Report on

Information and Telecommunication Technologies applied to Education and Training

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Purpose of the report

This document is the report of the Review Board on "Information technologies and telecommunication technologies applied to education and training". Article 4.2. of the Council Decision 91/353/EEC requires the Commission to review the Telematics Programme and send a report to the European Parliament and the Council. The report shall be accompanied where necessary by proposals for amendment of the programme. In this context a peer review of Area 4 (Flexible and Distance Learning) of the Telematics Programme has been set up: the Review Board on "Information technologies and telecommunication technologies applied to education and training". It will provide strategic level input into the overall Review of the Telematics Programme ("The Mid Term Review").

The Review Board met on five occasions in the period March to May 1993. The objectives of the Review Board on "Information technologies and telecommunication technologies applied to education and training"are to provide strategic level input on:

1. Implementation of the action on Telematics Systems for Flexible and Distance Learning under the Third Framework Programme.
2. Orientation of the current action
3. Requirements and strategies for future research and development in the domain of telematic systems for learning.

The members of the Review Board are:

Mr. Curran	**National Distance Education Centre**	**Ireland**
Mr. Natoli	**RAI**	**Italy**
Mr. Menahem	**Association pour la Recherche et le Développement de l'Informatique Pegagogique (ARDIP)**	**France**
Mr. Musto	**Confindustria**	**Italy**
Mr. Rebelo	**Petrofina**	**Belgium**
Mr. Ortega	**Polytechnics Madrid**	**Spain**
Mr. Haldane	**Staffordshine Open Learning Unit Chairman of British Association for Open Learning**	**UK**
Mr. Perriault	**CNED**	**France**
Mrs. Olesen	**UNI-C**	**Denmark**
Mr. Lindsay	**Employment Department**	**UK**

The report is divided in four chapters:
Chapter 1 addresses the rationale for R&D in the domain of flexible and distance learning.
Chapter 2 assesses the current action under the Third Framework Programme
Chapter 3 addresses the main mission for a future R&D action in this domain and defines its target groups and scope.
Chapter 4 contains the recommendations on future R&D actions addressed to those who will draft a new Framework Programme, and considers the options for its implementation.

The Review Board wants to thank the rapporteur, Mr. Chris Curran as well as the DELTA office for the excellent support.

Executive summary

1. Rationale

Life-long learning by use of technologies -

The implications of technological change for lifelong learning and human resource development in Europe will be significant. The potential role of flexible and distance learning, in meeting this challenge, is recognised. It provides a flexible, accessible, and potentially cost efficient means of extending high quality education and training to individuals and enterprises throughout Europe. The application of learning technologies in flexible and distance learning, could reinforce and expand its role in widening access to lifelong learning, and in equipping the workforce with the required skills and expertise. The role of learning technologies restricted to flexible and distance learning, they may additionally complement, replace, and enrich more conventional modes of education and training.

Learning in the 21st century

For all citizens of Europe

Meeting the need for lifelong education and training through learning technologies could provide a service for all citizens of Europe. Autonomous learners, employees of small and medium sized enterprises and highly skilled professionals will benefit from this. In addition to contributing to the competitiveness of European industry, learning technologies could potentially have an important social role in reducing the instance of unemployment in disadvantaged regions; facilitating the reskilling of the labour force, meeting the needs of those with disabilities, and extending access to individuals and enterprises in remote regions. Technology-based learning could respond to the specific needs and requirements of individuals, especially for those otherwise precluded from participation.

- *Improving industrial competitiveness*
- *Social return*

2. Programme Review

Substantial contribution of Flexible and Distance Learning

The Board reviewed the objectives of the Telematics programme of General Interest in the area of Flexible and Distance Learning which were agreed by the Council Decision of June 1991. It notes the positive conclusion of the Board of Technical Auditors with respect to the progress and results of the programme to date and additionally recognises the positive effect of the programme in widening interest and promoting research in technology-based learning in and between Member States. In general, the programme has made a substantial contribution to flexible and distance learning opportunities across Europe.

The Board considers, however, that the development of this field has now reached a point where the link between technology-based learning and its implementation needs to be developed and strengthened. There is still a gap between technological developments and the needs of users. An increased emphasis should be given in the future to the identification of means to bridge this gap so that technology-based learning is tailored more closely to the needs of end-users. In the view of the Review Board, the market for learning technologies is still relatively underdeveloped and the demand for technology-based education and training needs to be stimulated. Attention needs to be directed towards educational and other barriers to implementation and to the identification of means through which these barriers might be overcome.

Strengthen link with implementation

3. Vision for the future

To support the change from once-in-a-life education to lifelong learning, major efforts should be made to improve access to learning for all citizens of Europe and to improve the efficiency of the learning process. ***To develop and test technologies which improve access to and efficiency of education and training should therefore be the mission for the future programme for R&D in telematic applications for flexible and distance learning.***

Priority mission: *Improving access to lifelong learning*

To accomplish this mission the future R&D actions should be embedded within a more global context of putting research into practice through experiments, development and pilot applications projects.

Scope of Priority mission: *Putting research into practise*

The implementation of large scale demonstration projects, which would operate as testbeds for trans-national technology-based learning, is recommended. This approach, and a commitment to respond more directly to user needs, would provide a basis for addressing issues arising from the application of technology supported learning. Issues to be addressed should include the pedagogical effectiveness of technology-based learning; its cost efficiency; the identification of ways in which cultural and language barriers can most easily be overcome; the exploitability and reusability of learning materials and their adaptation to divergent cultures; and the identification of appropriate management and organisational structures to support an extensive, diversified, complex and multifaceted infrastructure.

Testbeds for future implementation

User led

The technologies should be tested within real-life education and training environments, with projects based on practical, testable hypotheses. A further important factor to be examined would be the potential to extend the user basis and the applicability of technologies to the whole education and training sector. The latter would include autonomous learners, employees of small and medium sized enterprises, specialised

professionals and learners from educational institutions in general. The experimental operation of large scale pilot studies would allow the European added value of transnational co-operation to be assessed and should provide a basis for a productive synergy between national and international initiatives in the development and delivery of technology-based learning. A number of complementary measures should be undertaken to diffuse the learning services to a wider public.
To ensure that these infrastructures are able to integrate new technologies and are able to cater for the opportunities they open up, it is important to research the possibilities emerging technologies provide for learning.

4. R&D actions for the future

To achieve the aims set out in the preceding paragraphs, four interlinked area of research and development actions have been defined by the Review Board. The first three actions describe the research to be undertaken in order that emerging telematic and education infrastructures should serve all types of learners and learner settings. The objective of these actions is to undertake research and development on the components of these infrastructures and on issues related to their interconnection, and to examine related longer term research topics such as high performance computer networks for learning. The fourth action is concerned with accompanying measures for diffusion and implementation strategies.

Research for integrated infrastructures for lifelong learning

The first area of R&D actions should be concerned with enabling a Europe-wide decentralised network service infrastructure and to interconnect networks for lifelong learning which would enhance learning services and potentially open the vast potential of traditional education and training. In essence, it is proposed that a testbed facility should be established, proposed as a network of networks; to provide for decentralised access through regional nodes such as centres of expertise and resource centres. It is envisaged that the network would function as a clearing house on the lines of a brokerage model, which would allow providers of education and training easy access to course delivery and provision, while affording users easy access to learning services and related products.

Learning applications and systems

The second area is closely related to the first, and is concerned with research and development on components of information technology and telecommunications-based learning environments, and interaction within these technology-based media. Areas to be examined would include the application of new cognitive models and theories as a basis for the pedagogy of technology-based learning; the design and production of technology-based learning materials and services; the

adaptation of communication systems to learning; interfaces for retrieving material from bibliographic databases and virtual libraries; and for automated self-evaluation; assessment; and accreditation.

Research into advanced systems

The third research area is proposed on basic longer term research on learning technologies for the year 2000 and beyond. An important ancillary objective is to develop further visions on the learning network for the future. Areas requiring further research are: customised and embedded learning, services for mobile learners, trials of broadband services for learning, and virtual presence applications, together with research on interactive and immersive learning.

Diffusion and implementation strategies

The final research area is concerned with measures for diffusion and implementation strategies. This is an important activity to ensure that the results of research are disseminated to a wide audience and to create an awareness of the potential the new technologies offer in education and training. It was proposed in particular that demonstration centres should be established within the nodes of existing and emerging infrastructures, which among other activities would function as a natural focus point for dissemination activities.

1. Rationale: Learning in the 21st century - lifelong learning by using technologies

1. Information and Knowledge Society

Europe today is in transition toward an "information and knowledge society". The technological transformation in telecommunications and information technologies presents a challenge and an opportunity with potentially profound implications for industry and learning.

1.1. Implications for Industry

The primary challenge for industry emerges from the effect of this technological change in increasing global competition; accelerating the pace of change in process and product innovation; and in reinforcing the decline of traditional industry. Furthermore knowledge and expertise (especially in high technology areas) are becoming very specialised and concentrated in a few centres spread out over Europe. The pressure on industry will be all the greater because this technological transformation is happening at a time of increasing economic integration, with a concomitant increase in the intensity of international competition for both traditional and new industries.

However, this technological change also offers opportunities to European industry. The capacity to generate new ideas, and to disseminate information quickly and easily, will lead to an exponential growth in the volume and kind of information exchanged, and so provide the means of improving productivity and increasing innovation in industry. This exchange could become a primary resource for generating economic prosperity, and improving the quality of life, by increasing European competitiveness.

1.2. *Implications for Learning*

The implications of technological change for lifelong learning and human resources development in Europe will be significant. The IRDAC Report concluded that education and training issues related to industrial competence and competitiveness have an overriding importance in relation to the future well being of Europe and its citizens. Overall the quality of human resources will be the key factor in ensuring the competitiveness of European industry in the global market place. The education and training system must play a significant role in meeting the needs of European industry for a highly skilled workforce. The development of high technology industry and the wider application of technology based communications in the services sector will inevitably create a demand for workers with new and more advanced

skills. There will also be a concurrent call for continuing updating of skills. Demographic changes in Europe, with declining birth-rates, and increased longevity will create additional need for lifelong learning. The trend towards greater internationalisation of education and training, both on a European scale and world-wide, due to the scarce and widely diffused expertise and specialised knowledge, is yet another factor which is creating demands on the system. Companies require access to training 'just-in-time' and on specialised topic. It is the view of the Review Group that these many demands on the education and training system cannot be met without the substantial support of technology, which will facilitate new forms of learning to a widely dispersed and diverse range of learners.

Europe has a long tradition of excellence in education. In the past, education has served Europe well, supporting the social, cultural and economic development of its people, and in particular providing the skills and knowledge necessary to create and sustain the development of industrial innovation over more than two centuries. There is now concern, however, that Europe is lagging behind its global competitors. As the IRDAC Report points out, Japan, where "educational development and economic growth have been linked reciprocally" has enjoyed rates of growth of productivity far in excess of the European norm. In the United States a commitment has been made to the development of a high speed infrastructure ("electronic highway") for research and education. This infrastructure is intended to provide an integrated network linking workplaces, educational institutions, communities and homes, thereby potentially providing universal access to education, training and lifelong learning services to the population at large. The challenge facing Europe, therefore, requires an appropriate response from the education and training system.

2. New ways of learning

In this climate of change, education will become a lifelong project, providing for the development of new skills; for continual updating; and for accommodation to technological, demographic, and economic change. This is the real human resource challenge of the future. The challenge will call for opportunities for learning which are not offered by existing education and training facilities.

New ways of learning by using technologies .

Flexible and Distance Learning (FDL), by utilising the potential of technology, can widen access to lifelong learning; improve the quality of education and training; and equip the workforce with the knowledge and skills necessary for competitive industry.

- *self-learning competence*

Motivation is a key requirement for learning, and the use of FDL, by virtue of its capacity to give the learner control over the process of learning (self-learning competence), has an important role in this

connection. New facilities which combine traditional knowledge transfer with technical information retrieval, and dialogue 'on line' with experts, will facilitate the trend towards increased teleworking and teletraining.

The workforce must be equipped to cope with the fast exchange of information, and taught how best to communicate information to others; a view which accords well with the growing consensus that learning systems should not focus on teaching facts, but should help learners to process information and knowledge. Increasing emphasis should be placed on communication and on the social aspects of learning, especially on how to access, structure and communicate information. Learning should be seen as a collaborative process, which stimulates insight and deeper understanding. Active reflection, discovery learning, learning-by-doing, and learning-to-learn are key components, for example in apprenticeship learning and on-the-job training. New technologies open new possibilities to support these learning approaches through performance support systems, job aids, ways to structure knowledge, easy access to information sources. As working and training can be integrated and assessed by the learner the way he/she wants, and when and where he/she wants.

- *collaborative learning*
- *learning by doing*
- *discovery learning*
- *learning to learn*
- *active reflection*

Technologies are not an end in themselves; and are likely to be used only where they provide a better or more cost effective solution, or can complement the more traditional modes of education and training. The appropriate circumstances of such use may not always be self evident. New learning approaches and methodologies should be analysed and developed in order to cope with learning in these technology-supported environments.

3. Learning Needs

There are several factors which reinforce the demand for learning in Europe. The first is demographic; some countries are grappling with the problems posed by growth in the workforce, where the numbers entering the labour market are in excess of those retiring; other countries are facing the problem of declining population. A second factor is the growth of unemployment to which unskilled workers are particularly vulnerable. A third factor is the need to provide for a general rise in the skill-level of the workforce as a whole, or for a reorientation of skills development towards emerging sectors of high employment growth. The economies of most Western European countries are experiencing a decrease in the demand for low-skilled workers, and a corresponding rise in the demand for workers with more advanced skills.

3.1. New Skills

There is a need to launch multi-disciplinary training measures in several critical areas. These areas of need include the greater use of information technology and telecommunications in management and production

systems; the greater importance of effective management of SMEs; the particular needs of widely dispersed industries such as the banking sector; provision for technology transfer to staff in regional locations; and the need to support research and scientific communities. Changes in the organisation of work, for example, the increasing need for the exchange and collation of information in the manufacturing sector, will require the updating of existing skills. In addition, workers will need to attain new 'multi skills' to handle complex and ever changing environments created by technological developments, and expansion in the services sector (for example in financial services, or tourism). Such skills will include complex problem solving, global trend analysis, multi-tasking, handling complex knowledge structures, processing skills, learning-to-learn and mediated communicative skill, and last but not least self-learning competence. The development of such skills for use in virtual environments will become increasingly important. These recommendations are in line with those of bodies such as the Council of Europe[1], the European Round Table[2] and IRDAC[3]. Learning through technologies may enrich, complement or replace traditional education and training schemes in addressing the skills shortages in Europe for technically educated persons, as well as for persons who implement and use technology. The Treaty on European Union (Title VIII Article A) and the Commission's Memoranda on Higher Education and Open and Distance Learning in the European Community, highlight the importance of flexible and distance learning in this regard.

3.2 Professional updating

There is a need to provide for professional updating, especially in relation to the new technologies in areas such as bio-technology, fine chemicals and new materials, and to provide training for cross-disciplinary tertiary specialisations which are vital to industrial development, such as product quality control, design, technical sales, engineering skills, and the management of innovation.

3.3. Redressing disadvantaged

In addition to these specific professional retraining or updating programmes, a general effort should be made to provide education and training to redress disadvantages experienced by particular groups. Learning through technologies could provide a solution to the learning needs of disadvantaged and excluded individuals of groups within European society, such as the homebound, people with disabilities, women re-entering the workforce, and individuals living in remote

1Council of Europe: Enseignement a distance: examen de la premiere partie de l'etude de faisabilite (1992)
2European Round table: Education and Competence (1992)
5. IBIT
4 Council Decision 91/353/EEC, 7 June 1991. The overall programme is part of Directorate General XIII on Information technologies and Industries, and telecommunications, Directorate C of the Commission of the European Communities.
3 Industrial Research and Development Advisory Committee : Skill shortages in Europe (1992)

regions. In addition, efforts should be directed towards upgrading skills of the 18-20 year age group who did not complete their second level studies.

3.4. Lifelong Learning

The need for lifelong continuing education and training is universally recognised. Many education systems have framed lifelong training policies and these are accompanied by specific arrangements in some countries. Lifelong learning through telematics could provide a service for the benefit of society and for each individual European citizen, as well as for the economy. It should respond to the specific needs and requirements of individuals or societal groups, especially for those otherwise precluded from participation. In addition to increasing the competitiveness of European industry, learning technologies could potentially play an important social role, and generate a high social return, in activities such as reducing the incidence of unemployment in disadvantaged regions, the reskilling of the labour force, meeting the needs of those with disabilities, and extending access to individuals and enterprises in remote regions.

4. Need for research

To reap all the potential benefits of technology based flexible and distance learning, research and development is essential. There is a need to focus on new R&D, with a mid- and longer term view, which will enhance emerging service infrastructures for learning . This has been hindered by the lack of clear perspectives on lasting technological solutions and on their efficiency for learning. Questions such as, which technologies are the best suited for different types of learning settings?; and how to overcome isolation using learning applications as an autonomous learner or in an on-the-job situation?; should be resolved through further R&D.

Furthermore we need to increase our practical knowledge of the potential of learning technology to improve access to learning facilities Europe-wide through research and experimentation. This poses a particular challenge as a consequence of the many languages, cultures and regions in Europe; and the scale of the response required to meet new and emerging training needs. There are, moreover, marked variations in the density of population, with consequent implications for economies of scale in the application of technology-based education and training in sparsely populated rural regions. The technological infrastructure to support technology-based education and training is widely divergent between countries in Europe; and as a consequence technology-based training approaches which work in one region may be unavailable, or inappropriate, in another.

As a consequence, Europe faces unique problems in the application of learning technologies and therefore

there is a need for a substantial programme of research and development to support technology-based education and training in Europe.

This R&D may not be confined to the development of new tools and systems for technology-based learning, but should be related to issues such as effectiveness; evaluation methodologies; management and implementation strategies; technological appropriateness; cultural factors; quality control; market research and demand; and learner support.

Such an R&D action will bring together educational researchers with industrial and service sectors such as IT&T manufacturers, software and electronic publishing houses, network operators and service providers. All of them will address jointly education and training from a multi-disciplinary perspective, which will shape the future of European lifelong learning services while boosting the competitiveness of European industry with advanced learning products and services.

2. Assessment of R&D actions within the Telematics Programme for Flexible and Distance Learning

The Review Board has reviewed the objectives of the Telematics Programme of General Interest in the area of Flexible and Distance Learning[4] which were agreed by the Council Decision of June 1991 and presents the following observations.

Community policies and overall goals

Community policies in respect of global competitiveness, the scientific and technological basis of European industry, social and economic cohesion, and the internal market, form the basis of the rationale which underpins the research policies of the Commission of the European Communities. The objectives of the Telematics Programme of General Interest for the area of Flexible and Distance Learning[5] is consistent with these policies and forms a significant response to the goals of the Community policies. The DELTA programme has shown that there is a real potential for harnessing technology to the support of lifelong learning.

The Review Board notes the positive conclusion of the Board of Technical Auditors with respect to the progress and results of the Programme to date, and additionally recognises the positive effect of the Programme in widening interest and promoting research in technology-based learning in and between the Member States. In general the programme has made a substantial contribution to flexible and distance learning opportunities across Europe; in particular those which set up experiments with end-users in real-life settings, and paving the way for increased access and efficiency through the development of new learning systems. However, development of the field has reached the point where the link between technology-based learning and its implementation needs to be developed and strengthened.

Specific objectives addressed under the 3rd Framework Programme

Five specific objectives were set out in the Workplan for the Telematics Programme of General Interest on Flexible and Distance Learning:

Objective 1.
To develop technologies and systems tailored to the design, distribution and delivery of learning material

There have been major changes in the orientation of this objective since the initiation of the DELTA programme, from technology-driven towards more user-oriented applications. In the future even more attention should be directed to ensuring that products and services are more directly related to user needs. This objective, while still part of an R&D programme, should be more closely linked to market needs and user strategies. Technological developments are still necessary, but should accord more closely with the needs of users and with the clear objective of improving cost and pedagogical efficiency.

The gap between technological developments and the users should be bridged

There is a still a gap between technological developments and the needs of users. Emphasis should be given in the future to the identification of means and ways to bridge this gap so that the technologies arising from the use of technology supported learning, are tailored to the needs of end-users. Issues such as cost-effectiveness, pedagogical efficiency; exploitability; reusability of learning materials; cultural adaptation must be fully explored.

The market for learning technologies is still underdeveloped, and the demand needs to be stimulated. Cultural barriers have to be overcome, new learning approaches and methods should be diffused, and their acceptance facilitated. Pedagogical, sociological and economic viewpoints must be incorporated in projects designed to utilise learning technologies. The technologies should be tested within real-life experiments based on practical testable hypotheses.

Objective 2.
To harmonise technologies, systems and infrastructures, and their adaptation to convey learning services European wide.

Objective 2 is very important but presents a difficult task for DELTA. As other European Commission initiatives are dealing with standardisation problems, a core activity of DELTA should lie in maintaining a connection with European Standardisation Bodies, to facilitate awareness of their activities, to assess the implication of these activities for FDL, and to influence the formulation of standards in the interest of the wider application of FDL. Disseminating information on standards to facilitate such implementation is an important task. However, the objective should be rephrased as follows: *To contribute* to the harmonisation of technologies, systems and infrastructures, and to facilitate their adaptation in conveying learning services Europe-wide

While the standards of hardware and software tend to be set in a world context, there is a desire on the part of DELTA to Europeanise developments in the domain.

This action should extend beyond consideration of technical standards. It should include the identification of barriers to implementation and ways to overcome these; and the attainment of lower and more uniform telecom prices in Europe. The transferability of learning materials, technologies, products and services between regions and nations, with its specific problems of multi-translation and trans-cultural adaptation, is another important issue to be addressed. At minimum, issues of particular relevance to Europe need to be addressed such as. the problem of language, and wide variation in market scale within countries.

Dissemination of standards and issues of transferability should be further addressed

Substantial progress has been made with respect to objectives 3, 4 and 5 under the IIIrd Framework Programme and this should be continued. The approach to experimentating with learning technologies in real-life settings is considered as very relevant and a core activity of research. Such projects which demonstrate real world applications rather than theory, are vital to achieving the levels of uptake necessary to make investment in research and development worthwhile. More pilot projects should be conducted so as to include a rigorous "test market" component in their methodology.

Objective 3. To use pilot experiments to validate technologies, systems and infrastructures, usage patterns, methodologies and guidelines for the design, distribution and delivery of learning based on information and telecommunication technologies

Objective 4. To develop implementation plan for technology-based learning services and infrastructures European-wide

Objective 5. To raise awareness and fost consensus on the usage of learning technologies

These research actions should be continued and enforced in the future.

Special importance should be given to:

- analysis of successful and non successful cases of flexible and distance learning which utilise technologies in order to investigate success criteria and to show clear advantages over more conventional approaches;
- analysis of the training services, contents and methodologies required by different users;
- implementation scenarios, including accreditation, curricula, titles, connection with university/industry actions;
- common training needs covering substantial numbers of learners;
- common training needs of learners dispersed throughout Europe.

More pilots should be conducte with a rigorous test market

New diffusion and exploitation strategies to reach the additional users such as publishers, administrators and trainers should be developed. The relationship between public and private sectors is important in this context.

Diffusion and exploitation strategies to reach real needs

Link between technology-based learning and its implementation needs to be developed and strengthened

To summarise.
The first objective addresses the development of technologies and systems tailored to the design, distribution and delivery of learning material. The second objective emphasises the need to harmonise technologies, systems and infrastructures, and their adaptation to conveying learning services Europe-wide. While both objectives have been well addressed by the programme, they need to be more clearly linked to learning applications and experiments in real-life situations. The time is opportune to move the emphasis from disparate, technology-led research projects, to experimental research with operational systems and networks on a Europe-wide basis.

Pass from disparate, technology led research to experimental research with operational system and networks Europe-wide

The experimental and implementation focus of objectives 3, 4 and 5 are seen as a core activity of research. More pilot projects should be conducted so as to include a rigorous "test market" component in their methodology. In general a shortening of the time scale of the full R&D cycle (from user identification, to development and testing through the EC R&D programmes) is desirable. A greater emphasis on applications would reduce the time and effort required for effective dissemination, compared to the slower process of natural diffusion of information.

Partners and consortia

Greater involvement of publishers and end-users

There is a need to expand the range of partners involved in project consortia. In the past multimedia publishers have not been sufficiently represented in the DELTA programme; in part because the technologies for design and production systems for learning are still relatively underused, and in part because the market for advanced learning products is underdeveloped. Both research on large scale multimedia publishing and small-scale (specialised, localised, or customised) courseware is needed.

Demonstrations to boost interest of cluster target users

Emphasis should be given to attracting end-users by tackling problems such as cultural differences, difficulty of access, and incompatibility. Clusters of users with common needs and learning environments should be identified, as a means of facilitating rapid implementation of Flexible and Distance Learning and thus providing a stimulus to the market. Specific awareness actions should be launched to involve the end-users such as demonstration projects involving concrete examples of real-live applications and extensive publications aimed at the general public.

Synergism with other programmes

Research and development is an integral part of a full cycle leading to application projects, experiments and market implementation, with their own sectoral or regional flavour. Research and development has its own particular role in this cycle and provides input for the later application and implementation phases; implementation in turn provides feedback on usefulness and appropriateness of certain developments. These phases are represented by different programmes in EC actions. Within this global framework, it is essential for the future to define the boundaries and linkages between the different EC programmes. The DELTA programme should not be seen as an objective in itself; the research and developments outcomes from the programme should feed applications and implementations; training content developed should be taken up by more technology-oriented R&D projects.

Ongoing co-ordination activities between DELTA and Task Force Human Resources programmes and initiatives (such as Comett, Distance Learning initiative, FORCE, LEADER, LINGUA, EUROTECNET) and national and regional implementation programmes such as the Structural and Social Funds (DGV; e.g. EUROFORM), SME training programmes (DG XXIII) should be continued. The education and training infrastructures should be fully aware of developments in information/communications technologies for training. Synergism with programmes on multimedia publishers such as MEDIA and IMPACT should also be emphasised. For the dissemination of the results of the R&D projects, full use should be made of the VALUE programme.

3. Vision for the future - Priority Statements

Introduction

It will be evident from the discussion in chapters one and two that developments in communication infrastructures and information technologies are changing the ways in which individuals collaborate, by enabling them to access and exchange information with less regard to the constraints of distance or geographical boundaries. These developments also facilitate fundamental change in education and training, by making learning products and services more accessible, by making the learning process more flexible, and by providing a basis for more intense and extensive interactivity between learners and their teachers. The appropriate application of these new technologies, therefore, could facilitate more extensive and more effective learning, with a potential increase in the social return to investment in education and training. The application of these technologies to specific areas of education and training could additionally facilitate the development of skill, competence and expertise, which could otherwise only be acquired more slowly, or at high social risk, through more conventional modes of education and training; (the use of simulation training in respect of hazardous processes in industry is one such example).

Lifelong learning

The core theme of a future Research and Development programme for the area of Flexible and Distance Learning is to provide new approaches for lifelong learning by using new technologies. Continuous training and updating throughout life is a key theme and involves major changes in the approach to education and training, to its organisation and delivery, and to the application of technology. Technologies are playing an enhancing role.

3.1. Priority Mission for the future: Access to and efficiency of education and training

To support the change from once-in-a-life education to lifelong learning. major efforts should be made to improve access to learning for all citizens of Europe and to improve the efficiency of the learning process. This is the first and most essential priority statement:

To develop and test technologies which improve access to and efficiency of education and training should therefore be the mission for the future programme for R & D in telematic applications for flexible and distance learning.

Widening access to education and training in Europe, and improving the quality of learning services through the effective application of

technology, is a core objective of Community policy in distance and flexible learning. More extensive access and more effective learning should have a positive effect on industrial competitiveness and redress disadvantage; in addition, an enhanced capacity for transnational learning should facilitate the mobility of European citizens.

To widen access, increase effectiveness, and facilitate the diffusion of advanced learning services closely adapted to individual needs, a service infrastructure is required to bridge the gap between the potential demand for learning services and their supply. The essential social aim of such an infrastructure should be to provide access to learning services at a time, in a place, and through the language, appropriate to the learner's needs; thus allowing individuals to learn in the manner most appropriate to their circumstances. It would be important also to provide for learner interaction with peers and tutors where appropriate. These objectives cannot be met by existing arrangements: they require further research on:

- the interlinking of both, existing and emerging, learning and telematic infrastructures, through large-scale pilot experiments:
- components of the infrastructure, including development, production, delivery, and support of learning products and services, and related application of telematic networks; and
- longer term research on emerging infrastructures based on high performance computer networks.

Research should be put into practise

The R&D actions under the Telematics Programme for Flexible and Distance Learning should be embedded within a more global context of putting research into practice through experiments, development and pilot applications projects. Although implementation is beyond the scope of this research programme, the work envisaged should pave the way for the emergence of trans-European services for education and training and facilitate market uptake.

Diffusion of learning services

The diffusion of services for flexible and distance learning Europe-wide should be an integral part of the programme. To foster consensus; to stimulate trans-national co-operation and to promote cross-fertilisation of results; to disseminate the R&D results to a wider public; to facilitate the setting up of human networks and information networks all over Europe; to stimulate synergy between users and providers, and between universities and industry; should also be important activities of the programme. The raising of awareness and dissemination of information on programme and related activities should be the focus of particular attention.

European-added value

Promoting co-operation between researchers on the one hand, and between service providers and users on the other, is important, not only because of market related considerations (such as broadening the scale, and increasing industrial competitiveness) but also because of the necessity to provide a Europe-wide learning dimension. In this way the diversity of learning systems which exist all over Europe, could be made more accessible.
Joint dissemination and co-operation on research, facilitated by these technologies, could provide Europe with an excellent tool to cross-fertilise results, improve cohesion and share knowledge.

Education and training is a key service for the European population, which could be further facilitated by the use of these technologies. Flexible and distance learning is a part of education and training, to which the application of technology-based systems is particularly relevant. The potential advantages of technology-based distance learning over conventional approaches should be clearly demonstrated through scenarios and experimentation. There is a need for demonstration projects of telematic learning services, which could function as blueprints for regional or national initiatives and provide the necessary input concerning costs, efficiency, acceptance and uptake.

Experience elsewhere shows that the involvement of public operators has a positive aspect in promoting the application of technology-based learning. In other countries, for example, local communities, universities and state administrations sponsor several infrastructures for education and training by providing content and products, thus supporting the development of a market. It would be worth examining the factors which are conducive to the success of these ventures with a view to identifying the specific strategic initiatives which are needed to generate similar approaches.

Flexible and distance learning has a specific relevance in meeting the social objectives of redressing disadvantage. In meeting the educational needs of disabled and disadvantaged persons (homebound individuals, or those subject to physical and social isolation, barriers to access to the workforce and education; or those dependent on advanced technical aids). Service infrastructures for learning should therefore be easily accessible. The same applies for all other individuals socially and physically excluded from education and training such as those living in remote and peripheral regions, women re-entering the workforce, micro-enterprises. FDL could potentially provide an adequate economic answer, and a positive social return for the society as a whole.

3.2. For Whom?

It is recommended that a major part of the R&D activities should be focused on the user groups discussed below. These target groups have their own specific learning needs and specific working/learning contexts and should therefore also have their specific IT&T-based learning environments. This is contrasted to a broadly-based consideration of technology-supported learning, that could be applicable to any type of learner or learner situation.

(i) The learners:

- *Independent learner*
- *Small and medium sized enterprises*
- *Specialised professionals*

Despite differences between these learner groups they have much in common in that they are largely dispersed users and that their demand for distance learning is linked to an individual use of technology. Hence in so far as possible, the system should be based on user-friendly and accessible technologies.

1. Autonomous learners

- *to overcome isolation;*
- *to improve self-learning*
- *to access to learning resources*
- *communication with tutors and peers*

Much learning now takes place independently from any formal support and isolated from peers or tutors. It is proposed therefore to investigate further how autonomous learners can best access learning as part of a learning technologies network, embracing open universities and training networks; and how best the technological environment, within which learning takes place, can be developed to overcome isolation and improve self-learning. While many autonomous learners will require access to education and training technologies from home, it should be recognised however, that some technologies are likely to be only cost effective for the foreseeable future on a study-centre or resource-centre basis. Access to learning resources such as libraries, and knowledge databases, are essential for isolated learners, as is interactivity and communication with peers and tutors in virtual groups.

Greater autonomy of the learning process is not restricted to adult learners. Primary and secondary students within formal educational systems are increasingly becoming more autonomous in their learning approaches, through activities such as participation in peer group learning outside the classroom, involvement in case studies in the field, and in the use of technology based education for science and languages. In view of these pedagogical changes in formal education, flexible and distance learning methods are increasingly used as a complement to traditional classroom education.

2. *Small and medium sized enterprises including micro enterprises*

SMEs in Europe are an important source of change and innovation in industrial production and trade. They are disadvantaged however, compared to larger enterprises, in having less opportunity to develop their expertise, and less access to technical and R&D facilities, or to management information systems, which could provide alternative sources of knowledge. There is an increased need in small companies for flexible and remote training systems, especially in peripheral regions. Despite the variety and heterogeneity of SMEs, they can be considered as a group with common requirements for learning.

Need for flexible and remote learning for SMEs

Technology offers the opportunity to customise training more precisely to the needs of individual SME's. Delivering such training "on the job", together with access to other support services facilitates work-based learning directly related to specific business problems and opportunities Research and development of telematic environments and infrastructures for training in SMEs should be a core activity of the future and should take into account existing regional, sectoral and national infrastructures. It is recommended that the in-depth needs and requirements of SMEs for training, and specific obstacles to the use of flexible and distance learning in providing such training; should be identified.

Embedded within existing information networks and resource centres with multiple purposes services

Learning services provided to SMEs should be part of embedded systems and networks, providing multi-purpose services to SMEs. The trans-national character of these infrastructures should not be limited to telematic delivery of training materials or courses, but should also facilitate co-operation between regional and sectoral SMEs, and provide access to information networks.

3. Specialised professionals

Need for specific learning environments and infrastructures for specialised professionals

It is recommended also that the specific learning environments and infrastructures needed by specialised professionals should be investigated:

- Professionals in areas of rapidly developing technologies such as engineers in high technology companies and medical personnel in hospitals.
- Professionals whose level of expertise is such that collaboration with other experts for mutual personal development tends to be at a distance.
- Teachers in formal education; managers and administrators in education; university professors; distance education tutors and trainers;
- Researchers;
- Professionals involved in the design, production and delivery of educational materials.

Many of these specialists require on-the-job training; access to performance support systems; remote access to laboratories and information retrieval systems; and some require training involving the complex simulations of high risk or other environments which are difficult or impossible to replicate in conventional teaching modes.

(ii) The providers

- *educational institutions or training centre networks*
- *designers, producers or service providers*
- *trainers*

Specific facilities are also needed for the design and developments of course or training materials, and for the providers of services. Easy access by providers to learning technology networks, at acceptable cost, would be likely to increase FDL activity significantly.

For many learning tasks most learners will continue to require the presence of tutors and peers for reasons of personal preference, or because of the social dimension of conventional modes of learning. Where teaching is primarily undertaken in a non-contigous mode, autonomous learners can still participate in occasional tutorials, and many have access to advice and guidance through local study centres. Obviously, in remote areas more use would be made of virtual rather than actual presence.

The increasing use of technology-based systems and networks by conventional students should increase the economies of scale of the learning technology infrastructure, and further reduce the distinction between full-time, part-time, home-based and, work-based distance and conventional students. Wherever a learner is based and whichever educational or training scheme the learner is following, teaching

technology offers the potential that each learner has access to learning facilities with full flexibility and individual support, which respond to the individual learner's needs.

- *Educational institutions or training centre networks*

Telematic infrastructures are as relevant to traditional education or training institutions as to distance teaching institutions. Through the application of telematics, traditional education or training institutions could reach an extended student population, which might otherwise be unable to follow on campus courses. Access to a Europe-wide infrastructure would further facilitate their provision of distance education services. An infrastructure allowing local organisations to plug in to the network would allow them to establish local distribution and support services for their customers.

Provision of learning services through telematic networks of study or training centres.

- *Support for designers, producers and service providers*

Producers and designers of technology based training materials would be able to collaborate on course development over the networks. Through the infrastructure they would be able to access information resources and re-use materials from other producers, thereby shortening the production time and making production potentially more cost efficient.

Easy access for designers and providers to learning technology networks

- *Training of trainers and teachers*

The training and re-training of trainers and teachers should be a separate high priority action. Communication infrastructures can play a crucial role in overcoming their problems of isolation. Furthermore, through trainers and teachers, the end-users of learning technologies can be indirectly reached. The training of teachers within formal education as well as tutors in distance education and training would have a major impact on the introduction and acceptance of FDL in conventional education and training schemes.

Overcoming the actual problems of isolation, intercommunication between trainers/teachers through technologies

3.3. Scope of the Mission for the future: Research into practise

Experimental research based on testable hypotheses

The core research should be experimental, focusing on the process of learning through technologies in specific real-life situations and environments. Future research and development projects should focus their activities on the testing of well defined hypotheses within a technology assessment context. Concrete experimentation with users, within real-life learning situations, would provide essential information on which learning technologies are likely to prove successful in terms of efficiency and cost effectiveness, and would provide useful insights into relevant questions relating to appropriate new organisational models, potential market acceptance and uptake, approaches to overcoming cross-cultural and language barriers, methods of enhancing the quality of learning materials, and use of resources. The potential impact can be measured through pilot tests validating innovative developments of learning systems and infrastructures.

This short and mid-term research programme of experiments and demonstrations should be complemented by longer term leading edge research.

Test beds for future implementation

It is recommended that the experimental research results should encompass large demonstration projects which function as testbeds for future implementation of trans-national learning through technologies. One objective of the demonstration projects would be to test the feasibility of the brokerage concept of providing access to telematic networks for educators and trainers. This would entail a small central brokerage, which would supply course providers with a range of telematic services appropriate to their needs. The brokerage would link the existing networks and only provide new services when they are unavailable at present. If successful these may be used as blueprints for future national or regional initiatives and for other large services. Through these demonstration projects it should be possible to market the concepts of flexible and distance learning and to identify and test the viability of niche markets.

The trans-national potential of telematic infrastructures for learning lies in cross-border co-operation between researchers, tutors and producers, and in the provision of a learning network of networks. Such a network

would be likely to generate a higher social and economic return than isolated regional or national networks, if only because of the potential for economies of scale. The development of a trans-national infrastructures for FDL could paradoxically stimulate activities within Member States, thus potentially leading to a greater aggregate sum of national activity.

User led

Users must be involved at an early stage and in the cycle of needs' analysis, definition, design and testing of the demonstration projects. It is envisaged that users should be mainly involved through evaluation and assessment of pilot experiments. Learners reactions, learning progress as well as technology acceptance should be gathered as feed-back to the development phase.

Process oriented

A new Research and Development action on learning technologies should not deal with developing specific products, but with the analysis of the process of delivering and producing learning through telematics. A priority for new R&D actions for learning technologies is the gathering of more knowledge and experience on the process of learning in a flexible and/or distance learning situation, extend our understanding of how and when it is effective and preferable to other schemes of lifelong learning.

Integration of technologies and learning approaches

A main research action is to review current and past R&D to generate best practice models and hypotheses that can guide implementation and that can be tested in real-life applications. Such a review should cover not just R&D in technology-based learning, but models of learning and pedagogy. More research through pilot experiments of real-life situations is needed so that learning approaches are tried out such as self learning competence; learning to learn; problem solving; peer learning; group or collaborative learning (virtual groups and social interactions); on-the-job learning, and learning-by-doing. It is essential that a variety of learning situations and environments are evaluated to provide information on

- learner needs profiles needs (adaptation to learner's background and needs, why they choose this way to knowledge), their benefits, the reasons for drop-out
- accessibility and efficiency (costs as well as pedagogical),
- learner acceptance,
- learner's progress and self-learning strategies,(learning to learn; inductive thinking),
- technical suitability,
- new requirements for access to knowledge. Empirical studies should provide information about the evolution of training content, knowledge transfer, technical information, dialogue with experts, groupware.

- competence evaluation. Many initiatives in enterprises lead to the evaluation of competencies. A new field of research has to be developed concerning the relationship between this domain and flexible learning facilities.

Pilot experiments of training technologies should be underpinned by sound learning models. Lifelong learning through technologies should complement existing education and training through new learning approaches and methodologies. In addition to these transferred learning strategies, the use of technologies supporting the learning process will evoke and facilitate new ways of learning such as learning to learn and situated learning,

Diffusion and implementation strategies

In order that a future R&D action in the domain of Flexible and Distance Learning can create an interface between the learning problems and the solutions offered by new technologies, other factors than technological development should be taken into account. Putting research into practise requires an integrated action research approach whereby users requirements and behaviours, organisational and contextual issues, instructional strategies, co-operation and consensus formation mechanisms are studied within real test beds and pilot experiments. This integration between vertical cases of technological configurations and more horizontal contextual issues is essential.
This requires the setting up of support and diffusion structures which facilitate this kind of action research on the field. These will be further elaborated in the next chapter.

4. Recommendations for future R&D actions

Within the context of the three priority statements outlined in chapter three, four action areas of research and development have been defined and are elaborated within the present chapter.

Four Action areas

The first three action areas describe the research to be undertaken in order that emerging telematic and educational infrastructures should serve all types of learners and learning settings. The objective of these action areas is to undertake research and development on the components of these infrastructures; and on issues related to their interconnection; and to examine related longer term research topics such as future learning services on high performance computer networks. The three R&D actions defined are:

1. *A focused R&D action enabling a Europe-wide decentralised networked service infrastructure for lifelong learning, enhancing learning services, and opening the vast potential of traditional education and training.*

Enabling learning infrastructures

2. *Research and development is needed on the components of IT&T learning environments, and on the interaction between, and the integration within these technology-based environments.*

Components of learning environments and their integration

3. *A specific action area on long term research which will prepare learning technologies for the year 2000 and beyond.*

Long term R&D

The fourth action area describes several accompanying measures for diffusion and implementation strategies.

4. ***Accompanying measures for diffusion and implementation strategies, such as demonstrator centres , and investigations of the process of implementing learning technologies, with a view to achieving a better understanding of enabling and hindering factors.***

Diffusion and implementation strategies

4.1. Action Area 1

A focused R&D action enabling a Europe-wide decentralised networked service infrastructure for lifelong learning enhancing learning services, and opening the vast potential of traditional education and training.

Learning infrastructures should build upon and be embedded within existing or emerging multi-purpose telematic infrastructures. They should link a wide range of institutions, industries and resource centres as well as home-based learners, students, service providers and business people from all fields. Telematic-based learning provision must exploit existing IT&T systems and build on, and add value to, existing training and learning infrastructures.

These infrastructures will integrate three essential elements: communications networks and information technologies, knowledge and information resources, and human networks.

- *Communications networks and information technologies:* Integration of the two is the key word. Learners at all levels and ages, teachers and tutors and experts will collaborate, in real or delayed time, through (high speed) networks.
- *Information and knowledge resources:* The infrastructures should enable access to a wide diversity and plurality of information resources from universities and educational institutions, research centres, libraries (e.g. electronic libraries, interactive and multimedia learning material libraries).
- *Human networks*: The infrastructures should enhance learning services and communication possibilities for a wide range of persons such as home based learners; workers in SMEs; students in remote areas far from learning resources; leading edge researchers, staff in large companies; specialised professionals; teachers.

Strengthen the local, regional and national diversity

These infrastructures should take into account local, regional and national diversity, and should build on existing local, regional and national networks. They should be scalable and open, that is they should allow sectors, regions, educational institutions and other entities to define and adapt their use of the infrastructures and learning products to meet local or national needs. An infrastructure of this kind is likely to have a higher social return because, on the one hand, it offers the potential of economies of scale, and on the other, provides a basis for meeting local, regional and national needs in an appropriate and effective manner. Furthermore, these infrastructures should facilitate co-operation and the transfer of knowledge and experiences between

small-scale and peripheral providers. Trans-national co-operation facilitated by learning technologies therefore, could open new possibilities for small organisations.

Scope

The infrastructures should be composed as a network of networks with decentralised access through regional nodes, such as centres of expertise, and resource centres. A wide range of networks is advisable; the uptake of such learning infrastructures will be enhanced if prospective users have access to evidence of successful use in their particular sector, or in meeting a similar training need. This network of networks should function as a clearing house following a brokerage model. The network will emphasise issues of importance for the implementation process such as organisational and methodological approaches.

A network of networks with access via decentralised, regional nodes

Model of brokerage

Implementation process

Future R&D actions

Four service infrastructures for learning

To stimulate the development of Europe-wide infrastructures for flexible and distance learning, the Review Board suggests that a testbed facility is established on which a series of providers can perform experiments, which are deemed to be necessary before decisions on establishing operational services are taken. To ensure the involvement of users at the early stages of implementation of services and systems for flexible and distance learning, it is important that the systems are evaluated in real life situations, including work-based learning. It is the opinion of the DELTA Review Board, that the involvement of users in the validations of different technologies is best done through pilot experiments.

Three sets of user groups each with its own distinct features, were identified in Chapter Three. These are autonomous learners in higher education, workers in SMEs, and highly skilled professionals. Designers and producers of technology based training are a fourth group. Potential service infrastructures for these user groups are detailed below.

- Digital broadcast services for distance learning using satellites should be tested, as this technology effectively disseminates learning services all over Europe. New methods, techniques and customised interfaces should be developed and tested to make an efficient and extended use of existing infrastructures, using a combination of

Service infrastructures for higher education and autonomous learners

different networks (Interactive Cable Networks, PSDN, ISDN, B-ISDN).

- Research on satellite networks should be carried out in synergy with the work done on High Performance Computing Networks, which are aiming at establishing a high speed network for research and higher education in Europe, based on the existing national networks (HPCN initiative, Multimedia Project in France). Some broadband networks are already being used for education and training or are at a planning stage (e.g. SuperJANET, EUREKA project COSINE, GNET).

- Language learning is a quintessential European issue. Experiments with technologies for language learning, like voice mail, ISDN communications combined with stand alone technologies should be set up.

- Access to bibliographical databases and libraries are important features in most higher education programmes. Experiments on establishing access to bibliographical databases should be carried out.

- Electronic publishing is expanding rapidly. Resources for learning, such as dictionaries and encyclopaedia are now available in digitised form, but traditional textbooks could also be replaced by electronically published material. Experiments validating the extent to which these techniques are acceptable to the providers and the learners should be undertaken.

> *EXAMPLE: Training using digital delivery services on satellites*
> *Pilot experiments should be carried out to provide educational and training services on the new generation of satellites ("HOT BIRDS"). Experiments could encompass decentralised management systems for the co-ordinated and simultaneous use of several channels of audio-visual distribution (up to 16 channels in VHS quality on one transponder). This would allow differentiated scheduling for time slots, geographic area, linguistic area, pay-per-view access. In addition tests of different compression techniques, simultaneous translation systems and facilities for interactivity should also be carried out.*

Service infrastructures for SMEs

- Flexible and distance learning has great potential to deliver training on time to the business world. This is especially important for small and medium sized enterprises. Systems suited for SMEs should be tested, notably in the form of networked study or resource centres allowing SMEs to have direct access to training in a wide range of subjects from different suppliers through PSDN, ISDN, B-ISDN and VSAT. These networks should incorporate established centres currently delivering training and information services to SMEs.

- The resource centres should also serve as information centres on FDL courses. The profile of tasks requires the development of an advanced information server.

- The infrastructure should also be used to test a broad spectrum of learning scenarios, which integrate varying technologies.

- Further R & D is needed on the technical scenarios of a telematics infrastructure for SMEs; to estimate the economic feasibility of this infrastructure, and to develop a strategic European plan for implementation.

> ***EXAMPLE: Design and testing of local, multi- purpose centres***
> *Easy access by users to telematic education and training services is crucial to the success of these systems. Pilot experiments should be undertaken on the design, management and technical configuration of local service centres. Learning services could include access to educational databases, multimedia training applications (interactive video, simulation programmes) and tele-training facilities (videophone, televised lectures, audio-graphic applications, computer conferencing) should be available at the centre together with more traditional counselling and guidance. Furthermore research in needed on interconnecting these resource centres; management centres, distribution facilities; remote communication and tutoring.*

Service infrastructures for Specialised professionals

- Pilot experiments should be carried out on services for distance learning on the ISDN network, like services for video conferencing and for information retrieval systems from multimedia digitised libraries. Services which allow flexibility in time, and independent study, and easy communication between peers, should be tested. Services which facilitate expanding knowledge bases built by peer groups should also be tested.

Service infrastructures for Designers and producers

- An integrated system allowing producers high speed access to libraries of educational material in electronic form using standardised didactic templates to create new course material, should be developed and tested.

- Systems for collaborative course development with facilities to choose between different didactic methodologies, automatic version control, and co-operation in virtual course-teams should be undertaken.

Common issues for all infrastructures

Cultural adaptation and Translation services

- Cultural and language differences in Europe are an obstacle to the creation of a market for flexible and distance learning. New technologies such as automated translation, allow for efficient translation services simultaneous translation on different sound channels on the new generation of satellties. Experiments with these technologies should be carried out to identify effective ways of overcoming the problems of language differences.

Management model

- One aspect which is of special importance with respect to the infrastructure is to establish a management structure which is acceptable to the providers, while at the same time being effective. Experiments on an open management structure for network service provision, for example in the form of a brokerage service, should be set up.

Connectivity, compatibility

- To ensure connectivity and compatibility between the networks and applications used in the infrastructures development, one should build further on standard platforms enabling the interworking of these infrastructures. This work will also encompass development of gateways between different networks used in the infrastructure (for example between the different business and academic electronic communication networks and between satellite and terrestrial networks).

Strategies for overcoming barriers to implementation

- The promotion of an effective network requires the adoption of appropriate strategies in relation to the human, technological, pedagogical and economic aspects. Strategies conducive to the emergence of compatible, flexible, and integrated networks should be identified. The ways in which technology based systems can be designed and operated to improve interactivity and flexibility, and be responsive to prior knowledge and to learner styles; should be examined.

Cost benefits and pedagogical effectiveness studies

- Cost effectiveness of the different configurations should be examined. The potential of FDL is unlikely to be realised, however technologically innovative, if the system is too costly for general application. The cost-effectiveness relative to traditional modes of course delivery and support is not self evident. Further research is required to identify appropriate social, economic and technical scenarios in which the application of telematics to education and training is cost effective.

- The same applies to pedagogical effectiveness of technology-based learning. More research is needed on diagnostic assessment of the learning process and behaviour and the development of individual learning action plans. Research should explore the extent to which different learning environments and service infrastructures support collaborative or individualistic modes of learning. The skill requirements for tutor effectiveness need to be established and the requirement for further support agencies identified. In particular more research is required on the relevance of specific technological configurations to specific types of learning needs.

4.2. Action Area 2

Research and development is needed on the components of IT&T learning environments as well on the interaction between and the integration within these technology-based environments.

To develop infrastructures for learning services, research and development on the components of IT&T learning environments should be undertaken. Major research and development activities should take place on the following issues:

Scope

There is currently a noticeable trend to integrated and embedded systems which enhance learner control and interactivity. More research is needed on the integration of training content and a personal training system with increased interactivity and personalised feedback, so that a student has greater control over the learning process.

A shift from a model, where training is seen as information transfer, towards more communicative models is apparent. In this connection the development of effective interactive learning approaches facilitating communication and interactivity, tutoring environments, user-friendly interfaces are crucial research issues.

Research is needed on the application of existing educational approaches to technology-based environments and on new cognitive models and theories as the basis of different learning technological environments.

R&D is needed on technologies for the design and production of advanced learning materials and services to reduce costs, time and actual development and production resources. Developments should focus on tools to develop products rather than on the products themselves.

In the context of the above, work must be undertaken on development of guidelines towards a coherent and harmonised approach to standardisation, interoperability, and a common use of terminology and quality standards.

Learners and tutors

- Integrated communication and conferencing systems should be developed which are specially tailored for learning with graphical interfaces and which facilitate different communication modes (real time audio, video and/or data transmission or deferred time communication, including telewriting, speech recognition and voice mail).

- Applications for retrieving material from bibliographic databases and virtual (multimedia) libraries based on artificial intelligence techniques, allowing automated information search according to personalised profiling, should be developed.

- Applications for automated self evaluation, assessment and accreditation should be developed.

- Applications with facilities to build learning materials from different sources, like discussions between groups of experts, and databases on different topics should be developed.

- Research in the field of learning technology should focus on the behavioural, pedagogical and psychological aspects of learning through technologies, and in virtual environments, whether these are in remote groups or in digitised worlds.

- Applications should be developed which use the potential of IT&T to train persons with disabilities (such as visual and hearing impairment, and physical immobility) or learning problems in general. Such applications should also address the development of user interfaces which facilitate similar participation for those with restricted manual dexterity or limited manipulative ability.

> ***EXAMPLE: Technology-based learner assessment***
> ***The assessment of learners' progress and understanding makes heavy demand on tutorial support services in distance education programmes. Applications to assist the tutors in assessing the students progress should be developed, evaluated and tested. Evaluation would include the pedagogic effectiveness and quality implications compared to conventional assessment procedures and should additionally include investigation of related cost factors.***

Service providers

- Advances in artificial intelligence and knowledge based techniques now makes it possible to start developing applications for the management of education systems and assets.

- The feasibility of applications supporting the coaching process, by systems enabling automatic profiling of the learners to complement tutor support, should be examined. The applications should be able to filter requests from different media .

- AI based teacher support applications for providing answers to students questions during a given course should be developed.

- Applications for storing and retrieving information material on educational programmes with facilities for preview of courses, automated routing of requests for courses, automated mechanisms for billing, registration and delivery, should be developed.

Authors and Electronic publishers

- While significant achievements have been made in authoring systems in the past years, more efforts should be put into further development of user-friendly interfaces to authoring systems, for learning applications. One aspect which has so far been neglected is the development of systems which enable a course provider to create individualised courses from generic courseware .

- Applications and tools enabling the implementation of instructional design strategies most suited to learning technologies and environments should be developed. This will enable the designers and producers to customise learning materials.

- Applications to create 'electronic books' for personalised learning from databases of generic material using hypertext and other advanced technologies should be developed. This will enable a high level interaction of the learners with materials and customised curricula.

EXAMPLE: Virtual Library - the Megalib
In Member States libraries of digitised texts, images and voice artefacts are being created. These libraries should be identified, and research and development should be undertaken on learning applications for access to distributed sources and on systems for storing and retrieving material. Remote access to information and knowledge sources is of utmost important for autonomous learning and on-the-job training. Learners should have flexible and easy access to various kinds of information, should be able to structure this knowledge, and should be stimulated to integrate the newly acquired information within his work and learning. Solutions to legal problems like copyright and security should be identified together with solutions to the problems of billing.

A specific action area on long-term research which will prepare learning technologies for the year 2000 and beyond is recommended.

4.3. Action Area

Scope

As noted in chapter two, development in the field of learning technologies has reached the point where the link between technology-based learning and implementation needs to be developed and strengthened. However, an important ancillary objective is to develop further visions on a learning network for the future, through research with a longer-term perspective. The results of this kind of research should lead to new pilot experiments and test beds for the future and should provide new concepts and ways for learning by technologies. This research should explore new avenues such as:

Future R&D actions

- Further research is needed in the area of intelligent interfaces and in learner and tutoring modelling, aimed at supporting the learner at all levels of interaction. The work will emphasise the design and development of integrated Intelligent Tutoring Systems incorporating a number of media (voice, video, images, text) and the ways that ITS can support the customising and individualising of training applications.

Customised and embedded learning

- The use of portable/handheld notebook computers, and of personal intelligent communicator devices (PICDs), should be investigated as a basis for personalised learning devices of the future. The extension of these devices to serve the everyday needs of learners, for example, as an electronic library, notebook, timetable-diary, database search terminal, and communication interface to learning services, should be investigated. Given the mobility of learners in the future, research in these issues is seen as a fundamental requirement.

Services for mobile learners

- Research should be initiated on the design and testing of new tools and systems required for virtual presence of the tutor or learner and on new modes of interaction. The latter will encompass the development and integration of real-time and deferred-time multimedia communication tools, as well as tools for learning by combining different modes of interaction, such as the use of novel peripherals emerging from virtual reality applications. This would

Virtual presence applications

also involve systems for 'tele-presence' like applications for collaborative problem solving, virtual laboratories, virtual classrooms, virtual workshops.

Interactive and immersive learning.

- Application with Micro worlds manipulating abstract entities (belonging to domains such as mathematics, and physics, etc. whereby vectors, models, multi-dimensions are crucial) opens up new fields of learning enabling constructive and discovery learning.

- New ways of learning through multi-modal interaction, for example, simulations and virtual reality techniques will enable advanced interaction and new problem solving techniques such as 'micro-worlds' environments to be developed. The multi-modal interaction should be an integral part of this research activity exploring the relevance and applicability to learning of speech recognition, telewriting, and of novel peripherals such as those emerging from the fast developing area of virtual reality, e.g. data gloves, head-mounted displays (active glasses').

EXAMPLE: Use of Virtual Reality for remote access:
A user in a remote region goes into his local community centre and using the VR facilities gains access to a "Virtual Library" - a computer representation of the inside of a library, with different rooms for different topics e.g. geography, physics, literature, each room comprising of other rooms.... By walking into any of these rooms he 'homes in' onto the topic of interest. At any stage he may consult a "virtual librarian" - a knowledge based program, animated by a human face - for help in finding specific material. At the end of the search he places the order directly at the 'virtual desk' in the library. The material is delivered to him in a few hours via electronic mail. [Although the Virtual Library appears as a single entity, it may represent the collected contents of a number of electronic libraries distributed over a large geographic area.]

Broad band networks for flexible and distance learning

- The advances in broadband technologies (bandwidth on demand, intelligent networks, interactive cable networks, fibre-to-the-home) will make communication services cheaper and more powerful, and thereby enable remote access to multimedia communication and information services. Establishment of high performance networks between research institutions, universities and companies will allow leading edge users to develop and test the application of virtual presence (e.g. virtual classrooms, virtual workshops and virtual laboratories) to flexible and distance learning. Advanced experiments on such applications will pave the way for introduction of these services to the industrial and private users as the broadband services become more widely available. In

this sense it is important to investigate the multimodal interactions in a learning context.

Accompanying measures for diffusion and implementation strategies

4.4. Action Area

Introduction

One of the major challenges for European flexible and distance learning is to create awareness of the potential that new technologies offer to learning. The Review Board suggest that FDL demonstration centres, located within the nodes of existing or emerging service infrastructures, be created. These demonstration centres could also function as natural focal point for dissemination activities. It is important that nodes of the network are established in each of the Member States. The set of features for these demonstration centres should be determined on the basis of research results but should at least comprise the following: communication facilities; distribution facilities; access to information facilities.

Diffusion networks for demonstrators

EXAMPLE: Demonstration centre
The demonstration centre should display state of the art learning technology: Well designed computer based training applications and audio and video programmes. Educational databases. Interactive learning applications on different media (CD-I, DVI, CD-ROM). The demonstration centre should be linked to the local and national educational and training networks and through them to the European networks. It should display the communication applications, computer mediated communication applications (e-mail, bulletin-boards, computer conferencing), audio conferencing, audio-graphic applications and picture phone applications. It should also be equipped with satellite receiver equipment.

To realise the potential of these service infrastructures specific awareness, dissemination and diffusion actions through demonstration should be arranged. This will provide a basis for effective dissemination and exploitation of R&D results, and help to raise awareness on the part of potential user groups.

- Electronic fora of learning technology groups (researchers, designers and producers, authors, teachers, education administrators, and publishers) should be set up. So far these research communities have been developed in closed enclaves, but rarely communicate with each other. If major advances are to be made, all these communities must be brought together and this requires multi-disciplinary co-operation.

This can be established by information selection and retrieval systems, and in the creation of electronic networks sectorally, regionally and nationally.

- To stimulate co-operation and exchanges between researchers with the support of EC programmes such as "Mobility of researchers".
- Co-ordination mechanisms with other Commission programmes, European industrial associations such as the European Round Table, IRDAC, Open Distance Learning Group, existing human networks such as EADTU, SATURN, EUROSTEP, European Lifelong Learning Initiative (ELLI) to be constantly informed about evolution of training needs, implementation plans and to feedback R&D results to the application and implementation programmes.
- Creation of networks with Member States which will cross-fertilise and transfer the R&D results. Demonstrations can be used as blueprints for regional or sectoral implementations.
- Diffusion network for disseminating standards and quality guidelines
- Information diffusion through a multimedia journal
- Creation of a consortium with a European, integrated dimension, able to co-ordinate and manage several learning networks and involving representatives of the main private and public actors .

Investigations of the proces of implementation and to better understand its enabling and hindering factors

Technology watch and assessment

Technology and society are in continuousl interaction and further actions are required to be fully informed about changes within society and the evolving trends of technologies. To define proper R&D work, it is recommended:

(i) to identify technology configurations such as virtual classroom; performance support systems for just-in-time training, with the capacity to match the needs of "clusters of users" such as isolated students at home; specialised professionals, SMEs, and designers;

(ii) to install mechanisms (through regional, sectoral and national market observatories, databases such as the one of ICDL and through service providers) which will provide regular updating of the market situation and trends of learning technologies and of the user requirements in the different Member States;

(iii) to generate scenarios for successful implementation of learning technologies in specific environments on the basis of evaluation and technology assessment results;

(iv) to analyse the new organisational models by using new technologies such as integrated teleworking/teletraining models; becoming a learning organisation;
(v) to study learner and user behaviours with the use of new technologies (useability studies);
(vi) to provide guidelines for trainers, providers and decision makers on efficiency, job performance, cost effectiveness, user acceptance and uptake, cross-cultural and language barriers, quality of learning materials of different learning technologies

The results of the projects in the telematic programme for education and training should be made available to the public. Guide-lines on technical standards and communication protocols and applications suited for education and training should be produced. Evaluation of the different technologies and applications against a set of relevant criteria like pedagogic effect, costs, and management implications should also be published as part of the programme.

Implementation strategies and plans

The functioning and interworking of service infrastructures will require the adaptation of appropriate strategies in relation to the human technological, pedagogical and economic aspects. An effective service infrastructure for learning will have to accommodate divergent infrastructures, provide for different education and training needs, and accommodate differences in language, culture, instructional strategies and costs. The objective would be to identify strategies conducive to the emergence of a compatible, flexible and integrated network of infrastructures. These strategies should be developed through the integration of results stemming from the DELTA pilot experiments or other experiments implemented nationally, sectorally or regionaly . These strategies should lead to common guidelines for implementation which should serve future implementations by training managers or educational decision makers.