# Live, Audio-Visual Communication Systems for Distance Learning: Experience, Heuristics and ISDN

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Submission

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**Abstract.** This paper collates some of the experience of managers, tutors and learners who have used live, audio-visual communication systems for distance learning. Eight design heuristics are abstracted from this experience and used to reason about how digital communications could make LIVENET more effective. The heuristics are: (i) encourage other (non-training) uses for the communications network; (ii) encourage the participation of otherwise unavailable experts; (iii) exploit visual images, both to communicate information and to support information communicated presented verbally; (iv) avoid technology-induced, inequable opportunity for learning; (v) encourage analogies with face-to-face learning modes, rather than conventional television and home video; (vi) help users to find out about other participants and what they are able to see and hear; (vii) actively encourage interaction; and (viii) reassure tutors that the apparent intrusiveness of the technology is just an initial impression.

## 1. Introduction

The use of live, audio-visual communication systems for distance learning continues to spread (Pugh et al. 1992). Such systems consist of one or more tutors, learners, and devices interacting over a network to achieve some desired competence on the part of the learner. A competence, here, is an ability to perform work, or attain other goals in a social situation (Ellis 1991).

Many live, audio-visual communication systems, such as London Interactive Video for Education Network (LIVENET) and Video Interactif France Telecom (VIF), have been fully operational for a number of years and are routinely used for teaching purposes (Voglimacci 1992; Kirstein & Beckwith 1991). Such systems are based on Audio-Visual (A-V) technology, that is, television and radio, video-conferencing networks and satellites. They are also apparently effective, at least, in educational terms and for some educational objectives (Whittington 1987). However, the capital cost

of such systems, particularly the video-conferencing network, is relatively high.

A possible response to this problem is to integrate established systems based on A-V technology with Information Technolgy (IT), that is, computers, educational software and digitial networks. For example, the susbstitution of relatively cheap Integrated Services Digital Networks (ISDN) for video-conferencing may considerably reduce the financial barriers to the geographic spread of such systems. Other forms of integration may offer pedagogic opportunities, such as greater flexibility or interactivity.

The strategy adopted here is to guide integration with the experience of using existing, video-based systems. Specifically, the strategy is to identify the reasons for the effectiveness of the system based on A-V technology, and then introduce IT in ways that are designed to be effective for the same reasons. Put casually, the strategy is 'to keep find out why what we've got works, and keep doing it'.

Many tutors, learners and managers have acquired considerable experience of using LIVENET and VIF. Similar systems have also been used elsewhere (Kristiansen 1991; Simpson et al. 1991; Hansford & Baker 1990; Catchpole 1986). Thus, relevant experience is available. However, much remains locked within the individuals who acquired it, or in fragments of various sizes. Consequently, for our strategy for integration to succeed, it is necessary to be bring this experience together, structure it, and write it down. It is also necesary to abstract from the experience some heuristics for integrating A-V and IT for the purposes of distance learning. The heuristics are required in order to support design. The experience must be documented to examine the basis for the heuristics.

In this paper, LIVENET and VIF are briefly described as systems. Two well-established systems are considered, in order to increase the likelihood that any heuristics will be appropriate (encourage effective design) and be generally applicable. Then, the paper presents the experience of LIVENET and VIF as it relates to three aspects of system use: (i) usage, that is, up-take; (ii) the decision to use a distance learning mode rather than a conventional, face-to-face alternative; and (iii) the delivery of distance learning sessions. This 'experience' is taken to have the status of informed opinions, which were acquired by users reflecting upon their work. As each aspect of system use is considered, the experience associated with LIVENET and VIF is compared and contrasted. The comparison of systems was found to assist the process of abstraction. To facilitate comparison,

LIVENET & VIF are considered throughout as means of delivering 'lecture-style' sessions only, that is, relatively structured sessions that are led from a single location and that involve alternating phases of 'Presentation' and 'Questions and Answers'. Although both systems have also been used in conjunction with other pedagogic styles, such as discussion groups and practical workshops, these styles are not considered here. Finally, eight design heuristics are abstracted from the experience collated. These heuristics seek to reflect the distinctive characteristics of interactive audio-visual communication systems as used for distance learning, rather than learning systems generally. The heuristics are used to evaluate a possible proposal for the introduction of ISDN into LIVENET.

Managers', tutors' and learners' experience of LIVENET and VIF was acquired by a variety of informal, but systematic techniques, including observation and video-recording of LIVENET and VIF sessions, informal interviews, distribution of post-session questionnaires and review of existing reports, including human factors evaluations. This approach was adopted in order to acquire a rich set of opinions in a cost effective way and to reflect the perspectives of principal stakeholders. The approach does not guarantee completeness, or elicit the consensus of opinion.

## 2. Background

### 2.1. *LIVENET*

LIVENET is a broadband optical fibre network that connects the principal, but geographically distributed, colleges within the University of London to each other and their respective Audio-Visual and Computer Centres. (Colleges within the University of London are effectively independent university institutions). This network supports fully interactive, audio-visual communication between dedicated 'lecture studios' and selected laboratories and offices within each college. Satellite links connect LIVENET with Europe, and gateways to commercial video-conferencing and cable television networks connect LIVENET with the rest of the U.K. and the U. S. (figure 1.). Recently, 128kBit ISDN links with studios in educational establishments outside the University of London have been installed on a trial basis. In collaboration with British Telecom, a separate Unit within the University of London supports the LIVENET network, operates the LIVENET service and conducts research into video communication.

LIVENET supports research, teaching and administrative activities. With respect to teaching, the primary objective of LIVENET is to facilitate

collaboration between colleges. It offers tutors and students the opportunity to avoid the time, cost and disruption of travel around a congested capital, and so removes one logistic obstacle to multi-site teaching. Collaboration frequently takes the form of inter-collegiate courses or the delivery of parts of one college's course by another college's staff. LIVENET sessions also make teaching more available, since each session is recorded, and so students who missed a 'live' session may view it at some later, more convenient time.

Lectures conducted over LIVENET are fully interactive. That is, each site may be seen and heard at all other sites, including itself. The reason for this is that students who are able to see themselves on a monitor along side other participants feel more involved and are encouraged to contribute. Verbal interruptions are also encouraged.

LIVENET studios are equipped to different levels. Some are equipped to the level of a student studio, some to the level of a tutor studio and some to the level of a 'student and/or tutor' studio. A student studio possesses a bank of monitors facing the class and a video camera located immediately above the monitors, which takes a group shot of the students. Microphones hang from the ceiling or may be fixed to desks or chairs. A tutor studio possesses, in addition to the equipment in a student studio: an overhead camera (for presenting hard copy material, such as prepared text or pictures); a device for broadcasting a computer display over the network. (This device enables e-mail to be used in conjunction with LIVENET); a slide to video converter; a video cassette player; and an image server (from which a small library of still and moving images may be retrieved) (figure 2). A 'student and/or tutor' studio has the equipment of a tutor studio plus rows of chairs next to the bank of monitors.

Slight variations between studios of the same type sometimes occur, typically due to maintenance problems or limits on expenditure. For example, in particularly large sessions, one studio may not have enough monitors to simultaneously view all other studios on a separate monitor. Consequently, that studio may receive smaller images of all other sites mixed together in split-screen or 'quad' format and displayed on the monitors that are available.

Each studio has control over its own equipment, but no control over equipment possessed by other sites.

LIVENET technicians prepare the studios for each session, and are on hand during the session to sort out problems with sound or picture quality.

The tutor produces the broadcast 'live'. Consequently, since the 'producer' of the broadcast is also the presenter, the production value of a LIVENET broadcast is minimal. That is, once captured, the basic sounds and images broadcast, although of professional quality, are not subjected to much further processing, or 'management' to enhance their meaning. Generally speaking, production involves cueing and cutting between images from diverse sources, principally the overhead camera. Although the precise treatment of visual material varies, this material tends to look like, and be used as, conventional overheads for an overhead projector in a lecture theatre. For example, it may comprise text and/or graphics and be scanned, zoomed or highlighted with a pen.

LIVENET lectures typically form part of a term-long course involving lectures, seminars, practicals/workshops and visits. Individual lecturers may deliver a series of lectures, or make a one-off 'guest' appearance. Each lecture is prepared some time in advance of delivery. Even when a lecture is based on a previous presentation, its contents typically needs to be brought up-to-date or modified to accomodate for changes in the course or the audience.

LIVENET lectures tend to adhere to conventional university formats. Following a brief introduction, the tutor typically delivers a prepared verbal presentation, supported by static visual overheads. The lecture closes with a short question and answer session and any administrative announcements. The size of a LIVENET class is typically between 20-30, that is, 5-10 students at each site, and a typical lecture lasts around 45 minutes, plus 10 minutes for questions and announcements.

Some stills from an example computer science lecture delivered over LIVENET is presented in figure 3. In this example, one of a series of lectures delivered by an experienced LIVENET tutor, a verbal presentation was supported by bullet-points, outline diagrams and extracts of program code displayed via the overhead camera. The visual presentation comprised an iteration of the following basic sequence: head&shoulders of lecturer, overhead, head&shoulders of lecturer, overhead,head&shoulders of lecturer and so on. A continuous verbal presentation was synchronised with the basic visual sequence.

2.2. *VIF*

# Submission

VIF supports training and coordination within France Telecom, France's national telecommunications company. VIF delivers 'live', in-house training to all kinds of personnel, from technicians and designers to managers and sales representatives. The organisation responsible for the VIF training service is an extension of an established 'Training Video Production' department. Many of the staff, equipment and facilities required for the production of training videos are also used for the preparation and delivery of live, audio-visual training broadcasts.

The primary aim of VIF is to offer a more integrated, coordinated and responsive service to France Telecom's development projects than that provided by a network of regional training centres. Training programmes are made more manageable in two ways: (i) by reducing the delivery time for training programmes; and (ii) by making delivery time more consistent. In a company such as France Telecom, considerable time may be required for regional training centres to deliver a training programme to several hundreds of trainees dispersed throughout mainland France, Corsica, Guyana and the island of Reunion. If the development schedule is relatively short, then long cycle times for training may be particularly problematic. Further, the more consistent delivery times, that is, the more it is true to say that everyone in France Telecom acquires some new skill or knowledge at the same time as everyone else, and the more reliable and predictable delivery times, the easier it is to plan projects, and then adhere to the plans. Thus, to use an analogy with the brakes of a car, VIF seeks to make training services less 'spongy'.

In VIF, audio-visual broadcasts are made via satellite from a central production studio ('Centre Directeur' (CD)) (figure 4). The tutors and video production team are located here. There are two alternative locations for the CD (Montpellier or Paris), but only one studio plays the role of CD for a particular broadcast. The broadcast may be received by two types of receiver studio. One type of receiver studio ('Centre Local Interactif'(CLI)) supports more interaction between tutor and trainees than the other type of studio ('Centre Local Recepteur'(CLR)). The CLIs, of which there are 45, provide for 'live' audio-visual feedback via a video-conferencing network. Up to 5 CLIs may participate in a VIF session simultaneously. The CLRs provide for feedback via telephone, videotex (minitel) and/or facsimile. In principle, there is an almost infinite number of CLRs and an almost unlimited number may participate in a session. However, in practice, only CLIs normally participate in training sessions. In recent trials, communication between the CD and CLIs has been transmitted over 128kBit

and 386kBit ISDN links, running alongside the conventional satellite broadcast.

The CD is equipped, and functions, like a television studio (inset figure 5). The tutor(s) sit or stand on the set under the studio lights. In front or to the side of them are: the camera operator; a bank of monitors (showing the broadcast image, the image received from each CLI and hand-written messages from the control room; and a bank of fax machines, on which responses from CLRs may be received. There is no studio audience in a CD. In the CLI (figure 5), trainees view the sounds and images broadcast from the CD. There are enough monitors and/or video-projectors to ensure that each trainee has a good view. The CLI receives the sounds and images that the director of the broadcast decides they should receive, which may or may not include an image of themselves. For example, the received information may concern the tutor talking, a piece of equipment being operated, or a CLI and the CD having a discussion. A camera operator faces the trainees to take a picture of them, and an assistant may be present to welcome, organise the trainees and generally help out, for example, pass a radio microphone to trainees who have a question. There are slight variations between CLIs. For example, to help trainees make notes, some CLIs have tables, others have chairs with swivel-in, arm supports and others make no special provision.

The VIF production team comprises the project manager who procured the training programme, the tutors, a broadcast director and his assistant, the camera operators (in the CD and CLIs), graphic artists, various craftsmen and signal and sound technicians. The activities of this team cover pre-production and broadcast.

In the initial stages of pre-production, the project manager, director and tutors discuss the content and treatment of the training session. These discussions address at least four topics: (i) 'back-room requests', which sketch the computer graphics (moving and still images or text) that are required for the mixing room, and the posters, billboards or cardboard models required for the studio floor; (ii) a 'conducteur', a script-cum-storyboard, which specifies the broadcast to be produced. The nature of a 'conducteur' varies, but it is likely to indicate who is to say what and when and how long they have to do it. It may also indicate the cameras to be used, whether any music or graphics are to be involved and when there are opportunities for the audience to ask questions; (iii) a staging diagram, which indicates the seating arrangements, and the location of tables for demonstrations and cameras. This diagram ensures that all camera

movements and camera angles required by the conducteur are possible; and (iv) sketches for particular shots, devised to effectively communicate specific topics or to support particular training activities. For example, figure 5., which represents the tutor, a trainee and the output of a computer display, was devised to accompany a walk-through of a maintenance procedure. To test the trainees' comprehension of the procedure, one trainee (bottom right) is instructing the tutor to enter certain information into the computer. The tutor (top right) repeats aloud the trainee's instructions and enters the information. The computer's response is displayed on the left hand side of the screen and provides the trainee with the diagnostic information required for further decision-making.

During the later stages of pre-production, the network is tested and particular aspects of the forth-coming broadcast are explored and practiced on the studio floor. For example, the director and camera operator may ensure that they are able to construct a difficult shot reliably. The day before the session, tutors new to VIF may be briefly introduced to the system and given some basic advice about adapting their presentational style. For example, objects presented to the camera should be moved slowly and smoothly, so that the camera can focus upon it and track it.

On the day, the broadcast is directed from a control room. Here, the director is in audio contact with camera operators in the CD and the CLIs and may view a bank of monitors showing the image returned from each CLI, each camera in the CD, and the titles or graphics to be superimposed on the transmission. There is also a touch pen for writing messages to the studio floor (such as 'Hurry Up!'), a preview screen (on which the next shot to be transmitted is prepared), and a screen showing the image broadcast. During the broadcast, the director and his assistant use the conducteur to prompt their actions. The director is in control of the broadcast, and ensures that the tutors, camera operators and effects are prepared and that the transmission is produced as planned. The tutors conduct the training session and attempt to adhere to the script, whilst ensuring that the trainees have understood all that they should have.

VIF training sessions vary considerably in duration, content and structure. As many as 130 trainees have attended a single VIF session, but a figure of 50 - 100 (10-20 per CLI) is more typical. If the intended audience is extremely large (over a thousand people), VIF sessions may be broadcast on a number of separate occasions, for example, 10 sessions at 100 trainees a time. The duration of previous VIF sessions has varied between a few

hours, to several, 7 hr. days. A single day is, perhaps, typical. VIF sessions may concern such topics as 'Demonstration and Use of Pressurisation Equipment', 'Changes to the E10 and MT25 Gateways' (computer switches that connect national and international communication networks) and 'Product Information for the Agoris 60 and its Commercialisation (a facsimile machine about to be put on sale).

In a VIF session, the presentation of information is typically interspersed with more interactive questions and answers and discussion. The ratio of presentation to interaction is in the region of 50:50, with each phase of presentation or interaction lasting about 20 - 40 minutes. Some VIF sessions are structured as a series of lectures. Others, particularly those aimed at technical staff, open with an 'Introductory Lecture', followed by, perhaps, a Demonstration and then a Guided Exploration of a piece of equipment. VIF sessions conventionally close with an evaluation, in which the tutors, a representative of the VIF service and the project manager, ask trainees for their immediate reactions to the content and delivery of the session. Trainees later complete an evaluative questionnaire at their leisure. Video-recordings of the sessions are produced and are sometimes requested by those who could not attend the session.

Some stills from an example VIF demonstration are presented in figure 6. Extensive preparation and direction from the control room mean that a great variety of images and sequences are broadcast. The director actively leads and responds to the unfolding session on a moment to moment basis and creates images that support its content. For example, when a tutor asks 'Are there any questions?', the director may cut from a full screen head and shoulders shot of the tutor to a split screen. One part of the screen depicts the tutor. Another part depicts a group shot of the class in a CLI. The director rapidly flicks though images from each CLI, until a questioner at one site is found. As the question is put, the camera in the CLI zooms in on the questioner. If the question is expanded, then the director cuts to full screen on the questioner. If the question is answered, he cuts back to full-screen on the tutor.

As a final note, although preparation and control over the technology is exercised at the CD, the training itself is not necessarily led from, or focussed upon, the CD. For example, as described earlier, equipment located in the CD may be operated in response to instructions from a CLI. Alternatively, a question raised in one CLI, may be answered by another CLI, rather than the CD.

2.3. *Comment*

In some respects, LIVENET and VIF are similar distance learning systems. First, they are both highly interactive, in that they both involve high-quality, synchronous audio-visual communication between any of the participants. Communication is synchronous in the sense that tutors and learners may send and receive contributions in parallel with each other, with little or no delay between the sending and the receipt of a contribution. Further, tutors and learners may also respond almost immediately to each other's contributions. Highly interactive systems such as LIVENET and VIF are thought to offer a wider, more attractive and possibly more effective range of pedagogic options and learning opportunities than conventional distance learning systems, such as correspondence courses and electronic mail (Wilbur, Wilbur & Ing 1991). Second, LIVENET lectures and VIF demonstrations are both relatively well-structured and highly managed. For example, a session is typically devised to convey specific information, typically some aspect of an academic discipline or telecommunications. Periods for presentation, questions and answers, pause and review, are set aside to ensure that the required information is conveyed. The technology is also managed from a single studio. Thus, LIVENET lectures and VIF demonstrations are not conceived as imitation face-to face sessions, or devised to fully utilise all technological or social possibilities all of the time. Rather, a limited set of these possibilities are selected according to their apparent effectiveness. Third, both LIVENET and VIF studios have different levels of equipment. For example, the 'lead' studio (the tutor studio for LIVENET, the CD for VIF), has more equipment in use than the receiver studios (the student studio for LIVENET, the CLI for VIF). There may also be differences between receiver studios. Such variation in equipment levels reflects a number of factors, including: (i) financial limits on expenditure; (ii) the fact that LIVENET and VIF were not established by a single, initial investment, but have evolved over many years; and (iii) that responsibility for remote studios does not always rest exclusively with LIVENET or VIF management. For example, another organisation may be responsible for the building in which the remote studio is housed, and so has some influence over the studio itself. The implications of variation in equipment levels for equality of opportunity for learning are pursued in Section 6. Finally, LIVENET and VIF are similar in that both are currently analogue networks, with

potential to benefit from the flexibility and lower cost of digital communications. This issue is also considered further in Section 6.

In other respects, LIVENET and VIF are different. For example, LIVENET and VIF serve different purposes in different organisations. LIVENET facilitates collaboration between the colleges of a university, whereas VIF increases the manageability of training services in a telecommunications company. The effectiveness of LIVENET and VIF, then, must be assessed with respect the different criteria (see Section 3.) Also, LIVENET students tend to be a less varied population, to be taught in smaller groups and to be taught in shorter sessions than VIF trainees. The contrast is between approximately 30 undergraduate students taught for an hour and approximately 100 trainees of any grade, age or job description for half a day, or more. The difference in terms of number and homogeneity of learners has implications for the amount of preparation required (see Section 5). Finally, the visual images viewed by LIVENET students and VIF trainees vary in number and quality. LIVENET students receive a single 'managed' image, the one produced by the tutor, plus unmanaged, ‘raw’ images from all other sites including themselves. Also, in LIVENET, the managed image has not been managed to a great extent - the tutor is unaided in the presentation. VIF trainees, in contrast, receive only a single, managed image, but this image has been extensively manipulated by the central production team and remote camera operators. VIF images, then, may be said to be more time-sensitive than LIVENET. That is, VIF images tend to support interaction on a moment to moment basis, whereas LIVENET images support the next few minutes of interaction.

This concludes the consideration of LIVENET and VIF as systems.

## 3. Usage

The figures presented in this Section were extracted from information routinely compiled by LIVENET and VIF administration. The figures for LIVENET concern the academic year 1990-1991. Those for VIF concern the calendar year 1991. Also, although LIVENET and VIF have been used by outside organisations on occasions, such usage has been minimal (less than

1%) and for non-teaching purposes. Consequently, only internal usage is considered here.

3.1. *LIVENET*

(i) Amount and Type of Usage

LIVENET supports teaching, research and inter-college administration. Generally speaking, and taken together, all activities utilise about 25% of the network's notional capacity (estimated to be 1,976 bookable hours[1]). Teaching is the primary source of demand for LIVENET services, accounting for 306 out of a total of 478 teaching hours per year (64% of total usage) (figure 7).

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insert figure 7 about here

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(ii) Distribution of Usage

LIVENET usage is markedly seasonal. In 1990-1991, 174 hrs. (56% of total LIVENET teaching) occured during the autumn term, and only 20 hrs. (7%) occured during the summer (figure 8). This reflects seasonal variations in the academic year, which tends to focus on taught courses during the autumn and winter and project work and examinations during the spring and summer.

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insert figure 8 about here

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(iii) Achievement of Objectives (Extent of Collaboration)

Teaching over LIVENET involves an average of 3.2 sites per session, compared with an average of 3.6 sites per session for all uses (figure 9). Consequently, teaching over LIVENET is indeed collaborative, but less so than research (4 sites per session) and administration (5 sites per session).

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insert figure 9 about here

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[1]There is assumed to be a maximum capacity for the network of 8 hours per day and 247 working days per year, and that the network may only support one broadcast at a time.

For example, part of a collaborative undergraduate computer science course was delivered over LIVENET by Imperial College London and University College London. Collaboration was partly motivated by a wish to increase teaching quality - an 'expert' in human factors from University College delivered the task analysis lectures - and partly by the need for cost savings. Although the size of the class at each site was reduced, total class size was increased. In this case, LIVENET did not provide a reason to collaborate, but helped to reduce possible obstructions to it.

3.2 *VIF*

(i) Amount and Type of Usage

In addition to training, VIF supports a co-ordination function within France Telecom. Co-ordination, here, includes a variety of activities, such as regular panel sessions, in which special interest groups keep each other abreast of recent developments, and special broadcasts, in which senior managers address the company as a whole, for example, to communicate company policy. Generally speaking, and taken together, all activities utilise about 45% of the network's notional capacity (estimated to be 247 bookable days[2])(figure 10). Training is the lesser activity, accounting for an estimated 42 days worth of broadcasts, that is, 38% of total usage.

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insert figure 10 about here

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(ii) Distribution of Usage

VIF usage for training tends to be distributed unevenly and somewhat unpredictably (figure 11). That is, there are periods of intense activity, followed by periods of relative inactivity, and the start and end points of these periods vary. For example, in 1991, 39 days worth of VIF sessions (93%) took place in the first six months of the year. Only 3 days (7%) occured in the last six months. This reflects the requirements of project managers - when there is a need for training, it is desirable to satisfy this need at quickly as possible.

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[2]There is assumed to be a maximum capacity of one broadcast per day and 247 working days per year, and that the network may only support one broadcast at a time.

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insert figure 11 about here

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(iii) Achievement of Objectives: Manageability

The improvements to manageability that are achievable with VIF may be exemplified by the case of a one-day course in the maintenance of a new version of a digital exchange. 1300 trainees needed training. With conventional, face-to-face sessions, training would have been procured by the manager of the digital exchange project from approximately 17 regional training centres. A period of 6-12 months would have been allowed for delivery of the training and considerable liaison between the project manager and the regional training centres would have been required. With so many training centres and trainees, serious delays for at least some trainees are almost inevitable. With VIF, however, following a six week period (elapsed time, rather than person months) for preparation, the training was delivered in 13 sessions of approximately 100 trainees (approximately 20 at five sites) over a period of 3 weeks. As more interested individuals made themselves known mid-way through the series of broadcasts, two additional sessions were organised for a date 5 weeks after the completion of the initial 13 sessions. The project manager attended some of the sessions and was involved in the evaluation of the sessions. He also saw with his own eyes the training being delivered and the response to it. Thus, in this case, VIF reduced the cycle time of training by the order of 50% and significantly increases the perceived reliability of the service, and the manager's sense of being in control.

3.3. *Comments*

LIVENET and VIF appear to be similar in that there is anecdotal evidence that both systems are achieving some degree of success, that is, cost effectiveness. Up-take is at least sufficient to justify the continuation of the service. The two systems are also similar in that usage is unevenly distributed throughout the year - a common feature of many networks. Finally, both systems support other activities, in addition to distance learning. LIVENET supports research and administration and VIF supports coordination.

LIVENET and VIF appear to differ, in that training is the primary use of LIVENET, but a secondary use of VIF. This is not surprising, perhaps, given that education and training is the principal objective of a university, but a means to an end for a telecommunications company. Also, LIVENET usage is unevenly distributed in a seasonal manner, and so, is predictably uneven. It reflects the nature of the academic year. VIF usage, in contrast, is unpredictably uneven. It responds to the demands of development projects, whenever those demands are made.

These similarities and differences appear to be related. Given that usage is unpredictably and unevenly distributed, to be cost-effective, a distance learning system and network is likely to be required to find other, non-teaching uses. The required flexibility of LIVENET and VIF, then, is considerable. It must be possible to perform not only a range of learning and tasks but also a range of non-learning tasks with these systems. For example, when not broadcasting 'live' training sessions, the VIF production team and facilities are used to deliver co-ordination broadcasts or make training videos.

This concludes the short review of LIVENET and VIF usage.

## 4. The Decision to Engage in Distance Learning

Learning objectives may be pursued by a range of delivery options, including conventional, face-to-face sessions and sessions mediated by a distance learning system. Invariably, an explicit decision is made to utilise one or other of these options, on the basis of their perceived strengths and weaknesses. In the University of London, this decision is largely made by the course lecturers. In France Telecom, the decision is made by the manager of a development project. For both LIVENET and VIF, only lecturers and project managers who had chosen to use LIVENET and VIF were interviewed. Individuals who had chosen not to use LIVENET or VIF may well have responded differently.

### 4.1. *LIVENET*

Three LIVENET lecturers were informally interviewed and asked to comment on a draft of this paper. The following considerations were said to influence the decision to use LIVENET in preference to a conventional lecture theatre.

# Submission

(i) Tutoring Skill: The tutors who give the best lectures in a lecture theatre are said to be the tutors who give the best lectures over LIVENET. A tutor's skills and limitations in preparing and presenting lectures appear to transfer from face-to-face teaching to teaching at a distance. LIVENET is not a substitute for individual ability and training.

(ii) Level of Interactivity: LIVENET lectures are said to be slightly less interactive than those given in a lecture theatre. Students are slightly more reluctant to ask questions. This reluctance is particularly marked if students are unable to see themselves on the monitors. This situation may arise if sites are under equipped, or if a student is sitting out of shot, or in the relative darkness etc. Under such circumstances, there is a tendency, it is believed, for these individuals to feel not fully involved, or even excluded.

(iii) Transfer of Collaborative Courses: It is thought to be easier to transfer to LIVENET courses that are already collaborative than it is to transfer non-collaborative courses. Assuming that the non-collaborative course is being transferred to LIVENET as part of becoming collaborative, the difficulties associated with learning about LIVENET will be added to the difficulties associated with establishing collaboration. The latter, which may involve negotiating technical roles and relations, allocating student credits to colleges etc., may be considerable. Generally speaking, it is better to address one set of difficulties at a time i.e. use LIVENET to make existing collaboration easier.

(iv) Preparation time: As a rule of thumb, it is said that LIVENET lectures require about 10% more time to prepare than face-to-face lectures. Since tutors typically have less experience of LIVENET than lecture theatres, there are more delivery issues to consider (see Section 5). Further, tutors may need to inform students about LIVENET before they arrive at a studio. Providing such information may also involve extra work (see also point (vi) Logistics).

(v) Obstruction to the Achievement of Learning Goals
LIVENET technology does not appear to obstruct learning during lectures. Many tutors need reassurance that no such obstruction exists.

(vi) Logistics: Minor, logistical difficulties, such as arranging for someone to open and lock up each studio, or ensuring that the required equipment is available and working, are thought to be greater on LIVENET than in a lecture theatre. Generally speaking, such difficulties are of the same type as those encountered with lecture theatres, but since LIVENET teaching involves greater a number of colleges, departments and sites, the number of these difficulties tends to be greater.

(vi) Personal Interest: Some tutors like exploring new ways of teaching, and to support the college's attempts to develop them.

(vii) Intrusiveness: The immediate impact of a LIVENET studio is that it is a studio, and not a lecture theatre. One cannot help but be aware of the considerable technology located in the studio. In particular, a sense of proximity and relative location is lost. "It's like talking to someone across a football pitch" one user commented. However, with minor adaptations to a tutor's conventional lecturing style (see Section 5.), LIVENET technology generally ceases to intrude upon a participant's conscious awareness.

In summary, the decision to use, or not to use LIVENET, is thought to be principally based upon an assessment of the benefits of collaboration between colleges, rather than the perceived effectiveness, or ineffectiveness of the technology. Tutors perceive LIVENET as a means of delivering, with minor adaptation, conventional lectures to students in a variety of colleges from a convenient location.

4.2. *VIF*

One project manager from France Telecom was informally interviewed. The following considerations were said to influence the decision to use VIF, rather than regional training centres.

(i) Availability of Key Specialists: Sometimes, only a small number of key specialists are capable of answering trainees' questions. For example, these specialists may be the engineers responsible for a new piece of equipment, or France Telecom's expert on a particular issue. It would not be cost-effective for these specialists to attend colleges around the country. However, they may be willing to participate in VIF demonstrations, and sometimes find participation itself to be rewarding. Trainees are also said

to be more confident of, and more satisfied with, the information that they acquire, if they believe that it is provided by *the* authoritative source.

(ii) Frequent, Short, Timely Sessions with a High Visual Content and a Large Audience: It is thought that training which is high frequency, short, urgent, has a high visual content and a large audience is well-suited to VIF demonstrations. Sessions which up-date technicians about the latest version of a product frequently have these characteristics. Such sessions typically last for one day, and are relatively frequent. It is also important that they are well-timed. If training is not delivered rapidly, the next version may have been released. If not all technical and sales personnel receive training at approximately the same time, the launch of the product may fail to be truly nation-wide and co-ordinated with other activities, such as promotional campaigns. Demonstrations of equipment from the CD are typically sufficient for the technicians to do perform the required tasks themselves. They are already familiar with the equipment to some extent. Demonstration from a single location eases the logistical problems associated with this sort of training. Delivery from regional training centres would require many pieces of equipment to be transported around the country.

(iii) Financial Costs: Generally speaking, the financial cost of a VIF session is of the same order as a course in a regional training centre. Many costs are approximately similar. For example, the cost of producing a cardboard chart is the same, whether the chart is used in 4 VIF sessions or 50 face-to-face sessions. Occasionally, for example, where long distance travel and overnight stays by large numbers of trainees are avoided, VIF may achieve cost savings. But generally speaking, cost savings are unlikely to be the primary motive for using VIF.

(iv) Preparation: A VIF session may take around 30% more effort to prepare than a face-to-face session. The increase is such that schedules need to explicitly accommodate for this extra effort. Considerable liaison and planning with VIF staff and tutors is essential for an effective broadcast. That said, a period of 6 - 8 weeks (duration, not effort) and a few meetings with the production team is typically sufficient, and is rarely prohibitive.

(v) Attitudes Towards Conventional Training Centres: Some tutors and trainees positively like visits to regional training centres, because, despite

the disruption such visits involve, they isolate the trainees from other distractions, and offer trainees a trip away from home, and an opportunity to socialise.

(vi) Quality of Training Service: The centralisation of the VIF service considerably simplifies the logistics of organising a large training programme. It is easier to liaise with a central service that feels responsible for the delivery of the whole programme, than up to 70 regional training centres, each of which are only responsible for part of the whole programme.

(vii) Involvement in the Training Process: With VIF, project managers may become more involved in the training process, from conception to delivery. For example, he or she is encouraged to help prepare the sessions, introduce and attend the broadcast, and participate in 'live' feedback about the session at it closes down. Such involvement may be very satisfying, interesting and challenging for the project manager.

(viii) Obstruction to the Achievement of Learning Goals: It is possible to rapidly overcome the apparent barriers to training with VIF, such as the need to speak in public, and the presence of cameras and unseen individuals on other sites.

In summary, certain types of training, such as demonstrations of equipment which involve key specialists appear well suited to VIF. Project managers may also be attracted to VIF by the opportunity for greater involvement in the training process, and the service that VIF provides. The financial costs, the need for preparation and the technology need not prohibit the use of VIF.

### 4.3. *Comments*

The considerations that underlie the decision to use LIVENET and VIF appear to be similar in the following respects. First, the apparent intrusiveness of the technology is just an initial impression. Both systems are soon found to present few obstacles to the achievement of learning goals and not to impinge upon participant's moment to moment awareness to too great an extent. (Some exceptions to this rule are considered in the next Section.) Note, however, that both LIVENET lectures and VIF

demonstrations are structured to enable effective teaching within the limitations of the technology. Second, both LIVENET & VIF encourage the involvement of key experts. In the University of London, such involvement was expressed as a reason to collaborate. In VIF, it was expressed in terms of trainee contact with authoritative sources of information. Third, both LIVENET and VIF require more preparation than the conventional alternatives. LIVENET sessions require a little more preparation, and VIF sessions require quite a lot more.

The considerations that underlie the decision to use LIVENET and VIF appear to be different in the following respects. First, the decision to use VIF significantly impacts the task of project managers. They are said to be relieved of administrative difficulties and encouraged to participate throughout the training process. LIVENET, in contrast, has less impact on lecturers. Lecturers are already fully involved in the conception, preparation, delivery and evaluation of their courses, and the increase in logistic difficulties is thought to be marginal. Second, the VIF production team and tutors are more capable of exploiting visual images for teaching purposes than LIVENET. VIF devotes considerable equipment and human resources to the achievement of high production values. LIVENET, in contrast, seeks to simplify the task of producing a broadcast, so that a tutor may use the system unaided and with a minimal amount of training.

This concludes the review of reasons for using LIVENET and VIF.

## 5. Delivering Distance Learning Sessions

As suggested by the previous remarks, there is an 'art' to conducting effective interactive audio-visual learning sessions. This Section presents some advice for individuals about to conduct such a session for the first time.

The advice is categorised according to the point in delivery at which it needs to be considered. There is a separate section for preliminary experience with ISDN. The advice was acquired by informally interviewing two tutors, viewing video-tapes of sessions and by asking human factors evaluators familiar with such sessions to comment on the draft. For VIF, a session director was also interviewed.

### 5.1. *LIVENET*

*Preparation of Material*

(i) Innovating Other Aspects of the Course: Some lecturers do not to attempt to innovate their lectures too much at the same time as transferring them to LIVENET. It is difficult enough to learn how to perform well on LIVENET, let alone refine other aspects of ones teaching at the same time. It is better to vary just one thing at a time. LIVENET administration can often provide helpful suggestions about how to adapt existing material and delivery style to LIVENET.

(ii) Lecturing to Relative Strangers: Generally speaking, LIVENET tutors make a special effort to find out about the students that they are to teach over LIVENET. A lecturer tends to know the interests, personalities and abilities of students registered with his or her own department. But students on collaborative courses taught over LIVENET may be relative strangers.

(iii) The Size of Visual Material: Visual material for the overhead camera need to be somewhat bigger than those suitable for an overhead projector. TV monitors in LIVENET studios are smaller than, and of a different shape to, the projection screen in a lecture theatre.

*Configuring the Technology*

(i) Transmission Quality: Image break up may be very distracting and disruptive. Electronic feedback, and crunching sounds caused by students bumping into poorly placed equipment, is too often an intrusive irritation. Contributions that are difficult to hear are also irritating. (also Pugh et al., 1992)

(ii) Comfort: It may become noisy in studios, particularly when there is simultaneous activity in all other studios. (Audio links between all studios are permanently open.)

*Giving the Lecture*

(i) The Student's Model of LIVENET: Generally speaking, at least initially, students do not have a clear understanding of the system. Students may not fully appreciate that they may be seen and heard at all sites, and so behave as though they are not really present. They may do things sitting at the front of the class they would not normally do unless they were sitting at

the back (talk, fall asleep etc.). Also, the behaviour of tutors or students at other sites may be mis-interpreted. For example, a casual aside directed at an individual in the tutor's studio who is out of shot, may appear to the students as being directed towards them.

Telling students about LIVENET does not seem to be sufficient. They need to try the system out for themselves, or have it demonstrated. It is also conventional to open LIVENET lectures with some informal interaction, 'just to get things going'.

(ii) The Student's Expectations of Audio-Visual Broadcasts: Students' responses to LIVENET suggest that their expectations of the session are heavily influenced by broadcast television and home video. For example, some students may not expect to interact with other studios, so when a tutor asks 'Are there any questions?', the remark may be assumed to be addressed to an unseen audience in the tutor's own studio.

(iii) Synchronisation of Sound and Image: In LIVENET lectures, either the lecturer or the visual material, but not both, may be broadcast at any point in time. Consequently, as soon as visual material ceases to support the spoken commentary, it should be replaced by a shot of the lecturer. Otherwise, students attend to the visual material rather than the commentary, even when the image has ceased to be relevant.

(iv) Management of the Image: Lecturers need to consider how the students are to ‘read’ the images that are broadcast. That is, lecturers need to consider the meaning of broadcast images as a film director might. For example, if the tutor is absent from the screen for too long, students may forget that the session is a ‘live’ broadcast and that the lecture is interruptable. A certain ‘visual texture’, or rate of change to the image may help to prevent students from becoming bored or visually fatigued.

(v) Eye Contact: Eye contact is important for establishing personal relationships. Lecturers who do not look at the camera tend to look evasive or shifty and miss an opportunity to encourage interaction.

(vi) the 'Rolf Harris' effect: Drawing 'live' on a TV screen, say some lecturers, is far more impressive than drawing on an overhead projector. It may help to entertain and gain the attention of the students.

(vii) High-Tech Paper Darts: Although students are not required, or expected, to operate the equipment in their site, for some students, the desire to zoom in on themselves or up other people's noses, is irresistible. This may be disruptive, but may serve a purpose (see ‘the student’s mental model’), and adds to the excitement of a new situation.

(viii) Typical Errors and Difficulties: The following errors and difficulties frequently arise in LIVENET sessions: (i) the lecturer forgets to place visual material beneath the overhead camera before cutting to the overhead, and so displays a blank screen; (ii) the lecturer forgets to cut to another camera, and displays inappropriate information for too long (see ‘synchronisation of sound and image’); (iii) the lecturer forgets to reset the overhead camera after having zoomed in or scanned an image. The next time there is a cut to the overhead camera , the cut is to a detail of the next overhead, or to an off-set overhead, rather than to a full, centred screen; (iv) because the only image of the students received by the tutor is a shot of the whole class, it may be difficult to visually spot a student who wishes to ask a question. It may also be difficult to identify a student and distinguish their gestures or facial expressions.

*ISDN*

(i) Tutor's Requirement for Digital Feedback: If ISDN images are to be of low quality, tutors need to know how exactly how this low quality image will appear. For example, visual material displayed via the overhead camera blurs badly at 128kBit if the material is not absolutely still. Tutors tend to adjust material quite often, either to re-position it or just because their hand is resting on it. If tutors see only a high quality image, they are unaware of the distortions that some students are viewing.

(ii) Scripts as a Means of Coping with Transmission Delay: Transmission delays between the the studio connected via ISDN links and studios on the video-conferencing network were such that turn-taking was difficult, particularly when the session was led jointly from the ISDN studio and another studio. In later sessions, tutors developed a simple script for the lecture that listed hand over points and phrases.

(iii) Bandwidth Requirements for LIVENET: In LIVENET, a conventional studio receives sound and images from each participating studio, that is, at least 2x128kBit assuming three participating studios and basic image

quality, or 4x386kBit assuming five participating sites and better image quality. Thus, the bandwidth requirement for LIVENET increases exponentially with the number of participating studios. As would be expected, the absence of such bandwidth may result in feelings of exclusion and the errors and difficulties associated with poor system models.

(iv) Preference for High Bandwidth: Tutors, who are generally aware of the alternatives, tend to prefer 386kBit to 128kBit.

In summary, then, preparation for a LIVENET lecture involves finding out about the class, modifying overheads and resisting the temptation to do additional work immediately that may be deferred. Delivery of the lecture focuses on the production of images that effectively support the verbal presentation and break down the barriers to interaction. There are also some rudimentary presentational techniques to be learnt.

5.2. *VIF*

*Preparation*

(i) Inequable Opportunities for Learning: CLRs are considerably less interactive than CLIs and lack of interactivity is likely to severely disadvantage some trainees, or to make them feel excluded or discriminated against. Consequently, only CLIs participate in training broadcasts.

(ii) Notification of the Training Session: As cycle times for training reduce when VIF is used, so trainees have less time to register their interest in the training. Sometimes trainees fail to register in time. Since subsequent VIF sessions may be arranged relatively easily, late registration does not pose too much of a problem.

(iii) Collaboration between the Project Manager and the Production Team: Collaboration between the project manager and the production team is essential to provide adequate delivery of the broadcast and a satisfactory service. For example, to devise an appropriate structure for the session, the production team need to understand the expectations of the project manager and the context in which the training is to occur.

(iv) Breaks: The duration and distribution of breaks and pauses in a session needs special attention. Watching television for long periods of time may be mentally and physically demanding. Taking questions every 20 minutes or so, sustaining a rhythm and avoiding 'dead time', as when one CLI does nothing in order to let another studio catch up, helps to minimise fatigue. It also.

(v) Homogeneity of Trainees: Trainees should be carefully selected so that they all have similar interests and a similar level of experience. If a group of trainees is too varied, then the learning objectives of some of them may not be met.

(vi) Feedback and Re-Design: If a series of sessions is planned, feedback from early sessions may help to refine later sessions. Consequently, later sessions tend to be delivered better than earlier sessions.

*Mise en Scene*

(i) Implementing a Plan: VIF sessions pursue explicit objectives and follows explicit plans for how these objectives are to be achieved. A VIF training broadcast is often highly constrained, and must adhere to the script and the schedule for the day.

(ii) Salience of the Visual Channel: Information conveyed through images is said to be further emphasised by VIF, relative to information conveyed through speech. The salience of the visual channel may be exploited. For example, rather than describe the response of a computer, the response may be simply shown.

(iii) Content and Focus of the Visual Channel: Visual images may rapidly convey a lot of information. Images are also highly selective - they show a small proportion of what could be shown. For example, it is possible to broadcast a close-up, or a long shot, and the close-up contains information that is not in the long shot, and vice-versa. Given the salience of the visual channel, the selection of the image is particularly important.

(iv) Visual Support for the Auditory Channel: If the visual image does not support the spoken commentary, the focus of the session may be lost. For example, if the camera points towards an individual who neither posed, nor

is answering, a question, then the viewer's attention may seep away from the discussion and onto the person on the screen, although he or she may not be involved in the discussion. Displaying the discussants facing each other also helps to maintain a sharp focus.

(v) Demonstrations Make Good VIF Sessions: Demonstrations of equipment appear to be well-suited to VIF. For example, close-ups on the equipment may illustrate its handling and operation in detail and each trainee gets a good view. Also, there are ways of staging demonstrations such that interaction between tutor and trainees arises naturally. For example, if a trainee is unable to follow the tutor's instruction to dismantle the equipment in a particular way, then the trainee naturally asks the tutor for assistance. The tutor then guides and comments on the trainee's actions step-by step.

(vi) Bespoke Shots: It is often worthwhile designing specific shots to support particular segments of the training. Such shots effectively communicate the meaning of the session and users may find visual images attractive (see example in Section 2).

(vii) Dialogues: When there is a dialogue between the CD and a CLI, both participants may be displayed on the screen side by side. When a telephone call from a CLR is received, an overhead shot of the CD studio may the better than focussing on the tutor throughout.

(viii) Separating Sections of a Session: Jingles and introductory titles help to distinguish separate sections of training.

*Configuring the Technology*

(i) Comfort: For long sessions, the quality of the studio as a working environment becomes important. Appropriate lighting, number and arrangement of screens, and support for writing is required.

*Giving the Training*

(i) Role of Tutors: Some tutors need to be reminded that a VIF session is training and not television. Tutors are still tutors, not just actors. Although VIF places many constraints on tutors, it is still possible to deviate from the script to engage in normal teaching and social practices, such as taking the time to establish a rapport with the students.

(ii) Models of the System: It is said to be a good idea to reserve time at the beginning of the session to describe procedures for turn taking and communication, introducing the tutors and learners to each other, and soliciting informal, social interaction from the group. For longer sessions, periods for concertation ('putting ones heads together') within each distributed group may also be necessary.

(iii) Large, Long Sessions: Large, long sessions require special attention because such sessions typically require precise time management and communication procedures. The risk is that such demands may formalise the session so that it loses its flexibility, spontaneity and conviviality. Consequently, there is a need to actively break down reticence, reluctance to contribute and to gain the audiences confidence.

(iv) Interaction with Trainees: Certain individuals, perhaps because they are at their ease speaking in public or in leadership roles, seem to ask more questions than others. Trainees who are unused to expressing themselves verbally, such as technicians, may need particular encouragement.

(v) Getting Interaction Going: Particularly early on, trainees may be a little uneasy about asking questions. Tutors may encourage interaction by, for example, warning learners that they will be asked questions, and directly asking each CLI in turn for questions, rather than making a single general request. If no questions are forth-coming, then just being sociable may help, for example, asking about the weather or the traffic at the remote site. It also helps if tutors devise tasks which precipitate interaction naturally. For example, a practical exercise may require trainees to contact the CD to . Further, when a tutor says, "Are there any questions?", the director may combine a shot of the tutor with a shot of each CLI, and then flick through the CLIs. Thus, a broadcast may visually beg for questions.

Using such techniques, by the end of a day long session, much of the early reticence has typically disappeared.

(vi) Intrusiveness: Generally speaking, the studio is not intrusive, but the heat of the lights may be difficult.

(vii) A Sense of Occasion: A VIF demonstration is a change from the daily routine and, like other 'live', international public events, it may generate some atmosphere.

(viii) Typical Errors and Difficulties: The following errors and difficulties frequently arise in VIF sessions: (i) deviation and falling behind schedule. Unexpected events may be difficult to react to, and still deliver all the material in the time allowed; (ii) getting noticed - to ask a question, a trainee first needs to gain the director's and/or the tutor's attention. It may be difficult for tutors to identify trainees who wish to ask a question, particularly if tutors have to examine a groupshot of a large class, or the CLI is poorly lit. From the trainees point of view, it is difficult to know why the CD has not responded to a trainee's signal that he or she had a question. Was the signal seen ? Had they run out of time ? Was it another CLI's turn ?

*ISDN*

(i) Kaleidoscopic effects: With full screen images, panning, zooming or moving the camera, and shots in which 'actors' walk across the frame, tend to cause blurring and distortion at 128kBit. Trainees may find such effects to be comical, fascinating or sickness-inducing. In any case, the effect is likely to be disruptive and tutors temporarily 'lose control' over their audience. The effects are less noticeable with smaller images. At 386kBit, similar production causes smearing, which is more acceptable.

(ii) Loss of Dynamic Aspects of Non-Verbal, Personal Interaction: At 128kBit, a full screen image of a tutor appeared as a rapid sequence of stills, rather than a smoothly flowing image. At this rate of transmission, the dynamic elements of non-verbal communication, such as gesturing, were lost, leaving only facial expression and posture. Nevertheless, a 128kBit image could provide an informative and intersting focus to the session.

(iii) Getting Noticed: The resolution of a 128kBit image is noticeably less than that obtained via the conventional video-conferencing network. This does not make getting noticed any easier.

In summary, then, a smooth VIF demonstration adheres to a well-prepared plan, and exploits visual material to communicate, and to keep the trainees interested and alert. The design and delivery of the broadcast provides

many opportunities to interact, tutors and trainees must have appropriate expectations and models of the system.

### 5.3. *Comments*

From the point of view of conducting a session, LIVENET and VIF appear to be more similar than different. LIVENET and VIF are similar in that, first, both systems require additional effort to be expended finding out about, and receiving feedback from, learners. Distributed classes tend to be larger, more varied and less known to tutors than classes taught face to face. The physical separation of tutor and class may also make obtaining background information and feedback more difficult. Second, LIVENET and VIF also appear to be similar in that both further emphasise the visual channel as a means of communicating and exchanging information. Consequently, learning sessions must be designed to convey information visually and to display images that support the spoken commentary. Third, both LIVENET and VIF are thought to encounter users with inappropriate mental models of the system and expectations of the session. In many important ways, live, audio-visual broadcasts are unlike television, and the participants soon learn, through participation, to interact with the novel environment. Fourth, both systems are said to induce a sense of occasion in users, but require them to work in less than ideal conditions. Finally, in both systems, an ISDN network may be substituted for a conventional network without raising a different type of Human Factors issue. For example, distorted images tend to disrupt the session, whether they have the character of 'break up' associated with satellite broadcasts or the kaleidoscopic effects associated with ISDN. Poor resolution limits non-verbal communication, whether it is due to a poorly framed camera, a poorly lit studio or an inadequate data rate.

With respect to differences, LIVENET is said to exert minimal impact upon the nature, content and duration of teaching. Conventional material and its delivery must be adapted to LIVENET, but such adaptation is relatively limited. VIF, in contrast, is said to exert much more influence, and considerable work is involved in conceiving and delivering an effective broadcast. Unless tutor and director work closely together, the essential work of adaptation may not be achieved.

This concludes the consideration of delivering distance learning sessions.

## 6. Design Heuristics

# Submission

Previous Sections have collated, and compared and contrasted some of the experience of using two systems for interactive audio-visual communication in distance learning.

Reflection upon this experience suggests eight design heuristics. The heuristics suggested are:

(i) encourage the involvement of otherwise unavailable experts. The involvement of such experts is one of the principal means by which LIVENET and VIF aim to increase the quality of tuition provided.

(ii) encourage other, non-training uses of the system/network. Since usage of LIVENET and VIF for training purposes is unevenly distributed, one simple way of increasing cost-effectiveness, is to find other uses of equipment and facilities.

(iii) exploit visual images, both to communicate information, and to support verbal presentations. Visual images tend to be the salient means of communication and significantly impact many aspects of interaction and effectiveness. Also, interesting images are less fatiguing for the viewer.

(iv) try to avoid technology-induced discrimination. Technology frequently varies in its nature and spreads at different rates. If the equipment and facilities at one site are inferior to those at another, then learners at different sites will not have an equal opportunity to participate and learn.

(v) encourage tutors and learners to transfer to the distance learning situation their prior knowledge and expectations of conventional face-to-face teaching, such as lecture theatres, rather than conventional television and home-video. The interactivity of the former is an important characteristic for users to understand.

(vi) design facilities and the session to provide tutors and learners with opportunities to learn about the other participants, and what they can see and hear. Some options include: telling participants about the system; having frequent breaks for informal, social use of the system; or making comments that illustrate what you can see and hear, such as 'Would the gentleman who has just entered with a cup of tea like to ask a question?'

(vii) actively encourage interaction. Tutors and learners need new skills to participate in interactive broadcasts. Prompting and guiding interaction, and explaining its rules, helps learners to acquire these skills and feel confident about using them. Tutors may need minimal training.

(viii) reassure tutors the apparent intrusiveness of the technology is just an initial impression. Although the technology does place some constraints on tutors, most tutors soon become immersed in the act of teaching. Conventional practices, such as pausing to get feedback and establish a rapport with learners, are still possible.

In the following paragraphs, these heuristics are used to evaluate an initial proposal for the addition of ISDN links to LIVENET. Interviews are reported to have been a successful element of some interactive training broadcasts delivered over conventional networks (Catchpole, 1986). The proposal is that, during question and answers at the end of a lecture, a LIVENET tutor contacts through a networked computer a University of London researcher whose work is relevant to the lecture. The tutor "interviews" the researcher, putting questions to him or her on the students behalf. Such an interview may help to resolve issues that are not addressed by written work, could expose students to alternative points of view. Contact with the author of required reading may make study and research a more human, and exciting activity.

*Unavailable Experts at the University of London*

The proposal encourages researchers to participate in the distance lecture. In the University of London, the output of a research group often becomes part of the Department's undergraduate syllabus. Researchers are frequently too busy to deliver every seminar or lecture that addresses their work. However, they may be willing to be interrupted by desk-top video-telephone, particularly if they find contact with students progresses their own work.

*Possible Non-Training Uses of ISDN links to Researcher's Desk-Tops*

The proposal makes use of networks primarily installed for research purposes. University of London research projects are increasingly conducted by national, or international teams, who are brought together to achieve specific objectives. ISDN links have the potential to help members

of the research team, who may not have known each other previously, to establish working relationships with their colleagues and work together frequently and effectively. These ISDN links could also be used for distance learning.

*Visual Images that Support Temporary Participation in LIVENET Lectures*

From a students perspective, a head and shoulders shot of the researcher broadcast, combined with an image of the tutor, is likely to be sufficient to support an "interview". As a minimum, the researcher may require a head and shoulders shot of the tutor, plus some reminder of the presence of the students. Such images could easily be provided by an adpted video-telephone facility on a desk-top computer, together with relatively narrow (128kBit) ISDN link.

*Potential for Discrimination*

Provided that sound and images of the researcher are combined with those from the tutor's studio prior to broadcast, all other things being equal, each student studio should have an equal opportunity to learn from the interview.

*Face-to-Face Versus Television Metaphors*

The "interview" format encourages a television metaphor. Perhaps such an interview should only be conducted towards the end of sessions by experienced tutors, that is, once appropriate system models have been established.

*Opportunity to Learn About Other Participants and What They Can See and Hear*

The researcher is unlikely to have the time to learn about either the students or the system. Consequently, the researcher should communicate primarily with the tutor, who is likely to be the researcher's colleague, and only utilise conventional video-phone functionality.

*Encouragement for Interaction and The Initial Impression of Intrusiveness*

Since the interview is to occur towards the end of a session, and is to be delivered by an experienced tutor, its impact on interaction and the impression of intrusiveness is likely to be minimal.

There is no guarantee that the idea of researchers briefly participating on an occasional basis in LIVENET teaching would be effective. However, of the many options for the future development of LIVENET, at least the rationale for this option is explicit and based on the common experience of such systems in general.

## 7. Conclusion

This paper has collated only a fraction of the craft knowledge that is potentially available. No doubt, additional experience and heuristics could be acquired by using other techniques, involving other individuals or considering other systems.

The knowledge and heuristics acquired appear to generalise to other distance learning systems similar to LIVENET and VIF. For example, Norwegian Telecom's experience also suggests that people may be initially uneasy about the technology and that technology may be used to encourage contributions from remote groups (Kristiansen, 1990). The Canadian Navy have also attempted to make their system as similar as possible to face-to-face instruction (Simpson, Pugh & Parchman, 1991). The LIVENET and VIF experience also appears to generalise to less related forms of distance learning. For example, the Open University's experience of computer conferencing suggests that the introduction of new distance learning technologies may also have implications for equality of opportunity. The tutors ability to encourage interaction is also important (Mason, 1989). Let us hope that a way of applying the experience of LIVENET and VIF to computer supported collaborative work more generally may be found.

With respect to the integration of A-V and IT in interactive audio-visual communication systems for distance learning, it is notable that this paper has considered one aspects of integration - ISDN networks as a substitute for, and extension of, video-conferencing networks. Future work needs to consider other aspects of integration, such as computer systems as platforms for the delivery of live, audio-visual broadcasts, or the use of computer-based training programmes during such broadcasts.

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# Submission

Figure 7. Amount and Type of LIVENET Usage

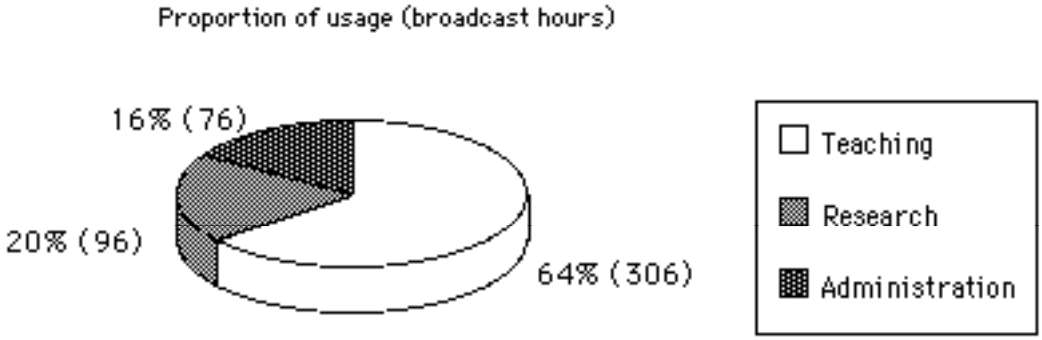



Figure 8. Distribution of LIVENET Usage (Teaching)

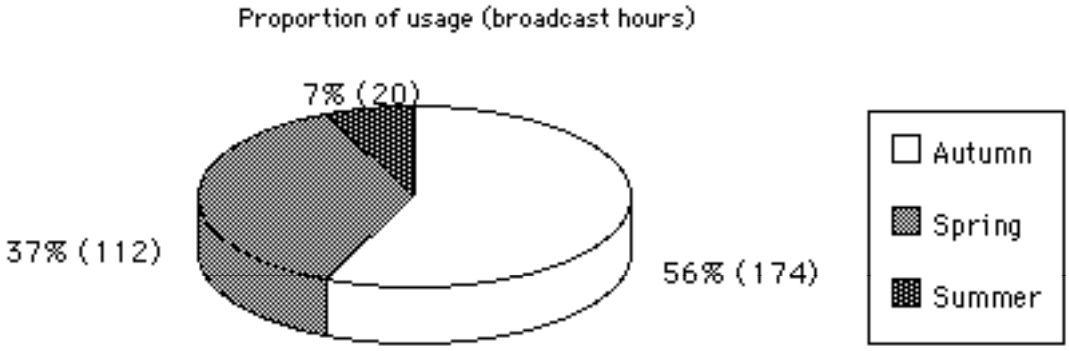



Figure 9. Extent of Collaboration with LIVENET

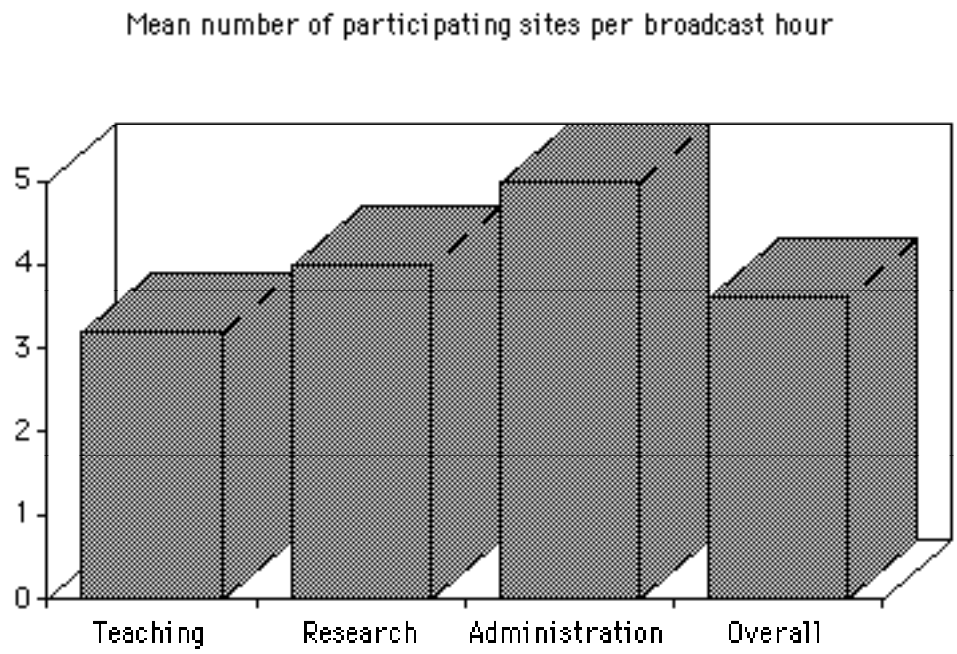



Figure 10. Amount and Type of VIF Usage

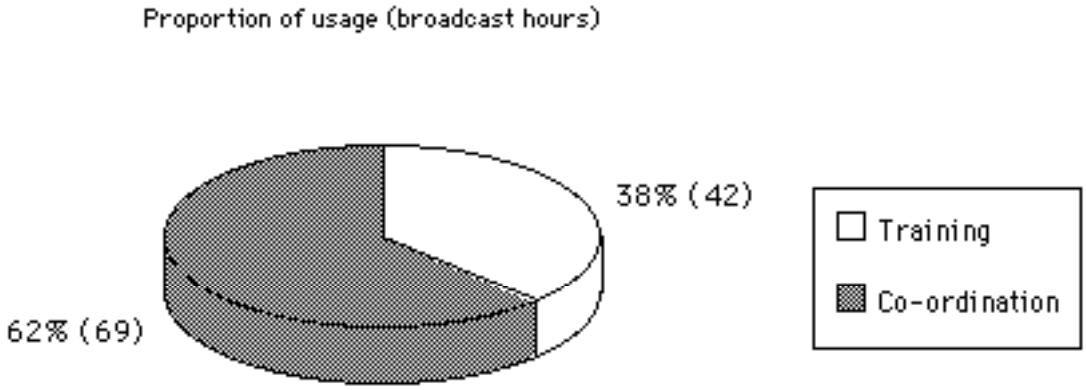
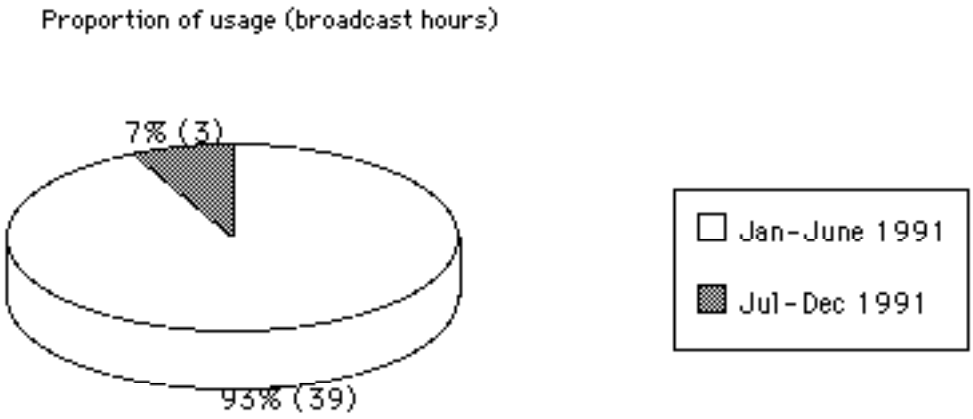



Figure 11. Distribution of VIF Usage (Training)



Amount of LIVENET Usage

| Activity | Absolute (broadcast hours) | Prop'n of total use (%) |
|---|---|---|
| Teaching | 306 hrs. | 64% |
| Research | 96 hrs. | 20% |
| Administration | 76 hrs. | 16% |
| Total | 478 hrs. | 100% |

Distribution of LIVENET Usage

| Term | Absolute (broadcast hours) | Prop'n of total use (%) |
|---|---|---|
| Autumn | 174 hrs. | 56% |
| Spring | 112 hrs. | 37% |
| Summer | 20 hrs. | 7% |
| Total | 306 hrs. | 100% |

Extent of Collaboration with LIVENET

| Use | mean number of participating sites per broadcast hour |
|---|---|
| teaching | 3.2 |
| research | 4.0 |
| administration | 5.0 |
| overall | 3.6 |

Amount of VIF Usage

| Activity | Absolute (session days) | Prop'n of total use (%) |
|---|---|---|
| Training | 42 days | 38% |
| Co-ordination | 69 days | 62% |
| Total | 111 days | 100% |

Distribution of Usage

Submission

| Season | Absolute (session days) | Prop'n of total use (%) |
|---|---|---|
| Jan-June 1991 | 39 days | 93% |
| Jul-Dec 1991 | 3 days | 7% |
| Total | 42 days | 100% |