student-centred learning, and, not least, the developments in technology, all tertiary institutions are finding it necessary, to a greater or lesser degree, to consider changes in their traditional delivery mechanisms.

Telematic networks can play a key role in many of the changes under consideration. The current educational imperative is undoubtedly the call for interactivity in the learning situation. This has arisen from a number of related factors – a dissatisfaction with teacher-centred delivery of content to a passive student audience, the growth in life-long education leading to a much larger (and more demanding) adult student population, the greater competition amongst educational providers to create and satisfy niche markets, and again, the technological and conceptual developments which have produced two-way learning potential in telematics.

The current focus on interactivity – whether between learner and teacher, between learner and learner, between learner and the course material, or finally, amongst groups in collaborative learning situations – continues to attract support and enthusiasts, despite the observation† that students do not perform better on exams after 'interactive' courses than those following traditional relatively non-interactive courses.

† Proceedings of *Distance Education for the 21st Century*, Bangkok , 1992 (*in preparation)*

However, measurement of final exam results is not the critical factor in determining pedagogical strategy. Much more crucial is the perceived value of interactivity – the satisfaction of students, the interest of teachers, the facility for reaching new students, the ability to teach a broader range of subjects to dispersed students, and the potential for innovation in teaching techniques. The promise, therefore, of the new technologies is that they seem to provide ways of realising interactivity in tertiary education. Despite the many reasons for introducing telematic based teaching, however, it is the cost effectiveness of using these technologies which is likely to determine their long term viability and growth.

While a major focus of this report will be on the cost of introducing telematic based teaching it should be stated at the outset that it would be a fallacy to assume that economic considerations alone dictate which delivery mechanisms are chosen by an institution. In most cases, the cost of introducing various forms of telematics teaching are simply not known and little reliable information has been published in this area. (Indeed, providing preliminary and indicative research on this issue is an important raison d'etre of this report.)

Much of the current use of telematics is heavily subsidised by governments, research and development agencies and other experimental programmes. Other trials are conducted on the back of existing facilities – large host computers, video equipment on loan, free satellite time. Some technologies may never prove to be commercially viable – but what the large number of experimental and pilot projects allow is the evaluation of the particular pedagogical strengths and weaknesses of the various forms of telematic based teaching.

Acceptability of Telematics Teaching

How acceptable, then, are these new technologies to teachers and tutors, to students and life-long learners, and to institutions and course providers? A look at current changes in banking facilities provides a useful analogy. Some people queue for what would predictably be an unacceptable length of time outside a 'hole in the wall' money dispenser. Impersonal banking appeals to them, it is said. Others will go to great lengths to find a live cashier from whom to extract their money. This example highlights the contradictory conclusions to be drawn about human adaptability, use of technology and openness to innovation. Nevertheless, one principle seems to hold from early applications of telematics in both banking and education: the principle of meeting needs.

Substituting audio conferencing for small group seminars delivered face-to-face, will hardly win applause from participants. Offering a previously unavailable course to a small campus via video conferencing may well win applause. Designing a text-only computer conferencing course with no possibility for meeting face-to-face may sound impersonal and limited pedagogically, but for students who can access the course whenever and from wherever it suits them, and who can interact with other students, take part in group assignments and access other resources on-line, this may be a wonderfully emancipating option. Travelling to a study centre to use a drawing pad and telephone for an audiographics seminar may not conjure up visions of a stimulating educational environment to a cosmopolitan urbanite, but to

a student on a remote island without access to higher education, it may be a lifeline to learning, giving support and visual stimulation in a way that correspondence material cannot provide.

Meeting educational needs is the answer to the acceptability of technology, whether the needs are for flexibility, wider choice or delivery to remote sites. Technological innovations fail when human needs are not given priority.

The principle of meeting needs also points to particular situations where a technology which would in general prove not to be cost effective would find a niche where it may be the *only* way of delivering an educational programme. This issue will be returned to in the discussion on the scenarios.

This principle also applies to teachers and tutors, as well as to administrative staff and other policy makers. Telematics can be used to reduce boring and time consuming travelling, to try new methods of teaching and contacting students, and to overcome institutional difficulties and shortfalls. Negativity towards telematics usually stems from fear of job cuts, of the erosion of a personal teaching environment and of reduced opportunities for travelling and meeting people. Experience from past telematics applications shows that telematic teaching can be very personal, can involve more not less interaction with students, can reduce ineffective travel and endless meetings in favour of a few, well-focused meetings, and can usefully tap expertise and scarce resource people to the benefit of all.

Reduction of entry costs

It has become a cliché to point out that traditional tertiary education and distance education are on a converging path due to the development of the computer and communication technologies. What this means for students and smaller institutions is greater choice. There will be no longer monopoly suppliers of educational material and credentials. Telematics creates a level playing field for providers and receivers. This is crucial when considering the variation in pedagogical styles, geographical position and social backgrounds of the total European educational scene. For example, while going off to study centres for evening classes has little appeal to many potential students in the UK, it is part of the tertiary educational tradition in Scandinavia, and compatible with the whole social ambience in Mediterranean countries.

Terrestrial telematics in compact countries such as Denmark, England or the Netherlands can make obvious sense, while satellite delivery in remote locations such as in Greece, Scotland or Eastern Europe may make better sense. For some Europeans, a computer in their homes for accessing tertiary education is acceptable and desirable, for others it would be unaffordable or simply intrusive. Educational choices must meet local needs and reflect social conventions. The variety of technologies available via telematics can offer this choice. The challenge facing providers and policy makers is the introduction and successful implementation of telematic based educational technologies which meet real needs in a manner which is appropriate in scale, pedagogically apt and cost effective. This report is a contribution to the on-going debate on the challenge.

1.3 Methodology

At the outset of the project, it was agreed that the way to proceed for this study of the tertiary sector was to present a number of scenarios. These described a hypothetical distance learning situations using a combination of media. For example, the first scenario was the delivery of a course with a high visual content using satellite broadcasting and an audio conference for post-broadcast discussion. This approach was more realistic (and interesting) to potential customers than some arid discourse on the comparative benefits of media.

In order to gauge the demand for a trans-European telematic network, a questionnaire was sent out to most tertiary institutions in Europe. The questionnaire sought to find out the extent of use of telematics in distance learning, analysed by type, class of institution, current and planned. A copy of the questionnaire is given in an Annex.

The first questionnaire produced many fruits, most important of which was a mailing list of respondents who had an active interest in the work carried out in this study. A list of institutions was drawn up whose interest would have an influence on the outcome of the network. These institutions were interviewed by telephone and the reactions to a number of questions recorded. The interview sheet is given in the Annex.

In parallel with the survey and interview activity, work proceeded with the economic aspects of the study. Data have been drawn together which allow the cost of various delivery methods to be assessed. The analysis method allows a comparison between methods to be carried out, for instance, between terrestrial video links and face-to-face tutorials.

1.4 Introduction to the Scenarios

The methodology adopted for this section of the study is based on the development of five telematic based educational scenarios. Each of the scenarios is grounded in an appropriate pedagogical basis to ensure its relevance. The technology and telematic networks required to implement each scenario are defined, along with level of interactivity, amount of tutoring required, student/tutor ratio, number of hours tutoring, student's location, etc. For each of the scenario except the fifth (which as we will see below is a special case), a conventional means of delivering the same educational programme was developed and both means of delivery were costed to estimate the cost effectiveness of the telematics-based method.

It is not possible to develop a precise conventional analogy to a telematic based teaching scenario and the discrepancies are brought out in the discussion on each scenario. However, for the most part, the comparisons provide some basis for an indicative cost comparison of the delivery systems. In the detailed discussion of the scenarios, the pedagogical, technical and other relevant assumptions (for example, distances between students and local or national study centres) are outlined. These assumptions must be borne in mind when interpreting the ensuing analysis because, as mentioned earlier, changes in the underlying assumptions can radically affect the cost comparisons for better or for worse. In addition, it was necessary for comparison purposes to reduce what were rich educational scenarios to more

manageable proportions. For the most part this entailed bringing out the 'pure media' aspects of each scenario. The effect, if any, of this is elaborated in the discussion.

1.4.1 Technologies for Telematic Teaching Scenarios

How did we choose the most significant technologies to include in the five scenarios? These emerged from a review of current research and development projects and the variety of applications and trials currently taking place. There were a number of factors to consider – the degree of interest shown world-wide, the views of users reported in evaluation studies, and the pedagogical appropriateness of the technology. It is believed that the scenarios chosen cover the major applications of telematic based teaching available today.

What follows is an introduction to the media which underlie the five scenarios.

Satellite

There is now a huge variety of examples of educational communication via satellite throughout the world. One of the first was in the third world, where vast populations and distances, coupled with critical shortages of trained personnel and teachers, were the perfect reasons for the adoption of a distance education programme using satellites for communication. India, the Philippines, Iran, Indonesia and Fiji all boast educational satellite applications. Australia and Canada with similar geographical difficulties have also been major exponents of satellite technology in education. As in many areas, the US has taken the lead and even found the means for a commercially based distance education satellite venture.

Fundamentally, satellites merely provide a channel – a means of transmitting audio, video or data from point to point, or from point to multipoint. Although they are best known for delivering one-way broadcasts (for example, EuroPACE and Eurostep), or live broadcasts, perhaps with an interactive telephone return, satellites can be used to carry computer conferencing data, video conferences and audiographics courses. Satellite education, therefore, can encompass many kinds of courses and technologies. In our scenario, however, the emphasis is placed on the more traditional broadcasting use of satellite with the facility for feedback provided by telephone and audioconferencing.

Video Conferencing

Video conferencing networks in North American teaching institutions are now very extensive. They are used primarily to deliver live lectures to remote sites. Some applications involve full two-way interaction (such as the LiveNet video conferencing system linking the various colleges of London University), but others provide only an audio link back to the delivery site. Many tertiary institutions in the US are multi-campus sites. Video conferencing, via either satellite or terrestrial links, is the most common, the most acceptable and most cost effective way of extending course choice at smaller colleges.

Computer Conferencing

Of all the proposed technologies in this study, the most widely used is undoubtedly computer conferencing. Over the last six years, this form of asynchronous, group discussion vehicle has grown from marginal applications in distance teaching support, to significant levels of use in curricula in every form of educational institution in the US. Education and social science courses are particularly amenable to this form of delivery, as are many graduate courses. It has been used in a wide variety of contexts from teaching, tutoring, and counselling to staff development, community development and administration. These uses are beginning to spread to Europe and find significant applications in the UK particularly, but also in all the Scandinavian countries. A significant application for Europe is language teaching – providing a meaningful, contextualised environment for second language practice.

Audiographics

Audiographics systems have been available and in use by educational institutions for over 20 years, although they were known by other names, such as electronic whiteboards. However, recent improvements in the hardware and software technology have led to a resurgence in successful implementations. Current systems offer far more efficient and flexible facilities and more complex display and communications options. All systems combine multipoint audioconferencing with displays of graphics, but computer-based systems can also offer animation and full colour pictures. Most systems are fully interactive; any student at any site can talk with the instructor or with students at any other site, and can ask a question or use a graphics tablet to draw on the computer screen at any time. All sites share the audio and visual information equally.

The use of audiographics systems is widespread in Canada, and in certain parts of the US such as Wisconsin and Alaska. In Europe, there are major applications in the Highlands and Islands of Scotland and in Finland. User statistics in one specialist area, continuing engineering education in the US, show that of the 86 universities offering distance education courses in this area, 100% use one-way video, 20% use computer conferencing and email, 12% use audio conferencing and 9% use audiographics. These figures reflect roughly the extent of the use of this technology in other areas, but as the software developments are relatively recent, all expectations are that increasing use will be made of audiographics.

Feedback from user sites list the following advantages to this technology:

- Communication is highly interactive, resulting in an effective teaching tool
- In work-based settings, data for real case studies is at hand on the students' workstations and can be used by them for student presentations.
- Teaching can originate at any site in the network, anywhere expertise is located.
- The technology is able to reach small clusters of students scattered over a large geographic location.

Resource Centres

Resource-based learning is another concept which is gaining adherents in educational circles. Due to the increasing need to reduce costs and extend enrolments, many institutions are considering the implications of resource-based learning. By making current teaching resources available in electronic form, their use can be extended to other staff, and to students to access in their own time. The expectation is that it should be a relatively cost effective extension to turn these resources (lectures, overheads, video or audio material) into credit courses and make them available at remote centres.

The notion of telecottages has been well developed in Scandinavian countries and examples are spreading to other European countries. In these centres, resources are available in one location for the use of the community or region. The combination of

(a) local resource centres with expensive equipment, on-line connection to the wider world and a facilitator to help with access, and

(b) the concept of resource-based learning with course materials being available from a wide variety of teaching institutions,

gives rise to the notion of *Euro Study Centres*. These would extend access to education into local communities at the same time as they extend the teaching resources of tertiary educational institutions.

Axes of the Scenarios

The scenarios take into account five different applications of telematics, but also the pedagogical domain. They take into account three distinguishing factors: course population, location of learners and 'interactivity'. These factors are now discussed.

The course population is one of the most important factors in making distance learning economically attractive. Given a large enough population, the cost of providing the learning is less for distance learning students than for students at conventional institutions. At the other extreme, one would find courses with highly specialised subject material and low student population, which could be increased by allowing students from the whole of Europe to participate.

The location of the learner is the second distinguishing factor. The 'extended campus', where a video conference links a lecturer with an audience of learners at one or more remote locations, is now a reality. By contrast, the distance learning model of students working from their homes or a local study centre is perhaps the most common model found in Europe.

The 'interactivity' relates to the learner's degree of participation. There are some courses which require little or no input from the student as part of the immediate learning process; differential calculus would be one such area. There are subjects that require the student's active participation, where their personal experience is part of the learning experience. Interactivity has an important bearing on the technical details of the telematic infrastructure. A subject with low interactivity could be delivered with a one-way satellite broadcast, with no provision for a return link (phone, email, etc.) to the provider.

2 The Scenarios

Overview

Each of the five scenarios are described in terms of their pedagogical dimensions. The scenarios have been deliberately constructed so that a quantitative comparison between conventional and telematic-based delivery can be made. Where possible, break-even points have been calculated to indicate the circumstances under which one medium is preferable to another in terms of cost. Full details of the costs that have been used in the analysis are given in the Annex. This is followed by a discussion where the salient factors are drawn out and conclusions can be drawn.

2.1 Scenario One – Satellite broadcast with audio conferencing

2.1.1 Pedagogical Basis of Scenario

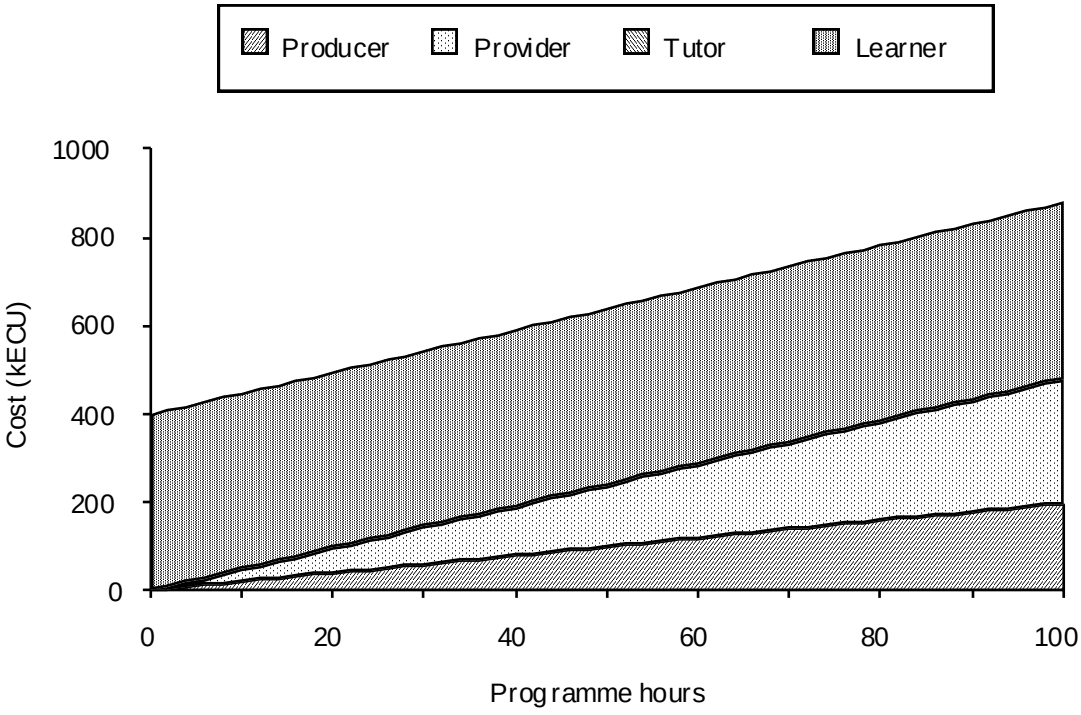
The pedagogical basis of this scenario is that of a university which proposes to extend access to its courses to students in locations throughout the European Community. The courses are assumed to have a substantive visual component, and satellite broadcasting is being considered as an alternative to delivery of video tapes to students' homes, or to study centres.

Many satellite broadcast systems provide for communication with students in the form of small group audio conferences, or phone-in question and answer sessions, after broadcast transmissions. In addition, many university courses incorporate print or other course materials as part of satellite broadcast programmes.

2.1.2 Analysis

The cost of distance learning is commonly expressed under four budget headings, corresponding to the cost of the: i) producer of learning material, ii) provider of learning material, iii) tutor , iv) student. These headings are based on the Learning System Reference Model (LSRM) and serve as a useful starting point for the analysis. All the calculations in this report split the costs into these four components although, as will be seen, the deciding battle is often fought under just one budget heading.

In this scenario two different delivery methods are compared. In the first case, a number of TV programmes are transmitted by satellite to students. The process can be thought of as a chain of costs: the programmes will cost a certain amount per hour to produce, the satellite uplink will cost a certain amount per hour to rent, students will need a satellite receiver, video recorder and TV set. There are no tutorial costs associated with the programmes. These quantities are expressed as simple spreadsheet formulae (see Annex) which are related to the number of programme hours. The costs used in these formulas are described in detail in the Annex and, for the sake of brevity, the results alone will be stated here.



The cost of learning material when distributed by satellite. The chart shows the costs for a fixed population of 500 students. (There are no tutor costs in this scenario; the legend is used throughout this document)

The chart shows the cost of the distance learning for 500 students. The upper band of the chart (shaded dark grey) is of unvarying thickness, which indicates that the cost to students is independent of the number of programme hours; this is to be expected. This is because students will need to have a satellite receiver, video recorder and television before they can watch any programme material. The student costs are average costs, based on the number of students that would have to purchase equipment. Socio-econometric tables indicate that in the UK, for instance, the ownership of satellite dishes, video recorders and televisions is 4%, 58% and 96% respectively (see Annex).

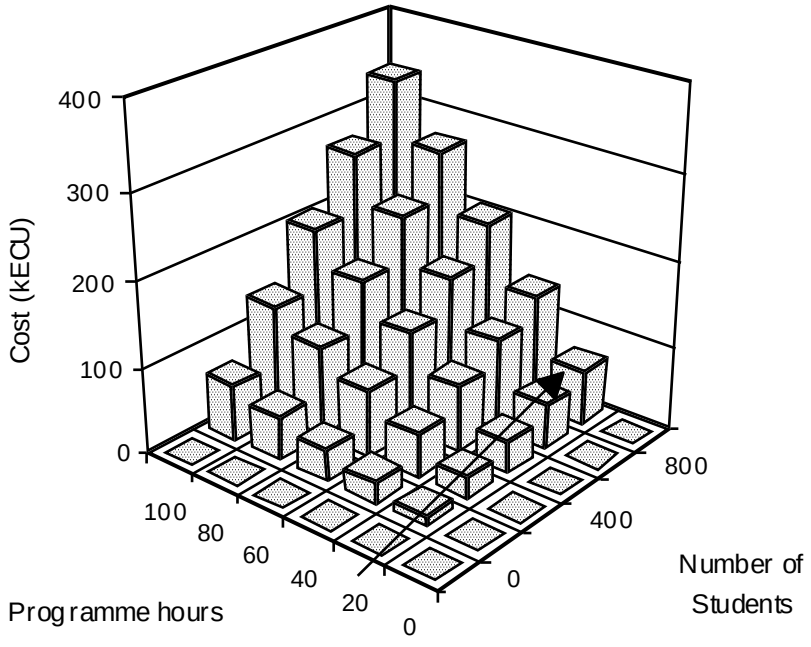
The total cost for 500 students will be around 400 keuro, i.e. 800 euro per student. This cost is borne by the students and some would argue that it is sufficiently large to act as a discriminatory barrier. Those students who cannot afford this kind of investment are disadvantaged. This raises an issue of policy that is outside the scope of this report – how are students going to pay for their distance learning? It is mentioned here for the record, but the policy decision is of a political dimension. Once students have bought this equipment, however, it can be used for family entertainment. There is no time-related charge for using the equipment.

The two lower bands, light grey and hatched, indicate the cost for the provider and producer respectively. Both these costs are proportional to the number of study hours transmitted. The cost to the provider of the service is that of hiring a satellite uplink for the requisite number of hours. In this example, the value used was the typical rate of 2825 euro per hour (£2000 per hour). It will be shown later in this

section that this factor determines whether the least expensive delivery method is by satellite or by videocassette mailing.

When considering the costs for the delivery of programme material by videocassette, two shortcuts can be taken. First, since the resource cost of academic input and producing a master copy of video tapes is the same whether tapes are transmitted by satellite or by post, the cost of production can be excluded from the comparison. Secondly, this analysis is concerned, ultimately, with costs that arise from using the network. The cost to students should be borne in mind, but there is little that the producer or provider can do to reduce the cost of access.

The cost of programme delivery by videocassette mailing depends upon two factors, the number of hours of programme material and the number of students participating in the course. Since there are two variables, it is appropriate to use a 3D plot which shows the relationship between cost, the number of programme hours and the number of students. The formula and cost assumptions that produced this chart are given in the Annex.



The cost of delivering material by videocassette mailing

The chart above is a convenient means of representing the cost of programme delivery by videocassette distribution. It takes into account the cost of duplicating cassettes, packing and mailing them. As a guide price, the first class national UK postal tariff has been used, since this applies to EC post too. The speed of delivery, the immediacy of the material, is another key factor and will be discussed later.

To see how the chart works, consider the cost of duplicating and despatching 20 hours of programme to 1000 students. Look along the row of 'pillars' labelled 20 programme hours. The height of each pillar represents the cost for that particular combination of programme hours and student numbers. The first pillar, closest to

the '20 hours' label is flat, like a paving stone: this indicates that the cost of production for zero students (read the axis to the right marked 'number of students') is zero. Move along this row of pillars, following the arrow away from the '20' label, and the cost rises linearly. The cost of delivering 20 hours of programme to 1000 students is about three quarters of the way between the zero and 100 keuro lines, say around 75 keuro. As another example, see that the cost of delivering 60 hours of material to 1000 students is about 200 keuro.

The resolution of this chart has been kept low for the sake of clarity. The essential purpose is to show how the cost of videocassette programme delivery is dependent on two variables.

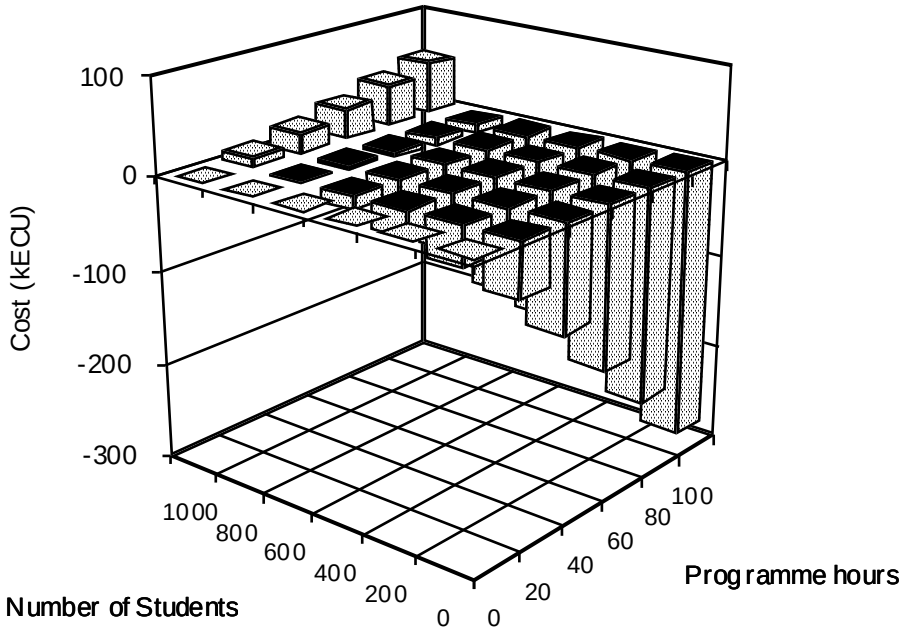
2.1.3 Cost Comparison between Satellite Broadcast and Videocassette mailing

The previous section showed that the provider's cost is the key area when comparing the satellite and videocassette delivery. The cost of producing a programme will be the same regardless of the delivery method, and can therefore be eliminated from the comparison. The cost borne by students can be similarly eliminated. It should be remembered, however, that the cost to students is less in the case of videocassette mailing because there is no need for satellite receiving equipment.

The method of determining the break-even cost is as follows. The cost of delivering x hours of programme to y students is calculated for satellite broadcast and videocassette mailing. If the two values are the same, the difference between them will be zero. To extend this concept, if the cost of videocassette mailing is subtracted from the corresponding cost of satellite broadcast, then a positive value would indicate that video is the more expensive option. Conversely, a negative value would indicate that satellite broadcast is more expensive.

The key to understanding diagrams like the one below is to identify the zero plane; look at the vertical scale (left of the chart) and find the zero value. The zero plane is the grid that touches the zero mark. The height of a pillar indicates the cost difference between the two delivery methods. If a pillar extends upwards, videocassette mailing is more expensive than satellite broadcast. If the cost is identical for both methods, the difference will be zero; you can see six such pillars of zero height along the row, corresponding to zero programme hours.

The immediate conclusion one can draw from the diagram is that, given a satellite uplink cost of 2825 euro/hour, videocassette mailing is *more expensive* for a student population of between 800 and 1000. This is shown by the mass of pillars pointing downwards with their black ends visible. Satellite broadcasting should be ruled out as too expensive for all but high-population courses. These calculations, however, are based on an uplink cost of 2825 euro per hour which is the current 'commercial' rate (around £2000).



Cost of Delivery by (Videocassette mailing – Satellite broadcast). Points which extend above the zero plane are where videocassette mailing is more expensive. Points below the zero plane – with black ends – indicate that satellite broadcast is more expensive. Satellite Uplink cost: 2825 euro/hour

If a lower rate were available, it might change the whole picture. To get a deeper insight into the problem it is expedient to turn the question round: 'how cheap would the satellite uplink have to be for it to be cheaper that videocassette delivery?' A little arithmetical manipulation shows that the break-even cost is independent of the number of programme hours and is related solely to the student population (all other parameters remaining constant).

The next chart shows the required cost of the satellite uplink as a function of the student population. The line represents the cost of a satellite uplink when it equals the cost of delivering the course material by videocassette. For example, if the student population were exactly 800, then the cost of the satellite link would have to be 2712 euro/hour for delivery by satellite to equal the cost of delivery by videocassette. Looking closely at the chart, it will be seen that a small population course of 120 students could be delivered cost-effectively by satellite if satellite costs were under 400 euro/hour; this level of cost is not unheard of, especially at off-peak times.

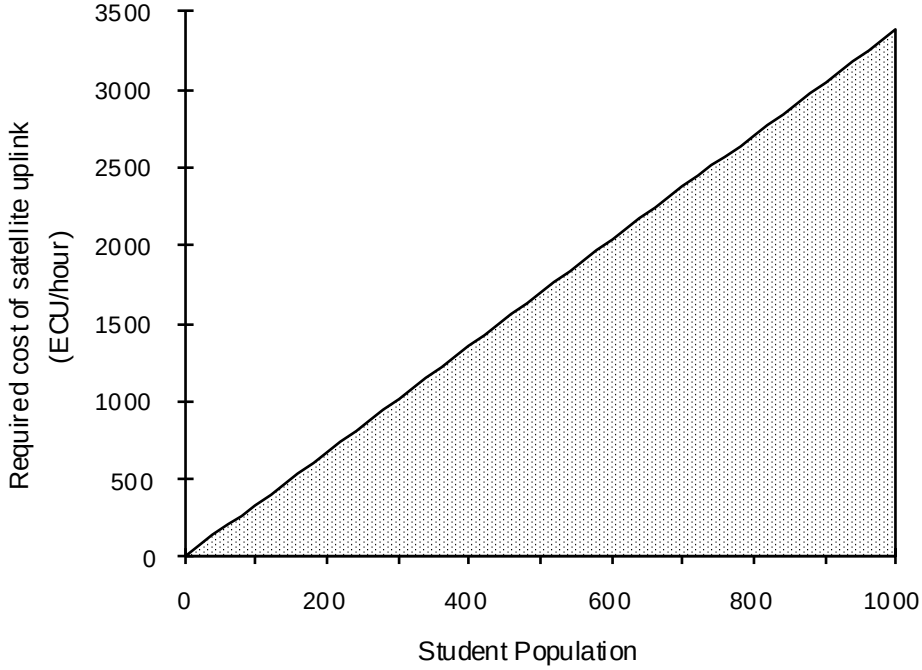


Chart showing Required Cost of satellite uplink for it to equal the cost of videocassette delivery. If, for a given student population, the cost falls into the shaded region, satellite delivery is cheaper

2.1.4 Discussion

The previous section leaves one with the impression that the prospect of satellite broadcasting *en masse* for distance learning should be considered seriously. This prospect should first be tempered with a discussion of the key factors.

It has been assumed that the cost of students' equipment at home has no bearing on either the cost of producing or providing the distance learning material. This may or may not be a legitimate assumption, but the fact is that students will have to equip themselves with a television, video recorder and satellite receiver. Disadvantaged students – those on low incomes – may not be able to afford the equipment and will therefore be barred from these forms of distance learning. This is an important issue, but one that is best resolved by politicians and eurocrats.

Proceeding with the assumption that students have the necessary equipment, many interesting possibilities emerge. The low cost of the uplink t– so important to the viability of satellite broadcasting in distance learning – is within reach. To get such a low tariff, programmes would be broadcast at the most unpopular, hence cheapest, time of the day (and night) and recorded on the students videorecorder. Many satellite receivers available today that have built-in encryption and subscription systems that automatically activate the video recorder at the correct moment. Operationally, there are many benefits to be enjoyed.

Satellite broadcasts can be used for the dissemination of 'fresh', up to date information. Producers of distance learning material could make programmes based on recent events, such as a marine accident involving oil spillage, to convey special

teaching points in the course. Of course there will be many courses, too, where this immediacy is not at all necessary.

Where the material is not time-critical, it might make better sense to deliver using videocassette mailing. The postage cost used in the calculation is for a three-hour videocassette in its packaging, posted first class from the UK. With a very large student population (i.e. tonnes of mail per week) this rate would be reduced through some kind of bulk postal tariff agreement. There is the problem of poor postal services in some EC countries; would the course material arrive in time for the assignments?

2.2 Scenario Two – Computer mediated communication

2.2.1 Pedagogical Basis of Scenario

This analysis is based on the premise that a conventional university in the United Kingdom proposes to expand student enrolment by offering some courses through distance education. It is envisaged that seminars/tutorials would be conducted through computer conferencing, rather than on campus. The distance courses will have a substantial print component comprising set texts and selected readings; however as this provision would be common to both on-campus and computer-conferencing seminars, it is omitted from the analysis.

2.2.2 Assumptions

The analysis is focused on the comparative cost of providing a variable number of seminars each year, to a variable number of students, either through computer conferencing, or in the conventional face-to-face manner at a local study centre. Costs are compared on the following assumptions:

(a) Course Teaching:

It is assumed that one tutor will be allocated to twenty students for both the conventional and computer conferencing seminars. The conventional seminars are assumed to take place in local study centres while students participate in computer conferences from their own homes.

(b) Student costs:

The important cost-related advantage of computer conferencing to students is the removal of the necessity to travel to study centres. The direct cost of travel to and from local study centres for conventional seminars is therefore included in the student cost. The opportunity cost of the time students spend travelling to centres for conventional seminars is also included (except where stated otherwise).

To participate in computer conferences, students require access to a microcomputer, modem and phone at home. However, it is to expected that some students will already own, or have access, to phones and microcomputers, and so a capital cost in respect of some students only is included in the estimates. The current ownership of suitable personal computers is estimated to be 22%, and current phone ownership is estimated to be 85%. It is assumed therefore that 78% of students will have to purchase their own computer, while 15% will have to install a telephone. It is assumed that all students will have to purchase a modem. The type of

microcomputer required is assumed to be of modest specification. It is also assumed that students will purchase a modem which is Hayes compatible, with a capacity of 2,400 bit/sec.

Students will be required to pay telematic call charges to connect with the computer mediated conferencing (CMC) system. The connection will use one of two methods: (a) direct telephone call over the public switched telephone network (PSTN), or (b) by making a call to the local public data network (PDN) access point and thence to the computer system. Call charges differ depending on whether the computer conference host is accessed via the PSTN or the PDN. Whether students use the PSTN or PDN for access depends on what the host institution provides.

It has been assumed that for a CMC population of 100 students or fewer, the institution will offer dial-up access through the PSTN. For a CMC population of more than 100 students, access will be through the PDN, and these generally have virtually 100% local rate coverage. These tariff assumptions have been built into the students' costs, using weighted averages as described in the Annex on cost assumptions.

(c) Institutional costs:

The primary institutional cost is the operation of the computer conferencing host computer system. Technical constraints arise when considering the choice of host computer hardware. This study assumes the use of three alternative computer systems, details of which are given in the Annex. For a small CMC population, it is sufficient to use a modest personal computer with a single modem and exchange line. The move from single user to multi-user is the biggest increment in cost and for the purposes of this report the following break points have been drawn up. The rather low user:modem ratio of 20:1 has been used; in practice much higher ratios can be used. The costs to the institution for CMC equipment and network charges are shown in the chart in Section 2.2.6. Note that the producer cost is zero and that the cost to students has been omitted so as to portray the institution costs in greater detail.

The cost to the institution of providing a conventional seminar includes the tutor's salary and tutor's travelling costs. A tutor has to be provided for the computer conference seminars. It has been assumed that the tutor:student ratio is 1:20 in both cases.

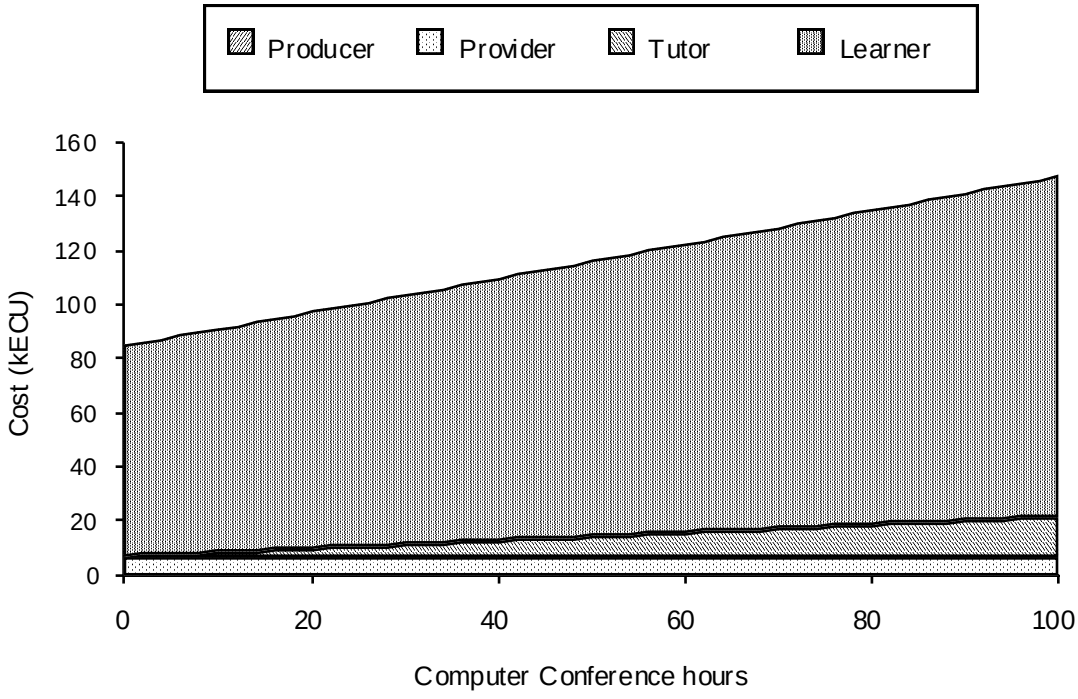
2.2.3 Cost of Computer Conferencing

The chart below shows the cost of providing a computer conferencing facility for 100 students, as a function of the number of hours. The cost to students covers the cost of the workstation, modem and telephone line, weighted by relative presence in domestic homes. The cost of the telephone call to the computer conferencing system has also been included, and this is the only time-dependent factor. No allowance has been made for depreciation or maintenance, since this is most likely to be the case in students' homes.

The cost apportioned to the tutor is the hourly rate multiplied by the number of contact hours allocated to her/his study group. The size of the computer conference

sub-group has been set equal to that of the conventional seminar, in the interest of simplicity and the absence of any better strategy. No travel costs apply to the tutor, or rather moderator, and no provision has been made for accommodation.

The other institutional cost is that of the computing facility, and this has been outlined above.

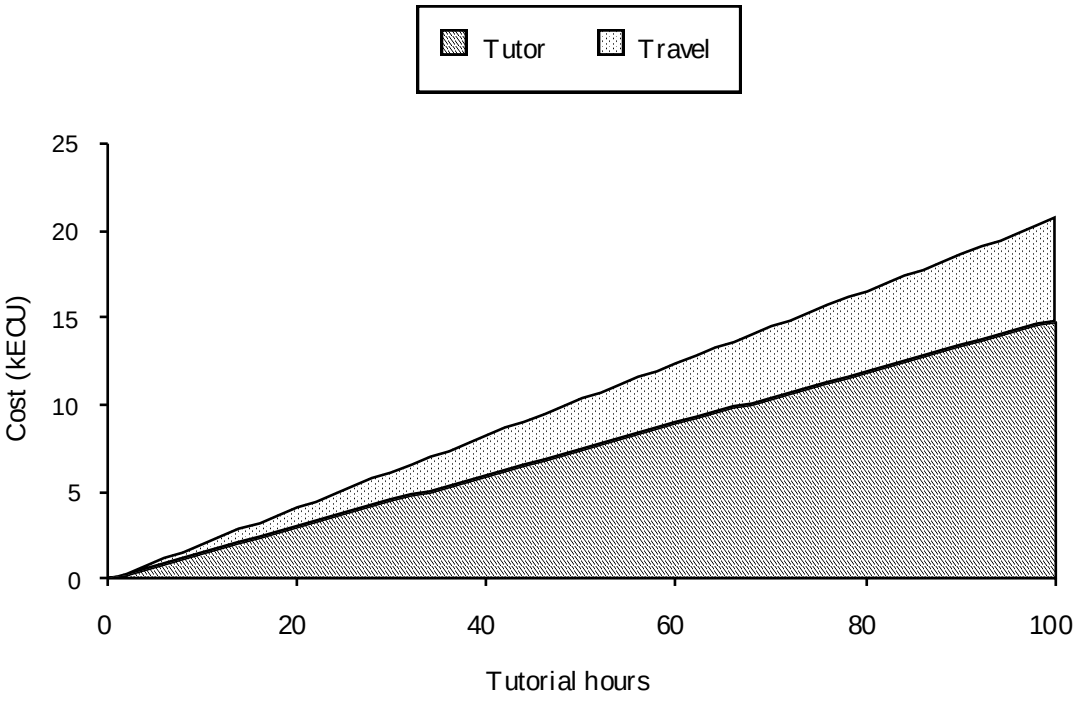


The cost of computer conferencing for 100 students

A few observations on this chart. The major cost goes to the 100 students who have to pay for their equipment and their telephone calls. The tutors' costs are relatively small and increase with increasing conference hours. The provider cost, that of purchasing the central computing equipment is constant; the costs have been spread over five years and annual maintenance. has been included.

2.2.4 Cost of Seminars

This analysis considers only the costs that the institution will pay the tutors. These are the hourly rate for contact time and the cost of travelling to the remote location. No allowance is made for the cost of accommodation, heating, lighting, etc. There are 100 students in the analysis and with the tutor student ratio of 1:20, this indicates that five tutors will be needed. The distance between the tutor's place of work and remote study centre has been set at 50km.



Cost of providing seminars for 100 students, assuming a tutor:student ratio of 1:20 and 50km between study centre and main institution

The chart shows that, for the values selected, the cost of travel is a significant proportion of the institution's cost.

2.2.5 Cost Comparison between Face to Face seminars and Computer Conferencing

The factor that is common to both these cost models is the amount paid to tutors. Whether or not the two media should enjoy the same tutor:student ratio is outside the scope of this comparison for the moment. The other cost that institutions will have to pay are the *computer installation* (amortised over five years) and the cost of *tutors' travel*. Between these two factors lies the battle line, but quite who turns out to be the victor depends on many assumptions. A straight trade-off between the two factors suggests that, since the amortised cost of the computer installation is about 7 keuro, then the break-even point occurs when the cost of travel equals this amount (around 150 hours).

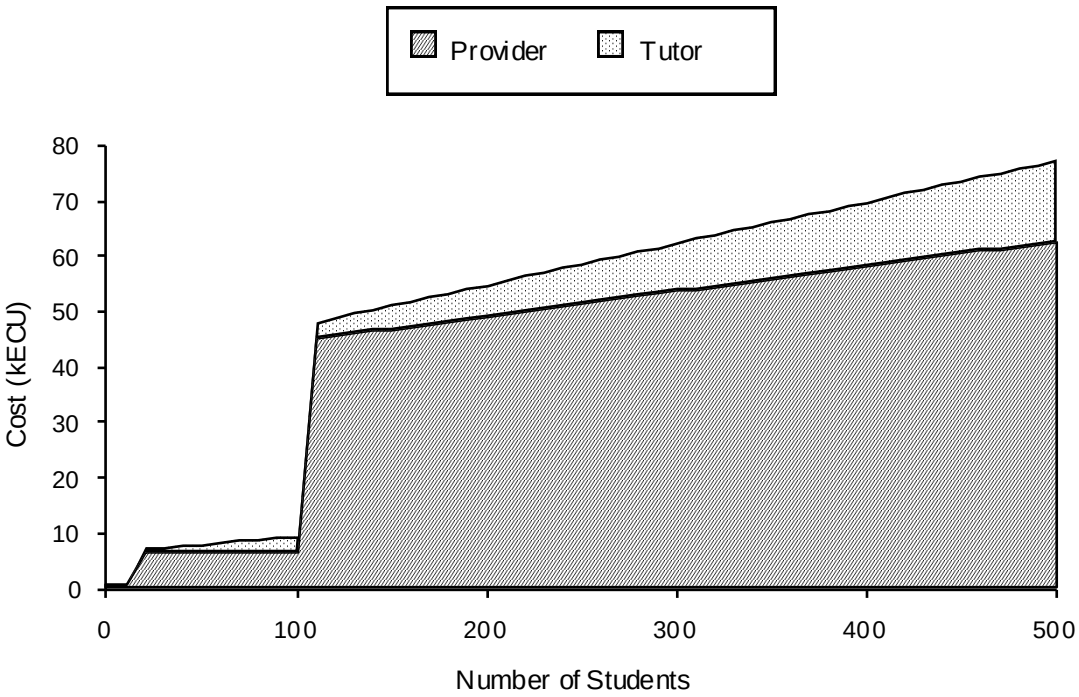
It takes only one small change to the assumptions to turn the conclusions the other way. For instance, what if the amortisation period were three years or the mileage allowance were 10% larger? The problem is that there are no dominant cost component and each on its own can only be described as 'marginal'. The conclusions would be quite different if there were some dominant cost, such as the cost of a satellite uplink in the first scenario.

2.2.6 Discussion

It is, perhaps, misguided to pursue the comparison between computer conferencing on a purely financial analysis. Both media have their qualities, purposes, advantages

and drawbacks. The opening section of this deliverable touched on this very issue by making reference to hole-in-the-wall cash machines: why do some people, for certain interactions, prefer to use passive technology rather than interface with another person? Both media have strong advocates and clear benefits over the other in particular contexts. Computer conferencing permits time shift and distance shift; seminars do not. Computer conferencing can be effective over a large range of student population. Seminars have a special human quality and sense of occasion that no computer conference can ever have.

Of more interest to this discussion is the allocation of the costs. In practice, no institution would set up a computer conference system from scratch. If the course population was small enough, capacity would be found on some departmental machine or a computer bureau. If the population was significantly large, one would wonder how the course grew to such a size with no bureaucratic infrastructure – including a large computer – to support it.



Institution cost for providing computer mediated communication

The cost to the student is an issue that has already been aired in this report. The student will need to purchase, on average, around 780 euro on equipment. This represents a financial barrier that disadvantaged students may not be able to surmount, adding further to their disadvantage.

In summary, the analysis has shown that the institutional cost of computer conferencing compared to conventional seminars is of the same order of magnitude. When producing a distance learning course, the decision between one or the other should be on the basis of pedagogical consideration, not cost.

2.3 Scenario Three – Video Conferencing

2.3.1 Pedagogical Basis of Scenario

Through the medium of videoconferencing, a lecturer at one site can communicate directly with a group of students located at another site. Students in turn can interact with the lecturer as if they were present in the same room as the lecturer. A typical example of the potential use of videoconferencing would be where a university incorporates a number of separate campuses, or where an educational institution wishes to extend its offering of courses to students located at other institutions some distance away, without incurring the cost of teachers travel to remote centres.

The advantages of videoconferencing include extended choice of courses on remote sites; access to courses for students located in remote areas; provision of a better view of material such as live surgical operations, or lectures with a high visual content. There are however some disadvantages which include: psychological barriers to active participation by students, in spite of the technical capability for communication; the possibility of technical faults in the equipment; and the sense of reduced intimacy in the teaching/learning environment.

This scenario envisages a conventional university which has a 'satellite' college at which it wishes to present a range of its courses. It is proposed to set up a videoconferencing suite at the main campus, and at the satellite college, and to establish a communication link between the two.

2.3.2 Assumptions

The analysis compares the cost of providing a lecture presented as in a conventional university, to that of presenting the same lecture to students at a remote institution through the medium of videoconferencing. On the conventional model the main cost difference which arises is the additional direct expenditure on travel, and the opportunity cost of the time a lecturer spends in travelling from the home campus, to the remote site. On the other hand, the adoption of videoconferencing incurs additional costs in respect of equipment and telecommunications charges.

The analysis is based on the following assumptions:

(a) Course Teaching:

Class size is assumed to be ten students at the remote site, and that the extension of the lecture to the remote students has no implications for class size at the host institution.

(b) Student Costs:

Student costs are assumed to be the same in both situations, whether they attend a conventional lecture, or participate in a videoconference lecture at the remote site. For this reason, no student costs are included.

(c) Lecturer Costs:

For the purpose of this analysis, it is assumed that the Institution providing the lecture is 50 km from the remote institution; that both institutions are 2.5 km from

the local PDN exchange; and there is no alternative use of the videoconference facility. The costs incurred in respect of the lecturer's time in delivering the lecture is assumed to be the same in both situations; however the time involved in travelling between sites, and the direct cost of travel, is taken to relate only to the lectures delivered in a conventional manner at the remote site.

(d) Hardware:

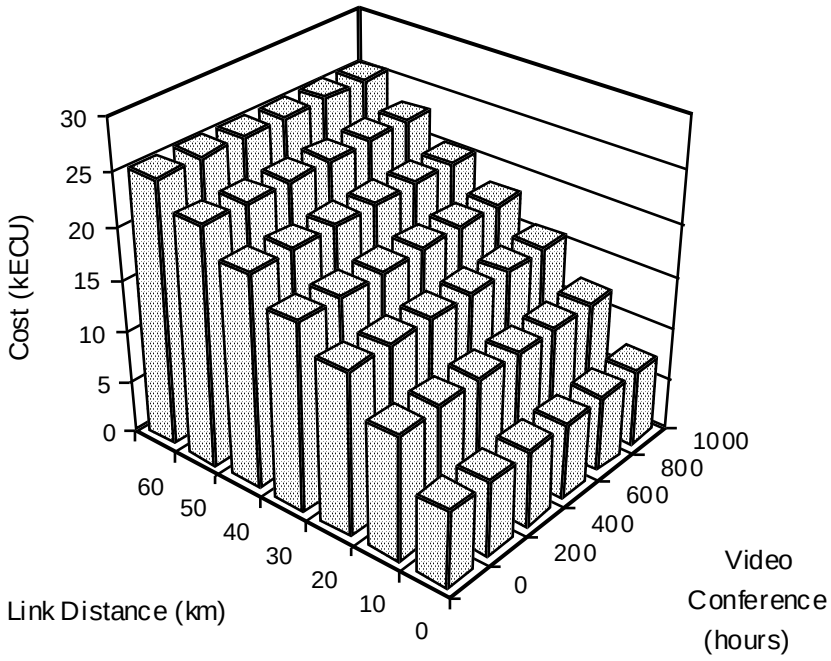
The videoconferencing facility comprises a stand-alone unit with camera and microphones, and can operate using either a 2 Mbit/sec circuits or two ISDN exchange lines giving 128 kbit/sec. All capital expenditure on equipment has been converted to an annual fixed cost amortised over five years. Maintenance has been included at 10% of the purchase cost per annum.

(e) Transmission Costs:

The link costs are made up of installation fees, annual rentals and a usage-related charge. Full details of these costs are given in the Annex, based on current prices offered by British Telecom.

Before considering the comparative cost of a face-to-face lecture and a videoconference, the analysis will look at the relative costs of 2 Mbit/sec and 128 kbit/sec circuits. This is because the main analysis can be simplified by eliminating 2 Mbit/sec links from the scenario at the outset. There have been many significant improvements in the field of video compression in the last year or so with the result that 128 kbit/sec compressed video is now quite acceptable for videoconferencing. Pundits are saying that 2 Mbit/sec compressed video is good, but the cost involved and inflexibility of fixed (as opposed to switched) links is now too much of a penalty to pay.

2.3.3 2 Mbit/sec cost

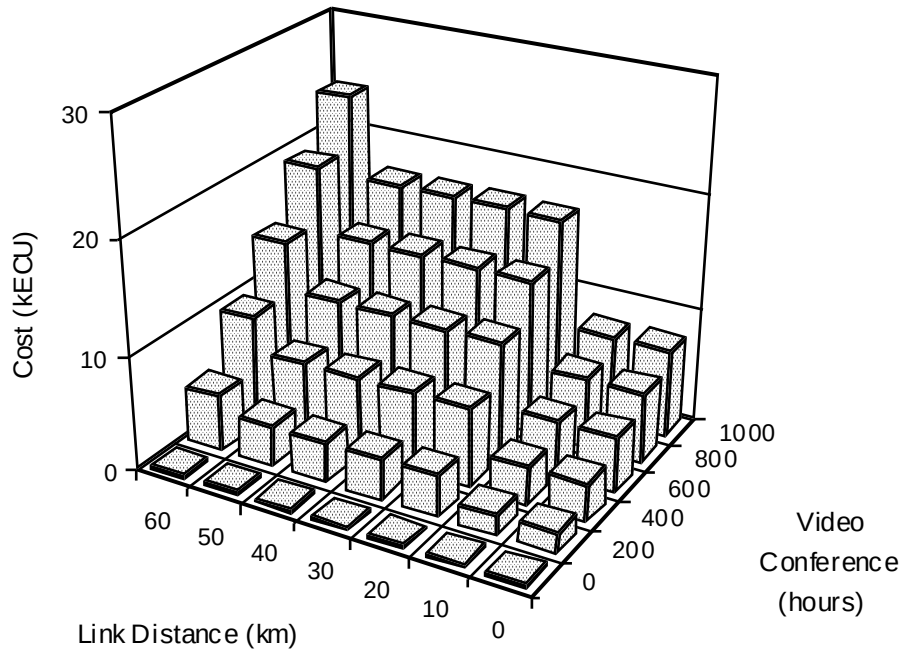


Cost of installation and use of a 2 Mbit/sec fixed link

The chart above shows the cost of installing and using a 2 Mbit/sec link. The tariff structure is complex (see Annex). There are fees for the link segments between each site and their local telephone exchanges, and also the trunk segment, and an annual rental consisting of a fixed payment and a fee related to the length of the trunk segment. It is instructive to spend a moment or two perusing this chart.

The cost of installing the 2 Mbit/sec fixed link is distance independent. Spread over five years, it amounts to 7.4 keuro and this is portrayed by the vertical pillar in the foreground which corresponds to a link distance of zero. There is no time-related charge for the link, and this can be observed by looking along the axis labelled *video conference (hours)*; the height of the pillars remains the same, regardless of the number of hours. There is, however a significant distance-related component. Look at any row of pillars parallel to the *Link Distance (km)* axis, and the height increases as the link distance increases. It can be seen that cost, spread over five years, for a 60 km link is 25 keuro.

2.3.4 128 kbit/sec (2 x ISDN B-Channel) costs



Cost of installing and using a 128 kbit/sec link made up of two ISDN lines

The tariff structure of ISDN circuits provided by British Telecom is identical to conventional telephone lines, although the installation fees are slightly lower. The installation cost can be seen in this chart as the flat pillar closest to you at the grid square corresponding to a link distance and video conference elapsed time of zero; the value, spread over five years is 0.4 keuro.

The usage rate is a function of the duration of the calls and the distance over which they are made. The distance-related component is stepped, corresponding to local, district and trunk calls. Looking at any row of pillars parallel to the *Link Distance* axis, you will see that there is an abrupt increase at 20 km and 60 km. The time-related component of the tariff is directly proportional to the duration of the call and the prevailing rate for the standard period has been used in these calculations.

2.3.5 Comparison between 2 Mbit/sec and 128 kbit/sec links

The last two sections have described the cost of the operating the 2 Mbit/sec and 128 kbit/sec links. The detailed spreadsheets that were used to produce these charts show that the 128 kbit/sec is cheaper than 2 Mbit/sec under all circumstances, with only one exception – at zero link distance and 1000 hours of video conferencing.

High speed links using 2 Mbit/sec circuits produce high quality video images with none of the jerkiness associated with the 128 kbit/sec circuits. The latter has a complex compression algorithm that seeks to minimize the amount of data that has to be transmitted and the penalty for this is that fast moving images tend to smear or to jerk. The smearing effect gradually wears away over an interval of several seconds and this process of refining the detail can be disconcerting at first. In practice, people who have used the 128 kbit/sec system accommodate to this

imperfect imaging very quickly and after a few minutes the effect is not noticed. In summary, the 128 kbit/sec system would appear to be adequate for the purpose of distance learning.

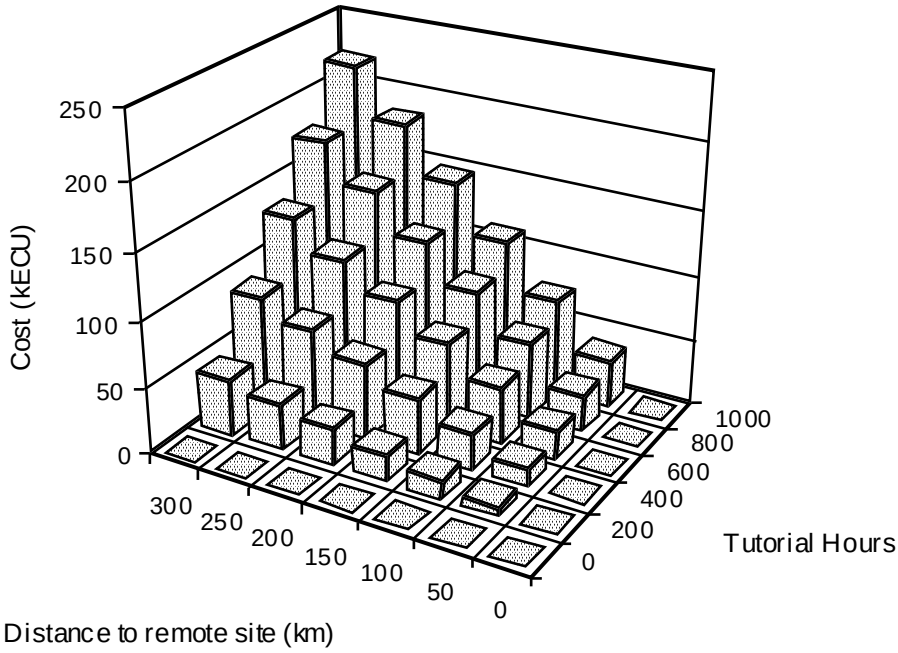
The 2 Mbit/sec circuits are fixed. Special co-axial cable has to be installed between the sites and their local telephone exchanges and this is expensive. The rental is related to the length of the trunk segment and there is no upper limit to the cost incurred this way. Once installed, the circuit is available 24 hours per day but the tariff structure holds no concessions for periods when it is idle.

ISDN circuits have none of the disadvantages that beset 2 Mbit/sec circuits. Installation is trivial, no more complicated that installing a conventional telephone line; no special cables have to laid to the local telephone exchanges. ISDN is a switched service, so it is practical to have a number of videoconference sites across the country or even the EC, all of which can participate in a two-way conference. In fact, it is possible to have several sites participating in a conference by using a multipoint bridge and dedicated codecs. An important observation is that the cost of using ISDN circuits within a country is *independent of distance* once the distance between sites has entered the trunk call charge band; compare this with 2 Mbit/sec, where the cost rises remorselessly with distance. The ISDN service is available 24 hours per day, but the tariff structure is related to the number of hours of use, just like the telephone service.

In summary, the way forward must surely be to advocate ISDN circuits for videoconferencing in preference to 2 Mbit/sec links, where flexibility and low cost are the dominant forces. 128 kbit/sec videoconferencing technology is mature and it works. Further improvements to the picture quality are in the pipeline, using exotic techniques such as real-time fractal compression.

2.3.6 Comparison between videoconferencing and face to face tutorials

The foregoing having effectively eliminated 2 Mbit/sec from the discussion, the time has come to compare the cost of face-to-face tutorials with videoconferencing using ISDN. The question to be addressed is whether the cost of a tutor travelling to a tutorial at a remote location is comparable to the cost of having a videoconference. To simplify the analysis, one can eliminate the cost of the tutor's time in preparing and delivering the tutorial; it will be identical in both cases. Further, it will be assumed that the number of students tutored will the same in both cases, although it is perfectly feasible to extend the lecture theatre to include remote sites and hence the number of participants.



Cost of tutors travelling to remote sites to give tutorials. This is the sum of the travelling expenses and the tutors' time spent travelling

The chart has the similar interpretation as the ones shown in the previous analyses. The height of each pillar represents the cost of tutors' travelling time and time spent travelling. It is important to include the tutors' time spent travelling because this is non-productive time which otherwise be spent in preparation, administration and teaching. It has been assumed that each tutor carries out two hours of tutoring when (s)he has arrived at the remote location.

The comparison with the cost of providing videoconference facilities using 128 kbit/sec ISDN links is made by calculating the corresponding costs for each co-ordinate of tutorial time and distance travelled, and subtracting it from the equivalent tutorial cost. If the resulting value is negative, it means that the cost of videoconferencing is greater than that of face-to-face tutorials, and this is shown on the chart below as a pillar with a black top. If the result is positive, the pillar will rise above the zero-plane and doesn't have a black top.

The comparison chart is shown below. In order to make the comparison as realistic as possible, the cost of the videoconference equipment and installation of two ISDN circuits has been included. When spread over five years, this amounts to a an annual payment of 19 keuro. The chart shows that videoconferencing is more expensive when a) it isn't used very much, and b) when the distance involved are small. Bearing in mind the 'distance independence' of ISDN links once the link distance falls to the trunk call charge band, it will be seen that above 200 km distance and 200 hours tutorial per annum, videoconferencing is actually *cheaper* than face-to-face tutorials. In general, the situations where the cost disadvantages of videoconferencing can be reduced include:

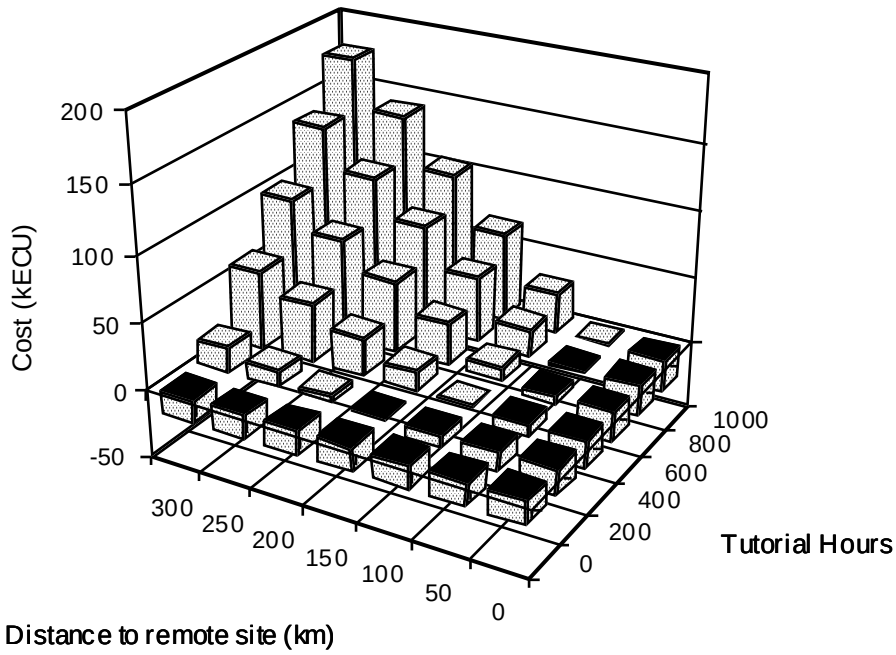
(a) Where there is a high usage of facilities per year

(b) The lecturer is unavailable to travel to the remote site and his/her expertise is in limited supply.

(c) The facility is used for additional teaching and administrative functions.

(d) The distance between the sites is substantial.

A factor that is more difficult to quantify if the effect that the videoconferencing facility will provide. Once members of the institution are familiar with videoconferences and realise they can depend upon it, it will be used for purposes other than tutorials, such as planning, administration, meetings, etc. The time formerly spent travelling can now be spent in productive work. The facility will affect the working practices of the institution as a whole, beyond the facility to provide tutorials at a distance.



Comparison of cost of (face-to-face tutorials – ISDN videoconference). The cost of the videoconference equipment and links (approx 19 keuro per year for five years) has been included

2.4 Scenario Four – Audiographics

2.4.1 Pedagogical Basis of Scenario

Many subjects on the curriculum require a visual or graphical component, and audiographics provides one of the few distance education delivery mechanisms for these subjects. Audiographics is a medium which combines voice communication and computer text or graphics. All audiographic systems combine multi-point audioconferencing with graphic displays. Some systems also offer animation and full colour pictures. Audiographics can be implemented in a range of configurations, with a variety of hardware platforms. They can be used over long distances, or over local phone bridges. Applications may include groups of up to five students working at one VGA screen, sharing a writing tablet, or audiographics used in

lecture mode with a large number of students viewing graphics on a projector, and using room microphones for audio feedback. Some systems allow as many as 32 computers to be linked on a single bridge, making this technology adaptable to large scale teaching. These systems are under continual development with constant changes to pricing structures.

This analysis compares the cost of delivering a seminar in a traditional face to face setting, with delivery through audiographics to local study centres.

2.4.2 Assumptions

The assumptions underlying the analysis are as follows:

(a) Course Teaching:

It is assumed that both the audiographics and conventional seminars have sixteen students, and that there are two students to each audiographics terminal.

(b) Student Costs:

The analysis of student opportunity and travel costs are based on a projected net additional distance which a student would have to travel to a provider institution, in the event of not having access to an audiographics facility in a local study centre. Except where otherwise stated, this distance is assumed to be 40 km one way.

(c) Institutional Costs

It is assumed that there will be one audiographics terminal in each of eight local study centres. Each study centre terminal will have the following equipment:

> Personal computer (486), graphics pad and pen, ISDN card, microphone and audio board, audiographics software and two ISDN B-Channels (2 x 64 kbit/sec)

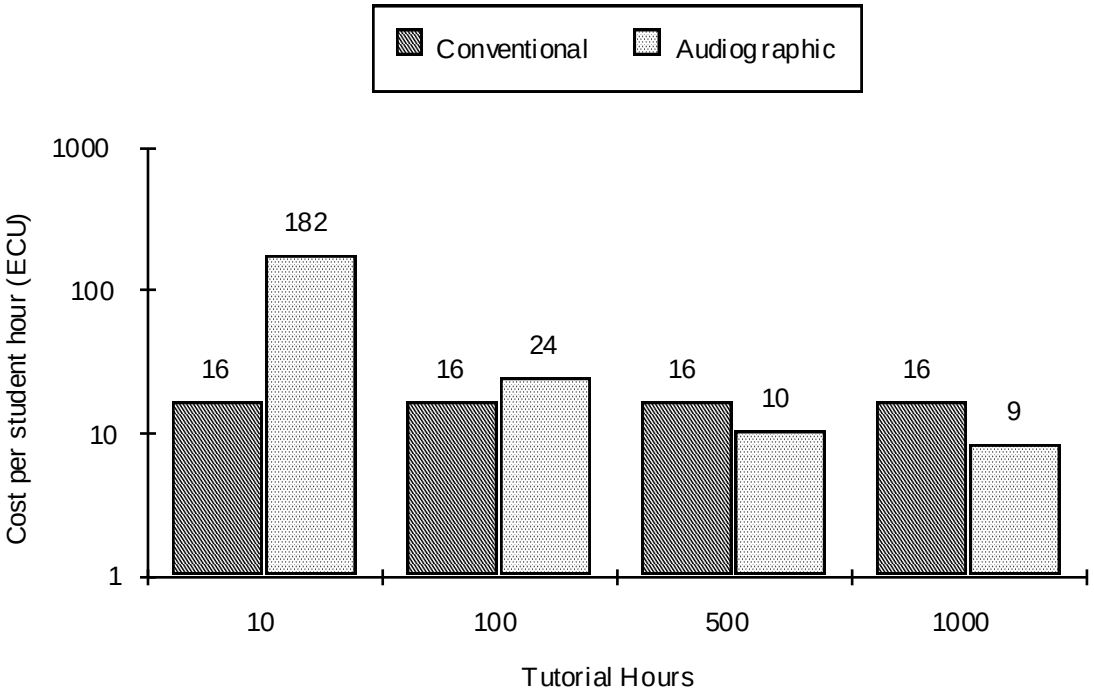
In addition the central node at the providing institution will have the following equipment:

> Digital audio multiplexer, headset, pre-amplifier and speakers, scanner, control audiographics software and an ISDN line

2.4.3 Cost Comparisons

The costs of delivering a seminar through conventional means is compared with delivering an audiographics seminar using the equipment and assumptions outlined above. The costs are compared over a range of seminar hours from 10 to 1000 hours.

The methodology is somewhat different to the foregoing analyses. This is because this scenario has many more variables and assumptions than Scenarios 1-3, making a 3-D representation difficult to devise and difficult to interpret.



Estimated average annual cost per student hour for a seminar through conventional education compared to audiographics

2.4.4 Discussion

As the chart shows, delivery of a seminar using audiographics is substantially more costly than using more conventional face to face methods, where seminar hours are few. Audiographics however has the potential to become more cost effective as the number of seminar hours per year increases.

Once again the specific results are dependent on the assumptions made. For example, an increase in the opportunity cost of students' time would favour audiographics over conventional seminars.

A further important consideration is the potential to cut down on direct travel costs, and opportunity costs, by arranging seminars so that students can attend for several hours on each trip. For example, the chart shows an average cost per student hour of 16 euro for the conventional seminar where the student attends one seminar per trip to the provider institution, this would reduce to 6.68 where on average students attend two hours seminar for each trip, and to 5.00 where they attend for three hours, once again based on the assumptions of this analysis.

Furthermore, changes in the average net distance (i.e., the difference between the student's distance from the local study centre and the provider's institution) have a marked impact on average costs for the conventional seminars. For example, the results indicate an average cost per student hour of 16 euro for the conventional seminar where the net difference is 40 km. This would reduce to 9 euro if the net difference in distance is 20 km and increase to 24 euro if the net difference is 60 km.

Audiographics systems are most cost effective in the following circumstances:

- Where the number of hours of usage per year is high

- Where net additional distances students must travel are high
- Where opportunity costs of students time are high
- Where students are unable to travel to the providing institution
- Where courses are delivered by specialists in high demand subjects, who are difficult to access through normal educational structures.

2.5 Scenario Five – Resource Centre

2.5.1 Pedagogical Basis of Scenario

The essential concept behind this scenario is the provision of a network of resource centres to provide local access for students to a wide selection of courses. This scenario envisages that universities engaged in distance teaching, acting individually or as part of a consortium, would provide their courses through a network of Euro study centres throughout Europe. Through the local study centres, students would have access to course materials such as printed texts, audio and video tapes, CAL programs, resource packs, bibliographic and other databases. It is envisaged that course materials could be assessed in hard copy, computer or on-line format, as appropriate. Local resource centres could operate at a number of levels:

1 At the most basic level, students could have access to information on the range of courses available; could register for courses; view videos and listen to audio tapes; could have access to at least some hard copies of course materials and to computer courseware; and receive satellite broadcasts.

2 At the standard level, in addition to the facilities outlined above, students could have access to a range of on-line learning resources, including bibliographic databases and picture stores; could participate in tutorials through audiographics, and in live satellite broadcasts (through audio links); and could interact with their tutors and fellow students through computer conferencing.

*3 Students in advanced resource study centres, in addition to the facilities outlined above, could create their own individualised courses, by drawing on an eclectic range of source materials, supported where appropriate by a course facilitator; and could additionally participate in remote lectures and tutorials through videoconferencing.

2.5.2 General Assumptions

The resource centres scenario is essentially futuristic, and there is therefore relatively little experience to guide projections of future levels of demand for, or use of, their potential services, nor is there a conventional system with which resource study centres could be closely compared. For these reasons, data was collected on the cost of equipping these resource centres at each of the three levels. The purpose is to provide an approximate assessment of the infrastructural costs required to support the facilities and services outlined above. In the absence of more extensive and reliable data, no attempt has been made at this time to provide estimates of accommodation costs, construction and renovation costs, rents, furniture, lighting, heating and other related services, operational costs, staff salaries and enrolments,

courseware acquisition costs, copyright clearance charges, institutional fees, telecommunications charges, and the like.

The estimates are based on equipment costs collected from a wide range of commercial and other sources in Ireland. In a few cases where equipment or service estimates were unavailable (e.g. ISDN charges) UK data was used instead, and converted to equivalent Irish prices. It became evident in the course of collecting data that the prices of some critical components of equipment and telecommunications charges, vary from one European country to another; it is important that this potential variation be kept in mind in interpreting the estimates. In summary therefore, having regard to the visionary character of the resource centres scenario, the estimates should be seen as essentially indicative of the difference of the cost of equipping these centres between the three levels, rather than as definitive estimates.

2.5.3 Hardware Assumptions

The hardware required at each type of study centre is detailed below.

(a) Basic Study Centre

Audio	2 Ordinary Telephones 1 Loudspeaker Telephone 1 FAX Machine 1 Tape Deck
Video	2 Televisions 1 VHS Video Recorder 1 Domestic Satellite Dish
Computer	1 PC (386, VGA, 4/40) 1 Modem 1 CD-ROM

(b) Standard Study Centre

Audio	9 Ordinary Telephones 1 Loudspeaker Telephone 1 FAX Machine 3 Tape Decks
Video	3 Televisions 3 Televisions (37”) 3 VHS Video Recorders 1 Centre Satellite Dish (150cm)
Computer	16 PCs (386, VGA, 4/40) 3 Laser Printers 8 Modems 8 CD-ROMs 8 ISDN Lines 8 ISDN Cards

1 LAN
8 Audio Cards

(c) Advanced Study Centre

Audio	11 Ordinary Telephones 1 Audioconferencing Suite 1 FAX Machine 6 Tape Decks
Video	6 Televisions 1 Television (37") 6 VHS Video Recorders 1 Centre Satellite Dish (150cm) 1 Video-conferencing Suite 2 ISDN Lines
Computer	20 PCs (386, VGA, 4/40) 5 Laser Printers 10 CD-ROMs 10 ISDN Lines 10 ISDN Cards 10 Audio cards 1 X.25 Link 1 LAN 1 LAN Bridge

2.5.4 Estimates

The estimated costs of equipment for the resource centres at each of three levels are shown below.

Technology	Basic	Standard	Advanced
Audio	2	3	10
Video	2	10	109
Computer	4	68	86
Total	8	81	206

Estimated cost of Equipment for resource centres (keuro)

2.5.5 Discussion

The resource centres scenario represents an innovative approach to widening student access through the use of telematic infrastructures, and as a consequence expanding the range of opportunities for students to participate in open and distance learning courses throughout Europe. The cost estimates for the resource centres each of the three levels are restricted to the cost of equipment and hardware. As the table shows the cost of equipping the basic centre is relatively modest, while the advanced centre would require relatively substantial funding.

A comprehensive cost analysis would require considerably more information on their functions and institutional structure and on the precise suite of services which the centre would provide. Projection of resource requirements would additionally need an indication of the extent of the network, and at least tentative indications of potential demand for services and related fees.

3 Validation by Surveys

Two surveys were carried out:

1 An extensive postal survey.

2 A limited but useful number of telephone interviews.

3.1 Postal Survey

This section summarises the findings to date from responses to a questionnaire sent out in July 1992. The analysis presents the information in statistical form with commentary where appropriate. The number of responses was relatively small but this does not diminish the usefulness of the findings.

3.1.1 Questionnaire

The questionnaire was the product of much discussion by CCAM partners, the result of which was a short questionnaire on a two-sided sheet. It was expected that by making the questionnaire short and easy to answer, more recipients would be encouraged to answer than if they were presented with anything larger. The questions covered:

- Current or planned Distance Learning
- Number of students, staff and study centres
- Use of media
- Presentation of courses in other countries
- Working language and acceptable other languages
- 'Open' questions, where respondents could comment on their plans for the future in the development of Distance Learning and the use of telematics.

3.1.2 Analysis method

The design of the questionnaire made it relatively straightforward to analyse. The analysis was carried out on an Apple Macintosh computer using the database application Filemaker Pro. This is a general purpose database programme that makes full use of the Mac's interface. Summaries and text searches can be carried out with relative ease and it is a simple matter to 'count up ticks' in response boxes. Customised forms were designed to facilitate data entry and verification. The questionnaire is shown at the end of this chapter and the number of responses to each question shown in the relevant boxes.

An aspect of the questionnaire that has been made apparent by the analysis is the number of data fields used. There are nineteen 'tick' fields, where the respondent has the opportunity to select from a choice. Simple arithmetic shows that there are over 500,000 combinations of these fields, and a correlated analysis of even a small fraction of these would be time consuming and of little value. No discernible correlation appears to exist between, for example, the student population and the type of media used. Such correlations that have been made, such as the number of respondents who are not offering Distance Learning currently but which have plans to do so, are useful for they give an indication of the current state of development.

3.1.3 Mailing list

The strategy for the mailing list was to make it as large as possible. All autonomous degree-awarding institutions within the EC were included, together with institutions that might possibly have some interest in Distance Learning. It was expected that a fair proportion of addresses would yield no response, but since the marginal cost of sending out a questionnaire was small there was little to be lost by including as many addresses as possible. In addition, contact addresses from the JANUS project, EADTU and general internal address lists were used.

The mailing list contains 764 contacts, and of these there are certain identifiable groups that gave a particularly poor responses. 47 Fachhochschules were mailed, but only one response received. 33 Hochschules on the mailing also resulted in only one response.

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3.1.4 Responses Analysed by Country

The table below shows the countries to which the responses were sent, and from which replies were received. The analysis picks out the institutions are universities and shows the number which indicated that they currently offer Distance Learning or have plans to. The number of responses is around 15%, and this is partly due to the nature of the mailing list. (A response rate of 1% would please most perpetrators of 'blind' mailshots such as this one.)

Country	Questionnaires sent out		Responses			Universities offering or planning DL
	Total	Univ.	Total		Univ.	
Belgium	60	18	5	8%	3	2
Denmark	30	5	0	0%		
France	74	55	7	9%	5	2
Germany	185	54	11	6%	6	2
Greece	40	26	4	10%	2	2
Ireland	24	15	2	8%	1	1
Italy	55	49	2	4%	1	1
Luxembourg	6	2	2	33%	1	1
Netherlands	54	14	21	39%	5	1
Portugal	11	9	2	18%	1	
Spain	24	22	3	14%	1	3
UK	172	101	46	27%	20	38
Totals	*735*	*370*	*103*		*46*	*53*
Austria	1		0			
Finland	8	4	0			
Hungary	1	1	1		1	1
Iceland	1	1	0			
Norway	6	1	3			
Sweden	11	5	4		1	1
Switzerland	1		0			
Totals	*29*	*12*	*3*		*2*	*2*
Grand Total	*764*	*382*	*113*		*48*	*55*

Analysis of responses by country

Of the Universities on the mailing list, the response is around 12%; not very high. There is encouragement, however, in the number of institutions saying that they would like to have further discussions regarding telematics; 80 indicated an interest of which 68 represent good leads. This latter group were sent the follow-up questionnaire and may perhaps form a core of Euro study centres.

3.1.5 Language and Countries in which Courses will be Offered

The responses are taken from all 113 responses to questions 6, 9, and 10 of the questionnaire.

The first column of figures indicates, for each of the respondents in a particular country, the number of institutions delivering courses in other countries. The second column shows the working language for course delivery. The third column shows the number of institutions that offer their courses in a language other than the native language, and represents a ranking of second languages used in Distance Learning.

Country (language)	1. Courses offered in other countries	2. Language used for Distance Learning	3. Other languages for Distance Learning
Belgium	7		
Denmark	2		2
France	17	16	14
Germany	13	17	10
Greece	4	4	
Ireland	2	1	
Italy	8	4	3
Luxembourg	1		
Netherlands (Dutch)	7	16	
Portugal	4	1	3
Spain	10	7	5
UK (English)	12	68	18

There are 87 institutions offering courses in other countries, a statistic that implies that there is indeed a potential demand for the telematics network. It would be wrong to infer that English is necessarily the most important language for Distance Learning, since not all countries were well represented by the responses, and the largest response indeed came from the UK. Italy, for instance, produced only one response. The table does show, however, the diversity of second languages that would be most acceptable. On the basis of the responses shown above, English French and German appear to be the most frequently used languages for delivery.

3.1.6 Use of Media

Question 5 on the questionnaire suggested a number of media that were currently in use or planned to be used for Distance Learning. The results are taken from all those institutions that currently carry out Distance Learning activities, numbering 56. The responses were as follows:

Medium	Current use	Planned use
Printed Material	53	15
Computer aided learning	32	24
Face-to-face tuition	43	15
Computer conferencing	27	26
Pre-recorded video	31	22
Telephone contact	39	14
Data networks	17	23
Other	15	11

It is interesting to see that printed material is the most commonly found medium for delivery, but other media involving telematics and computing have a good representation. As mentioned previously, there is plenty of scope for carrying out correlations between the various media but it would be an enormous task to assimilate the findings. The following key correlations have been found for respondents who currently offer Distance Learning courses:

Current use of Media	
No use made of printed material	3
No face-to-face tuition	13
No use of telephone contact	17
No use of either face-to-face or telephone	9
Use of CAL, CMC or Data networks	44

It is interesting to note that only 23% provide courses where there is no face to face contact with students. 16% make no use of either telephone contact or face to face contact, implying that the courses have a relatively low degree of interaction. 78% of respondents use some form of computer-based medium, some combination of computer aided learning, computer conferencing or data networks and only 5% don't make use of printed material.

3.1.7 Developments in Education and Training

Question 8 asked 'What do you see as important to your organisation's education and training development'. This was an open question where respondents were invited to write a few sentences describing their outlook. A typical response was included in the question so as to guide respondents towards the kind of statement that was anticipated; it is no surprise, therefore, that 30 responded with a statement regarding the 'need to increase student numbers'.

The analysis of the responses falls into nine categories shown below.

a. Coverage

It is interesting to see the areas mentioned under this heading, for it provides evidence for extension of coverage area and the use of study centres. References were made to the following areas: more study centres (3), localization of courses, international delivery, exchange with foreign institutions, joint delivery, delivery of other institutions courses and improved delivery,

b. Flexibility

Fifteen respondents remarked that increasing flexibility for students was an important factor in the development of Distance Learning. Some areas were mentioned specifically: time (3), distance, access (7), modularity (1), provision, curriculum (2).

c. Learning Environment

A number of interesting comments were made regarding the learning environment, indicating that pedagogy is still at the forefront of respondent's minds. The developments referred to were: improve counselling and student support (6), independent learning (3). There were also one each of the following categories: project-based learning, resource-based learning and improved practical courses.

d. Student Profile

The was a large response to the area of increasing the student population (30), but this should be tempered by the fact that the sample response given on the questionnaire asked suggested this answer. The respondents also specified the following areas: attract full-time students, working people (2), part-time students and, more generally, to increase the diversity of the student profile.

e. Course Profile

The two most common responses in the area of course profile were to provide vocational training (3) and training for teachers and tutors (3), expand the course programme and provide updating courses for professionals.

f. Quality

An improvement in quality of courses was mentioned be fourteen respondents. There was a specific mention of improving the performance of students. It may be that the space allowed for the response should have been larger, but there was no reference to problems such as the drop-out rate; the dominant aim seemed to be the increase of student numbers.

g. Cost

A number of comments have been placed in this category for they all relate to cost in some way. By far the most prevalent response was the need to increase resourcing (4). Other respondents mentioned the benefit of economy of scale (2), increasing the tutor/student ratio and income/cost ratio. There was one institution that saw research into the economics of Distance Learning as an important contribution to the field.

h. Use of Media

There were twelve responses that fall into this category. Some cited a need for media in general and the need for diversification of media (4), others specifically mentioned telematics (3), multimedia workstations (2), satellite TV (2) and audioconferencing.

i. Marketing

Five of the responses specifically mentioned aspects of marketing: develop the market (2), perform market research, define the target audience and produce demand-lead courses.

j. Developments

Under this heading are a number of responses that relate in some way to developments. By far the most frequent topic was to develop the use of existing resources (10), followed by training and supporting existing staff and tutors. Other areas mentioned were: improve existing courses (2), adapt courses for the international market (4), develop multilingual courses. There were also references to improving course production, demonstrating the efficacy of Distance Learning and imparting a cultural change from teaching to learning.

3.1.8 Telematics

Question 11 asked 'How do you see telematic networks helping your organisation's development?'. The responses fall into seven broad categories shown below.

a. Type of Telematics

Under this category various types of telematic systems mentioned in the responses have been brought together. There are twenty responses and they have been shown in order of descending popularity. Email (5), access to databases (5), videoconferencing (3), satellite TV (2), computer conferencing (2), telemaintenance and 'distributed lecture theatre'. There was also a more general reference to the use of telematics to bring more variety to the media employed in Distance Learning.

b. Interaction

There were 23 responses which alluded to this category. The overwhelming reference was to the need to establish a direct link with students (11); in addition, this was qualified with the need to sustain contact with students in foreign countries (1) and the need to need to overcome students' sense of remoteness (1). Interactivity (3) carries the connotation of involving students more, rather than merely making contact with students; for this reason, it has received its own sub-

category. There was also mention of the need to form a network of tutors (4) and to make course presentation more flexible, both in time and location (2).

c. Geographical

Nine responses are included in this category. Two features emerged: widening access (6) and promoting access to rural areas (2).

d. Delivery

It is interesting to note the number of responses that referred to some aspect of delivery. Some see it as a means of delivery (16), others as a means of delivering course information to students (1), of retrieving course information from other institutions (1) and of providing up to date information (2).

e. Learning process

Seventeen responses were found under in this category. The network would be used for tutorial support (2), general support and for monitoring students' progress (4). There was one response each for particular student sectors: part-time students (1) and full-time students (1).

f. Course development

There were twelve responses in this category: share expertise with other institutions (4), share courses from other institutions (3), joint course development (2), exchange and discussion of material (2) and collaborative production (1).

g. Management

It would be mistaken to think that the telematic network would be used exclusively for course development and delivery. There were a number of responses that alluded to management: exchange of documentation (2), general management (4), contact with study centres (1) and enrolment of students (1).

3.1.9 Discussion

The questionnaire was designed to secure a response from a wide cross section of the European tertiary education sector. This has resulted in a broad consensus which gives a general direction for further studies to follow, but owing to the questionnaire's brevity, it is not possible to extract too much detail. There was, in effect, a trade-off between the number of responses and length (depth) of the responses that could be anticipated. The relative lack of technical bias in the responses leads one to presume that the driving force in these developments is not technology for its own sake, more one based on the needs of institutions.

There were 113 responses, which is a respectable number upon which to draw conclusions. An important by-product of the questionnaire have been a list of institutions interested in further discussion which, after some refinement and selection, amounts to around eighty contacts.

The most commonly used languages, both for native and foreign delivery, are English, French and German. There is certainly a potential market for a telematics network, since 87 institutions offer distance education in foreign countries. Printed

material is still a most commonly used medium, although 78% of respondents said that their courses make use of some form of computing or telematic network. There is evidence that many of the institutions offer counselling and support since only 16% state that they use neither telephone or face to face contact with students.

The diversity of responses to the open questions leads one to think of the questionnaire as a kind of pan-European brainstorm on distance education using telematics! All areas usually considered by the distance learning fraternity were represented: coverage, flexibility, learning environment, student profile, course profile, quality, cost, use of media and marketing. It is interesting to see the relative weight given to the various areas. It was pleasing, for instance, to find a preoccupation with quality issues and pedagogy. There is a groundswell of opinion supporting increased flexibility and an increase in the number of students and courses. The Euro study centre concept will give support to these endeavours.

The second open question related to the use of telematics in the organisation's development. It is gratifying to see that there was only one response which mentioned the 'distributed lecture theatre'; this is perhaps an indication that the respondents no longer think of telematics in terms of lecturing alone and that other uses are in the forefront of their minds. Computer mediated communication, videoconferencing and satellite TV were all mentioned, although the absence of a mention of audiographics is perhaps an indication that this is still relatively novel in distance learning circles. The most commonly occurring categories for the use of telematics were for improving interaction with students, for effecting course delivery, for course development and as an adjunct to the learning process.

3.2 Telephone Interviews

The results of fifteen in-depth telephone interviews of tertiary education institutions across Europe have provided strong confirmation of the relevance of our telematic scenarios. A number of common approaches to telematics emerged, which reflect common situations and programmes.

a. Franchising, Collaborations and Mergers

Almost all of the UK-based institutions were involved in franchising their courses either to local colleges or to institutions in other parts of Europe. Some had various forms of collaborative links with other institutions and some had undergone mergers, such that they were now 'multi-campus' sites. The two-way video conferencing scenario was of considerable interest to these institutions.

b. Student and Teacher Exchanges

International exchange programmes between traditional campus-based institutions was another common element. These usually existed at faculty, rather than institutional, level and often involved joint courses with credit transfer. Email and computer conferencing contact with the home institution was of interest as a means of supporting distance students and teachers.

c. Awareness of Telecommunication Strategies

Although none of the institutions contacted had current programmes using any of the proposed scenarios, all of them were aware of the potential of at least one of them for their own organisation. Those interviewed reported that there was talk amongst their colleagues of the various technologies, and a kind of 'watching brief' on how they were developing.

d. Involvement in R & D Projects

Interestingly, almost all the institutions contacted were involved in an EC-funded project in some area related to one or other of the scenarios. Again, these projects were faculty or centre based, rather than institutionally based. Any telematics projects currently running in institutions tended to be in the areas of adult and continuing education.

e. Need for Interaction

One of the central elements in the scenarios – the need for learner interaction – was confirmed as essential by the telephone interviews. This may reflect the traditional, campus-based orientation of most of the institutions contacted. Nevertheless, the importance of human interaction (e.g. with the TV broadcast plus audio conferencing scenario) and the need for a tutor to guide and facilitate the learning process was emphasised by most of those interviewed. TV broadcasting without tutorial support and a proper course concept, was seen as useful for raising interest and encouraging viewers to sign on for a proper course.

f. Increasing Flexibility of Courses

There was an awareness amongst a number of those interviewed of the need to increase the flexibility of courses and course access in order to meet and/or increase demand for education. Although this was less the case in continental Europe, the UK institutions contacted often talked about the need to meet individual learners' requirements. They were also beginning to think in terms of resource-based learning: re-usable material, data banks, collections of teaching material such as case studies, videos and course outlines.

This flexibility was often related to home, rather than institutional, access to learning in the case of the UK. Continental Europeans, especially those in the south, were much more focused on study centre access, perhaps for economic reasons, but also perhaps because of a cultural bias towards a social environment for learning.

g. Need for Multiple Uses of Networks and Technologies

Most interviewees spoke of the need for multiple uses of networks and telematic technologies. Even so, the German interviewee felt that the cost of telephone calls and telephone related technologies (modems, video links) were still far too expensive in their country for educational use. "We are always 5 years behind the UK". This was also the view of the Dutch interviewee.

3.2.1 Discussion

The telephone interviews have been invaluable for bringing out more detail and background to the first questionnaire. Many of the initiatives in distance learning

from centres within an institution rather than from the institution as a whole; this observation implies that it will require a substantial effort to make the concept of the Euro study centre network well known within the tertiary education sector. There is, however, significant interest in the concept and most of the interviewees appear to be waiting for developments to crystallize before committing themselves to a course of action. This represents a body of potential clients for the service – there is latent demand.

The general feeling is that a telematic network will be useful in providing courses with flexibility that meets the students' needs. The network would enable resource-based learning to be promoted and provide the essential ingredient of a high level of interaction with students. The major concern was that the cost of telematic services are too high.

But did the responses correlate well with the scenarios? The scenarios were devised as realistic uses of a telematic network, and this is reflected in their use of media, various scales and sectors. Their purpose was to fire the imagination of respondents and to bring the possibilities to life. That this is the case is undeniable but it would be unwise to use these short surveys as the basis for planning the network details. Many respondents are 'thinking about' producing courses that would use telematics and they were able to identify with some or all of the scenarios. They are in touch with developments and are waiting for the right conditions to prevail before starting development.

3.2.2 Conclusions on the surveys

The surveys have yielded important information as to needs and aspirations of distance learning in the tertiary sector. It is important to bear in mind, however, that they were never intended to be an in-depth market research activity, more an overview of the current state of tertiary level distance learning in Europe. The following conclusions can be drawn:

- There is a significant level of interest in the use of telematics in distance education.
- Institutions see the need to:
  - Improve coverage and delivery
  - Improve quality of courses and course development
  - Provide flexible courses, in terms of time, location and student sector
  - Increase the level of interaction with students
- There is a latent demand for a network of telematic-based study centres across the EC, but this demand must be focused and exploited.

4 Conclusions

4.1 Conclusions on particular media

Some of our main conclusions are given below. It should be stressed that our conclusions are mostly phrased in terms of *overall* system costs including student costs. The issues of who actually incurs the costs and who notices them raise complex organisational and political questions.

- *Satellite TV* in most cases is less cost-effective than postal delivery of videos; but can become cost-effective as the number of students grows large. In addition, given the under-developed character of postal services in some parts of Europe, and the complexity of working with several national systems, satellite TV offers a single integrated solution to the requirement of Europe-wide delivery of video. The apparent cost-effectiveness of this increases if use is made of domestic satellite TV receivers and overnight transmission time.
- *Computer conferencing* has limited economies of scale because of the need for tutor/student ratios similar to conventional tutorials. It is therefore less cost-effective than commonly believed for large numbers of students. However, if students have home or workplace access to the appropriate hardware, software and telecommunications, it can provide an effective method of extending access and support even for small study programmes.
- *Video conferencing* used for video lectures can be cost-effective at relatively low hours of usage per year. At present, however, the initial capital outlays required are substantial. A potentially significant factor affecting costs is the decreasing requirement for bandwidth, opening the way to the use of ISDN in video conferencing and substantially reduced charges. If network bandwidth is apparently free (as on many academic networks) this has a substantial effect on apparent costs.

4.2 General conclusions

1 Our survey work shows interest, but non-specific interest, in the potential of telematic networks

2 Standardisation is required in order to avoid the problems, and associated cost increases, of having to buy different products to fulfil similar requirements. For example:

- having to buy an extra or more complex satellite receiver because education and training channels are on different satellites [as were EUROSTEP and EuroPACE]
- having to buy a different type of microcomputer from that used for administrative tasks [for example if teaching needed a PC but administration was done via dumb terminals on Unix].

3 Media/technologies should be used extensively, if users wish to gain economic benefits from them:

- both for large numbers of students
- and for a large number of study hours.

4 Where telematic networks can be developed on existing infrastructure, the fixed costs can be reduced. For example:

- using mainframe computing power in the evening to support student access [at times when administrative use and staff access is light]
- using a satellite for which many users already have receivers or could be "easily" persuaded to buy them [such as Astra]
- use of existing computer networks cost-justified for other purposes such as research [such as the national academic networks].

5 Even now, little is known about true costs in actual situations.

5 Selected Bibliography

[*Editor*: this section is not available]

Annex

I. Analysis of Study Time and Telematic Components

This Annex is an analysis of the five scenarios in terms of their pedagogical and telematic components. Each of the scenarios has been designed for a course presentation lasting 200 hours at tertiary level. These parameters have been used as parameters for the cost models illustrated in this report.

Scenario No.	**I**	**II**	**III**	**IV**	**V**
Student numbers	100-2000	30-1000	50-500	20-50	100-5000
Sites			2		
Tutor: Students	1:20	1:20	1	1:20	1:20
Provider	1	1	1	1	*n*
Course Team	yes		no		
Producers	*n*	1	1	1	*n*
Audiographics (hours)				30	
CMC (hours)		100			
Course units	7			5	
Books		5			
Satellite (hours)	12				
Audio Conference (hours)	12				
Home Computer		yes			yes
Video link			40		
Preparation for assignments	20	20	20	20	
Private study	16 (galleries)		140	50 (projects)	
ISDN/PDN (hours)				30	yes
PSTN (hours)		30			

II. Questionnaire

The questionnaire is reproduced below. Where a number is shown, this is the number of responses received under the particular heading.

1 Does your organisation currently carry out any Distance Learning? 56

2 How many teaching staff does your organisation have?

3 How many student study centres does your organisation have?

4 Do you have future plans to develop open distance learning programmes? 67

Production

Delivery 71

5 Which of the following methods are relevant to your organisation's open distance learning activities?

Please tick the methods used by your organisation

	Currently	Planned
Printed Material	63	24
Computer Aided Learning (CAL)	38	36
Face-to-Face tuition or instruction	54	20
Computer conferencing or electronic mail	28	36
Pre-recorded video cassettes	37	27
Telephone contact with students	39	16
Data networks	21	32
Others	15	11

6 Will you offer any open distance learning courses in more than one EC country? 49

7 How many students have taken open distance learning courses in the past three years?

1989

1990

1991

8 What do you see as important to your organisation's education and training development ? *e.g. Increasing the number of students or the use of existing facilities* 78

9 Which languages do you use for teaching? Please state in order of importance. 88

10 Which other languages would be acceptable? Please state in order of importance. 42

11 How do you see telematic networks helping your organisation's development? *e.g. Delivery of study materials to students* 72

12 Would you be prepared to discuss further the use of telematics in:

	Open Distance Learning	74
	Vocational Training	65
	Other specialised services	50
13	Is your organisation part of a larger organisation? Please indicate its address below	30

III. General assumptions on Costs

In this Annex will be found all the data that has been used in producing the costing for the analysis of costs given in the second section of this report. Under each section will be a found an explanation for each of the costs, where appropriate. The costs have been taken from generally available sources in the UK and the Eire, as an indication of the probable cost when averaged across the European Community.

There will undoubtedly be variation in the costs from one member state to another; in the course of compiling the costs, it transpired that most of the Irish costs were higher than those in Great Britain. The cost of network facilities on mainland Europe is also greater that in the UK. To obtain a true picture of European costs would take many months of work, and this would be a Herculean task which would alter the basic conclusions little. Work carried out on the JANUS project (Delta 2003) indicates that the UK network costs can be thought of as the 'asymptotic' cost to which other countries will eventually reduce.

The costs are included here so that the calculations and deductions may be verified by the reader. Each entry has three headings: type of equipment, Name (used in spreadsheet calculations) and cost in euro. The Name of each item is included so that the spreadsheet formulae that appear in the next Annex can be inspected. The analyses have been carried out using Microsoft Excel 3.0 and are available upon request.

1. Computing Equipment Off-campus

Students who need a computer for their Distance Learning course will need a computer of sufficient capacity and with the right interface cards. The following general specification has been devised.

Equipment	**Name**	**euro**
Workstation, minimum specification (286, 16 MHz,VGA Colour, 2/40)	PC_min	636
Workstation (386, VGA Colour, 2/40))	PC_386	989
Terminal emulator software		free
2400 bit/sec modem	modem	141
Audio interface card for MS-DOS	audio_card	35
ISDN card (+ software)	ISDN_card	706

It should be remembered that the above is merely a general specification and details will depend upon the application programs used. The general specification workstation, for example, is quoted as a 2/40 machine, i.e. 2 Mbytes RAM and 40 Mbytes hard disc storage. It is quite possible that more memory than this would be required. Another factor is that of price; the PC market is turbulent at present and value is tending to increase (higher specification machines for less money). The ISDN cards are also entering that phase in the product life cycle where development costs are being recouped with consequent lowering of retail price.

2. Institution's Computing Equipment

The scenario assumes the use of three alternative computer systems. For a small CMC population, it is sufficient to use a modest personal computer with a single modem and exchange line. The move from single user to multi-user is the biggest increment in cost and for the purposes of this report the following break points have been drawn up. The rather generous user:modem ratio of 20:1 has been used; in practice much higher rations can be used.

In practice, it is difficult to specify precisely the number of users that these systems could support without conducting benchmark trials. In general, the more users serviced by the system, the slower it becomes. The system specified for ten users will work for twenty, even fifty. As the number of users increases, they will find that at their chances of failing to connect will increase. To be provide more accurate results, the 'grade of service' must be defined and this is an empirical statistical concept. It is sufficient for the purposes of this report to estimate the likely computing needs and proceed with the calculations accordingly.

The cost of the CMC application has been taken from a quotation supplied by Kommunity Software who produce the PortaCOM system. The X.25 public data network charges are derived from British Telecom's service and are used in the 1000+ user system calculations.

Computer	CMC population	euro
PC	10	850
Unix workstation	100	14,500
Mini computer with front-end processor	1000	57,203
multi-user CMC application (PortaCOM)		9,177
PDN (Public Data Network) link installation	PDN_install	2,119
PDN rental 64k service (per year)	PDN_year	22,373
PDN call charge (per thousand chars.)	PDN_volume	0.01
PDN dial-up access, per user, per hour	PDN_dial_up	2.26
PDN dial-up registration	PDN_setup	85
PDN dial-up rental, per year	PDN_rental	85

3. Tutor-related costs

In order to carry out the calculations for the comparison between face to face tutorials and videoconferencing, the following tutor-related costs have been used. These are based on the rates used by the UK Open University.

Student contact time (per hour)	tutor_contact	30
Travel allowance (per km)	tutor_travel	0.24

4. Satellite TV receiving equipment

The cost of providing satellite TV receiving equipment at homes or in study centres are given below. There are a range of costs and the one selected depends upon the facilities required. The costs have been used in the calculations for the various types of study centre.

60cm dish (Astra or Eutelsat)	dish_60	282
90cm dish, multi-satellite receiver	dish_90	706
150cm dish, multi-satellite receiver	dish_150	989
Installation of fixed dish	dish_install	56
Installation of steerable dish	dish_steer_install	636
PAL data card for MS-DOS computer	PAL_Card	494
VHS video recorder	video_recorder	282
Television	TV_Cost	282

5. Video cassette production, computer conferencing, satellite uplink

The figures shown below have been used in the calculations which compare video cassette and satellite TV as a means of delivering programmes. The cost of the uplink, or playout station, is a typical value, but in the analysis it is treated as a variable in order to find the optimum required cost.

Video Codec for conferencing (PictureTel)	video_codec	42373
Video cassette duplication (per 3hr cassette)	video_duplicate	7.44
Video cassette postage (per 3hr cassette)	video_postage	2.73
Lease of transponder for TV, per year	transp_year	5649718
lease of transponder, per hour	transp_hour	1412
Uplink cost – full service (per hour)	uplink_150	2825

Note that the Uplink Cost represents the current 'high' rate for commercial use. It is anticipated that a more realistic cost would be much lower than this in practice, possibly even as low as 500 euro/hour.

6. ISDN and 2 Mbit/sec tariffs

These figures are derived from British Telecom, and have been used in the comparison between ISDN and 2 Mbit/sec links.

ISDN installation (per lines)	ISDN_install	226
ISDN rental (per line, per year)	ISDN_year	113
ISDN call charge, Local (per line, per hr)	ISDN_Local	1.74
ISDN call charge, National (per line, per hr)	ISDN_National	4.80
2Mb local installation (new)	BB_ins1	8757
2Mb local installation (existing)	BB_ins2	1695
2Mb trunk installation (fixed component)	BB_ins3	1059
2Mb local ends rental (pa)	BB_rent1	1511
2Mb trunk rental (fixed component, pa)	BB_rent2	5134
2Mb trunk rental (≤15km, pa)	BB_rent3	469
2Mb trunk rental (>15km, pa)	BB_rent4	244

7. Shortfall of equipment in students' homes

The data below is taken from the Eurodata handbook. It is usual to work in terms of *penetration*, e.g. 85% penetration of telephones means that 85% of homes have one. In this analysis, the complement has been used and is known as the *shortfall*. Thus the average cost to students to use video recorder will be the cost multiplied by the shortfall, i.e. 282 x *0.42*.

CD ROM player	Short_CD	70%
home computer	Short_PC	78%
ISDN line	Short_ISDN	100%
modem	Short_modem	100%
satellite equipment	Short_dish	96%
Telephone line	Short_phone	15%
Television	Short_TV	2%
video player	Short_video	42%

8. Learning process

The following are parameters concerned with the learning process. The first two parameters are estimates based on experience at the UK Open University and the remainder are postulated in terms of the scenarios to which they apply.

CMC moderator:student ratio	c_CMCMod	20
Tutor:student ratio	c_Tut	20
Students per audioconference	c_audioc	10
Number of video conference sites	c_n_videoc	2
Students sharing audiographic equipment	c_audiog	2
hours of tutorial per visit	c_remote_tutorial	2

ISDN lines needed for audiographics	c_isdn_audiog	2
ISDN lines needed for videoconference	c_isdn_videoc	2
Students sharing a central dial-in modems	c_modem_use	20
Maintenance cost, as % of capital cost	c_maint	10%
Amortising Period (years)	amort	5
euro conversion rate	£/euro_RATE	1.41

Note that the euro rate used in the analysis is the 'old' value, prior to the developments with the Exchange Rate Mechanism late in 1992. Since this factor is applied equally to all costs, relative costs will remain unchanged.

IV. Cost Models for the scenarios

1 Parameters

This section will be of interest to readers who would like to work through the calculations themselves and a) verify the conclusions in the paper, and b) use the cost models to experiment with costings and break-even points themselves. With this in mind, the structure of the spreadsheet calculations will be described and the notation used in the spreadsheet formulae.

Capital costs for equipment are amortised linearly over a period of five years. The yearly rates thus calculated are then multiplied by a factor that takes into account the cost of maintenance. Installation of telecommunications links usually require some installation fee to be paid; these too have been spread over five years in the calculations but there is no factor added for maintenance.

Constants

Constants, such as those listed above, do not vary for the purposes of this report. Thus a computer system of a certain specification will cost a certain amount, and that is the end of the discussion. Constants can be one-off , recurrent or usage-related payments; a telephone line is a good example of this, with parameters corresponding to installation, rental and usage tariff respectively.

Variables

The second type of parameter has been termed a *variable*, and in this report is taken to mean a parameter that will be used as the axis of a chart. The variables used in this report are listed below (the v_ prefix is to indicate that they are variables).

Student numbers	v_student
Audiographics (hours)	v_audiog
Audio Conference (hours)	v_audioc
Video Conference (hours)	v_videoc
CMC (hours)	V_cmc
Link distance (km)	v_link
Distance between tutorial locations (km)	v_travel

2 Cost models

The models have been devised using Microsoft Excel 3.0. Full use has been made of labels, links and formulae to produce spreadsheets that can easily be converted into charts. The constants, mentioned above, are all contained within a master spreadsheet called *K* and links are used to feed the relevant parameters to particular cost model spreadsheets. In this way it is an easy matter to keep all the cost models up to date and to reflect changes in parameters. If the cost per hour of a telephone call were to be increased, a change would be made to *K* which in turn would propagate the change to all the spreadsheets that required this information.

On the following pages the cost models are depicted as functional diagrams with the formulae shown below. References to *K* are indicated by a parameter prefixed with 'K!'. Where appropriate, the costs have been allocated to the four areas in the Learning System Reference Model (LSRM) of Producer, Provider, Tutor and Learner cost centres. This enables charts such as those in the discussion on Scenario I to be produced. The charts for the comparison between ISDN and 2 Mbit/sec services, and others, have no need on a breakdown by LSRM components and accordingly this has not been carried out.