Pilot Project:
Remote Action in Distributed Learning Environments (RADIO)

FINAL REPORT - ANNEX 1

– WORK PACKAGES AND PRODUCTS –

Vers. 06/08/2001

CONTRACT N°: D/99/2/07331/PI/II.1.1.a/FPI

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Universität Bremen

Research Centre Work - Environment -Technology (artec)

Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

Contract No.: D/99/2/07331/PI/II.1.1.a/FPI

PROJECT MANAGEMENT

Dieter Müller

Work Package:	**W10 Project Management**
Deliverable:	**D10-D12 Material for project installation** **D13 Final report**
Date of Delivery:	21. April 2000 (D10-D12) 31 July 2001 (D13)
Deliverable Type:	Restricted

Abstract:	This document includes basic material for project installation.

Keyword List:	RADIO project management

Contents

1. Handouts for project partner

1. Workpackage list
2. Workpackage description: Project Management
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4. Workpackage description: Teaching Unit “Tele-Service” – Module 1
5. Workpackage description: Teaching Unit “Tele-Service” – Module 2
6. Workpackage description: Evaluation and Dissemination
7. Products as measurable Output
8. Teaching Projects, Scenarios and Case Studies
9. Learning-Fields of the Curriculum-Frame Mechatronics
10. Questionnaire for interviews with companies using tele-service systems

2. Introduction to the RADIO Project (Slides)

1. Aims and Objectives
2. Overview: Subject area, focus, project data
3. Background: technologies, tools and work concept; new demands on vocational training and education
4. Main objectives for the project
5. Anticipated Benefits
6. Products as measurable output of the project
7. Teaching projects/scenarios
8. Focus of Research
9. Description of Work

3. Consortium Agreement (is part of final report / annex)

Workpackage list

WP No	Title	Partner	Start month	End month	Deliv-erable No	Pro-duct
10	**Project Management**					-
	1. Basic Material for Project Installation				10	
	2. Consortium Agreement	artec	1	18	11	
	3. Project Presentation				12	
	4. Final Report				13	
20	**Technical and Pedagogical concept**					
	1. Technical Bases: Tele-service in industry, basic technologies	artec	1	9	21	1
	2. Pedagogical Bases: Learning concepts, possible learning arrangements etc	artec	1	9	22	2
	3. Tools and Methods: Concepts of modelling and simulation in teaching tele-service	Cyprus	1	15	23	1/2
30	**Teaching Unit "Tele-Service" - Module 1**					
	1. Course Concept: Qualifications needs in tele-service, didactical and methodical concept incl. learning aids, material etc.	TBZ	1	9	31	2/3
	2. Documentation of held course: teaching experi-ences and results		10	15	32	4
40	**Teaching Unit "Tele-Service" - Module 2**					
	1. Course Concept: Qualifications needs in tele-service, didactical and methodical concept incl. learning aids, material etc.	Stock-port	1	9	41	2/3
	2. Documentation of held course: teaching experi-ences and results		10	15	42	4
50	**Evaluation and Dissemination**					
	1. Evaluation Concept: process analysis, summarisa-tion, documentation: technical, pedagogical con-cepts, field studies ..	artec	1	15	50	
	2. Dissemination: Project presentation (Internet, Workshops, papers), public demonstrations, press releases, co-operation with colleges, industry etc.	artec Cyprus TBZ Stockp.	16	18	51 52 53 54	5

Workpackage description: Project Management

Workpackage number:	**10 Project Management**
Start date or starting event:	1
Partner:	artec
Person-month per partner:	

Objectives

Co-ordinate all activities of the project.

Outputs: Reports, Reviews, Deliverables, Cost Statements, Workshops, Web-Page

Description of work

The Project Management (PM) will co-ordinate the different partners, all relations to the EU-Commission, related projects and the different Work-packages. He will control and supervise the work progress and will be responsible for communication with the Commission and for the transfer of payments to the contractors.

The contractors will use BSCW (Basic Support for Co-operative Work) as a communication means to exchange documents, have discussions and support the administration of versions and variants. English will serve as the project language.

The PM will run and maintain a Web-Server for the RADIO Homepage.

Deliverables

D10 Basic Material for Project Installation

D11 Consortium Agreement

D12 Project Presentation

D13 Final Report

Results, Products

Kick-Off-Meeting,
Project Installation: Material
Project Presentation

Workpackage description: Technical and Pedagogical Concept

Workpackage number:	**20 Technical and Pedagogical Concept**
Start date or starting event:	1
Partner:	artec / Cyprus
Person-month per partner:	

Objectives
Development of a technical (meta-)concept
Development of a pedagogical (meta-)concept

Description of work

The aim of this workpackage is to develop a technical and a pedagogical (meta-)concept which will meet the requirements of teaching and learning tele-service in distributed environments.

1. Technical Bases:
   - Tele-Service in industry: current and future developments
   - Basic and state of the art concepts, technologies and tools (automation and tele-service tools, data networks and busses in mechatronic environments etc.)
2. Pedagogical Bases:
   - Learning Concepts: research in tele-learning, co-operative learning, action-oriented
   - learning with emphasis on vocational training
   - General qualification needs, possible learning arrangements, and user scenarios etc.
3. Tools and Methods:
   - Didactical oriented transformations between different description languages for automation systems: UML, Bondgraphs, Modelica, etc.
   - Concepts of coupling Simulation tools (e.g. Omsim or DynaSim respectively) with tele-service systems, case study for a mechatronic system.

Artec is responsible for topic 1 and 2, the University of Cyprus (D.C. S) is responsible for topic 3. Each partner has to run and maintain web-pages for giving an overview of his scientific results.

Deliverables
D 21 Report: Technical Bases - Tele-Service in Industry etc. (artec)
D 22 Report: Pedagogical Bases - Learning Concepts etc (artec)
D 23 Report: Tools and Methods: Concepts of Modelling etc. (Cyprus)

Results, Products
Technical Concept
Pedagogical Concept

Workpackage description: Teaching Unit “Tele-Service” – Module 1

Workpackage number:	**30 Teaching Unit “Tele-Service” - Module 1**
Start date or starting event:	1
Partner:	TBZ
Person-month per partner:	

Objectives
Design and development of courses with learning aids
Installation of learning environment and support material
Hold courses, analyse courses, document experiences and results

Description of work

The aim of this workpackage is to develop and to realise a training course for the area of tele-service in the field of mechatronics . The concept of the course should be based on a co-operative and action-oriented learning paradigm. The training course is to be exemplified by practically oriented learning tasks and should be suitable for qualification needs in tele-service. The workpackage includes the following items:

1. Development of Course Concept:
   - Qualification needs in tele-service;
   - Didactical and methodical background information: learning goals, tasks, student activities, time structure, etc;
   - Learning aids: slides, worksheets, exercises, html-pages, examination material,

2. Documentation of held course: teaching experiences and results.

The central language of the training course will be English but they will be converted into national languages of the partners where necessary. The partner has to run and maintain web-pages for distributing his learning material.

Deliverables
D 31 Report: Course Concept incl. Learning aids
D 32 Report: Documentation of held course

Results, Products
Teaching Unit “Tele-Service” – Module: ...

Workpackage description: Teaching Unit “Tele-Service” – Module 2

Workpackage number:	**40 Teaching Unit “Tele-Service” - Module 2**
Start date or starting event:	1
Partner:	Stockport
Person-month per partner:	

Objectives
Design and development of courses with learning aids
Installation of learning environment and support material
Hold courses, analyse courses, document experiences and results

Description of work

The aim of this workpackage is to develop and to realise a training course for the area of tele-service in the field of mechatronics . The concept of the course should be based on a co-operative and action-oriented learning paradigm. The training course is to be exemplified by practically oriented learning tasks and should be suitable for qualification needs in tele-service. The workpackage includes the following items:

3. Development of Course Concept:
   - Qualification needs in tele-service;
   - Didactical and methodical background information: learning goals, tasks, student activities, time structure, etc;
   - Learning aids: slides, worksheets, exercises, html-pages, examination material,

4. Documentation of held course: teaching experiences and results.

The central language of the training course will be English but they will be converted into national languages of the partners where necessary. The partner has to run and maintain web-pages for distributing his learning material.

Deliverables
D 41 Report: Course Concept incl. Learning aids
D 42 Report: Documentation of held course

Results, Products
Teaching Unit “Tele-Service” – Module: ...

Workpackage description: Evaluation and Dissemination

Workpackage number:	**50 Evaluation and Dissemination**
Start date or starting event:	1
Partner:	all
Person-month per partner:	

Objectives

Development of evaluation concept

Application of project evaluation

Dissemination of project

Description of work

Evaluation: For the evaluation, we following an concept, which are described in the proposal (see N Evaluation).
In detail the evaluation enclose the following steps:

1. Pre-evaluation phase: Development of evaluation concept
2. Process analysis-phase: Documentation of project progress
3. Post-evaluation phase: Summarisation

Artec will be responsible for this process (Deliverable 50). To support the evaluation process all partners have to make their deliverables in time and should give interim results if necessary. The communication process will be supported by BSCW.

Dissemination: The results of the project has to be disseminated by national and international networks, by scientific conference papers and by public demonstrations and press releases. To support this process, continuous further education and co-operation meetings should be organised within the national project-groups. On transnational level, project workshops will be carried out, where all participants should present their concepts and experiences. Each partner is involved in the dissemination process and has to document his activities (Deliverable 50-54).

Deliverables

D 50 Report: Summarisation and Evaluation (artec)

D 51 Report: Dissemination activities (artec)

D 52 Report: Dissemination activities (Cyprus)

D 53 Report: Dissemination activities (TBZ)

D 54 Report: Dissemination activities (Stockport)

Results, Products

Transferable pedagogic results
Scientific results

Products as measurable Output

No	Name	Description	
1	**Technical Concept**	- Technical Bases: Tele-service in industry, basic technologies - Tools and Methods: Concepts of modelling and simulation in teaching tele-service	
2	**Pedagogical Concept**	- Pedagogical Bases: Qualification needs in tele-service, new concepts of teaching and learning, possible learning arrangements etc - Pedagogical frame concept: Development of a frame concept which bases on co-operative and action-oriented learning paradigm	
3	**Teaching Units: Tele-Service in Mechatronis**	- Didactical and methodical concept: learning goals, tasks, student activities, time, structure etc. - Learning aids: slides, worksheets, exercises, html-pages, examination material	
4	**Documentation of Teaching Projects**	- Teaching experiences and results based on held courses	
5	**Evaluation and Dissemination**	- Empirical based knowledge on ‚Remote action oriented learning in Distributed Learning Environments' - Documentation of Scientific Results - Dissemination	

Teaching Projects, Scenarios and Case Studies

This section comprises the exemplary development and the test of tele-medial learning arrangements together with the corresponding didactic materials of selected ranges of the tele-service in the field of mechatronics. For this purpose application scenario and learning offers referring to relevant working tasks and processes in the tele-service environment will be developed.

The aim is to establish different priorities at different learning locations depending on the availability of the necessary staff and material. Teaching projects and learning materials will be tested at different learning locations.

In the following passage a brief outline of some application scenario respectively teaching projects will be given as an example in order to explain the broad spectrum.

1. Tele diagnosis and maintenance in a virtual electropneumatic laboratory

An error occurred at a distant electropneumatic-controlled system. On the basis of a *path-step-diagram (Weg-Schritt-Diagramm)* a group of students gets the task to diagnose this error and to develop proposals for its elimination.

The first step is to analyse the *path-step-diagram* and to transfer the results into a circuit-condition table (Schaltzustandstabelle). Afterwards a logic plan (Logikplan) or an electro-pneumatic circuit diagram (Schaltplan) will be generated by means of the computer, and the students will try to find the error with the help of a simulation. Then, the results will be exchanged with another group of students via the web, and this group will correct the error at the real system. E-mails and audio conferences will support a continuing exchange of information between the two groups.

2. Virtual and real CNC (Computerized Numerical Control) workshop

For the milling of a workpiece the NC (Numerical Control) programm has to be created and the manufacturing process has to be simulated with the computer. The required software runs either locally, will be loaded from a host computer or, via the World Wide Web, from another vocational school and will then be locally available. The real process of milling can be started and stopped telematically and the manufacturing process will be supervised by live video.

The video camera, equipped with a zoom lens, possibly offers the students an even better view into details of the milling cutting process than this would be the case in a real workshop because the camera is usually located at a favourable place which is not accessible for the persons working „on the spot“.

3. Control of a tele robot

The remote control of a mobile tele robot causes some problems regarding the search for paths, the finding of objects and the avoidance of obstacles. The latter are for instance caused by the system’s dynamics, by the delay in time during the transmission or by incorrect data and control algorithm. In order to solve this problem the students must be able to programme and configurate correctly a distributed control system with On-Board-Controller which is located in the respective robot. It is necessary to develop a control algorithm which will be implemented into the distant control unit. The control programme will be tested at the real system monitored by a video camera.

4. *Tele configuration and tele programming of an automation system*

As part of the learning field „design and development of mechatronic systems“ an automation system must configurated and programmed newly by using paper based materials and simulation software. The last step is to practice at a real system which is made available by a different learning location.

The access to the real system can be effected by means of control programmes and control parameters which are loaded into the system via remote data transmission. A group of students or a single person supervises this procedure and reports on its success or failure.

5. *Distributed modelling of an automation system*

Students realise a control technology task by means of a distributed modelling environment. First of all, a real system will be built with system components which are usually used by industry. Synchronously, a computer-based model will be generated and made available to other groups of students via the web. These students will then try to verify the model by means of simulation and discuss their results within a computer-supported conference. The visualization and the description of the model will be realized by different technologies, e. g. WWW and VRML (Virtual Reality Modeling Language). Subsequently, all learning groups together should work on the development of a solution which can be applied to the real system afterwards.

Learning-Fields of the Curriculum-Frame Mechatronics

The following table shows a curriculum for technicians in mechatronics as they are educated in Germany. The learning fields, where Tele-Service could be important, are marked with a cross.

	Learning-Fields	**1.Year hrs**	**2.Year hrs**	**3.+ 4. Year hrs**	**Tele-Service**
1.	Analyse functional Dependencies	40			
2.	Produce mechanical Subsystems	80			
3.	Install electrical Components,consider Safety	100			
4.	Investigate Flows of Energy & Information	60			
5.	Communicate through IT-Media	40			x
6.	Plan & organise Workflow		40		
7.	Build simple mechatronic Components		100		
8.	Design and build mechatronic Systems		140		
9.	Investigate Information-Flow in complex mechatronic Systems			80	x
10.	Plan the Assembly & Disassembly			40	
11.	Start Operation, detect Faults and repair Systems			160	x
12.	Prospective Maintenance			80	x
13.	Deliver mechatronic System to customer			620	
	Sum	320	280	420	

Questionnaire for interviews with companies using tele-service systems

Guiding questions:

1. Which importance would you assign to tele-service in your company?

2. Which fields do you consider of particular importance for tele-service (differentiated by e.g. implementing, inspection/monitoring, diagnosis, processing support, maintenance/servicing, repair)?

3. Which tools, technical aid and methods will your service engineers apply at the customer's, if they are not in a position to solve a problem on their own but require, for instance, the direct co-operation with the respective manufacturer of the system?

4. Which information respectively data will be exchanged in this case?

5. In your opinion, to which extent can working tasks which are connected with tele-service be carried out properly by skilled workers?

6. Which competencies (differentiated by professional, methodical, social and personnel competency) do you expect from skilled workers being employed in the tele-service field?

7. What kind of education/training should a tele-service engineer have? Which professions would be suitable for this vocational training?

8. Which are the fields you are training your employees in to prepare them for tele-service tasks?

9. Who carries out this training?

10. Which learning concepts (e. g. CBT, Training-on-the-job) do you consider to be particularly effective in order to train skilled workers in tele-service?

11. What kind of teaching and learning media should be available for appropriate qualification measures?

12. In which way should vocational schools, in the framework of the basic vocational education, contribute to qualification measures in the tele-service field?

13. In this context, which role should the vocational school play regarding further and extended vocational training?

14. Which areas (e. g. qualification concepts, teaching and learning media, CBT, teaching and vocational training curricula) would you consider to show particular gaps in research and development?

Revised Budget

Participant EUR18 (Stockport, BfE) RADIO - dm/22.01.2000

	Total	1. year	2. year
a *personal*	30,8	20,5	10,3
b *overhead*	2,2	1,5	0,7
c *travel*	4,4	2,9	1,5
d *sub-contract.*	0,0	0,0	0,0
e *info process.*	4,4	2,9	1,5
f *other costs*	2,2	1,5	0,7
total	**44,0**	29,3	14,7

Participant CYPRUS

	Total	1. year	2. year
a *personal*	9,5	6,3	3,2
b *overhead*	0,6	0,4	0,2
c *travel*	5,6	3,7	1,9
d *sub-contract.*	0,0	0,0	0,0
e *info process.*	1,2	0,8	0,4
f *other costs*	0,7	0,5	0,2
total	**17,6**	11,7	5,9

Contractor and Co-ordinator (Uni-Bremen)

	Total	1. year	2. year
a *personal*	47,6	31,7	15,9
b *overhead*	3,4	2,3	1,1
c *travel*	6,8	4,5	2,3
d *sub-contract.*	3,4	2,3	1,1
e *info process.*	3,4	2,3	1,1
f *other costs*	3,4	2,3	1,1
total	**68,0**	45,3	22,7

Cost Summery (Shared costs between the partners during project)

	Total	Artec	Stockport	BfE	***UniCyprus***
a *personal*	118,7	47,6	30,8	30,8	9,5
b *overhead*	8,4	3,4	2,2	2,2	0,6
c *travel*	21,2	6,8	4,4	4,4	5,6
d *sub-contract.*	3,4	3,4	0,0	0,0	0,0
e *info process.*	13,4	3,4	4,4	4,4	1,2
f *other costs*	8,5	3,4	2,2	2,2	0,7
total	**173,6**	68,0	44,0	44,0	17,6

Cost Summery (Shared costs over project period)

Participants	Total	1. year	2. year
Artec	68,0	45,3	22,7
Stockport	44,0	29,3	14,7
BfE	44,0	29,3	14,7
UniCyprus	17,6	11,7	5,9
total	**173,6**	115,6	58,0

’Remote Action in Distributed Learning Environments’ (Radio)

Dieter Müller

Kick-Off-Meeting - Cyprus
27. - 28. March 2000

Table of Contents

- Overview: Subject area, focus, project data
- Background: technologies, tools and work concept; new demands on vocational training and education
- Main objectives for the project
- Anticipated Benefits
- Products as measurable output of the project
- Teaching projects/scenarios
- Focus of Research
- Description of Work

Overview: Subject and Focus

- **Subject area:**
  - Scope: Innovation in vocational training and education
  - Target groups: skilled workers, technicians and engineers in mechatronics
    - Initial and continuing vocational training
    - Live long learning
  - Learning fields:
    - Telemedia-based methods and
    - Tools in mechatronis
- **Focus:**
  - Development,
  - Test and
  - Evaluation of new learning concepts, material and media

Overview: Project Data

- **Project Partners**
  - Technical Colleges
    - Stockport College, Stockport - UK
    - Technisches Bildungszentrum Mitte (TBZ), Bremen - Germany
  - Universities
    - University of Cyprus (DCS), Nicosia - Cyprus
    - University of Bremen (Research Center artec) - Germany
- **Project type:**
  - Programme: Leonardo da Vinci I
  - Pilot project - action line: II.1.1 a
- **Duration:**
  - 18 month
  - Begin: 1/12/1999 (start of contract !)
  - End: 31/5/2001

Background: New Technologies and Concepts of Work

- **New key technologies**
  - Mechatronics
    - Integration of electrical, mechanical and informatical systems and components
  - Integrated networks in automation technologies
    - WANs + LANs
    - Actors/sensors + PLCs + Fieldbus + (Industrial) Ethernet
  - Mobile Computing
    - Notebooks, PDAs, Wearables, Wireless networks
- **New concepts of work**
  - Distributed autonomous production concepts (national and worldwide)
  - Telemedia-based diagnosis and maintenance concepts
  - Distributed telemedia-based groupwork

Background: New IT-tools and Qualifications

- **New tele-supported tools and methods**
  - remote installation
  - remote control
  - remote diagnosis
  - remote maintenance
  - remote ...

Tele-Service

- **New qualification needed**
  - Multi-skilled technicians (in mechatronics)
  - New job profiles:
    telemedia-based co-operative work

Tele-Service Expert

Background: New Demands on Vocational Training and Education I

- **Learning objectives**
  - knowledge of structure, behaviour and function of mechatronic systems
  - knowledge of tele-media-based tools and methods
  - knowledge and skills to use tele-supported tools
  - skills and attitudes to co-operate in tele-media-supported environments
  - ...

Background: New Demands on Vocational Training and Education II

- **New educational media**
  - paperware
  - software
  - hardware

Distributed telemedia-based learning environments

- **New concepts of teaching and learning**
  - Tele-learning
  - Co-operative learning
  - Action-oriented learning

‚Remote action oriented learning'

Objectives for the Project

1. Development of a technical concept which will meet the requirements of teaching and learning tele-service in distributed environments
2. Development of a pedagogical concept which will be based on co-operative and action-oriented learning paradigm
3. Development of courses and learning material
4. Realisation and documentation of courses and teaching projects
5. Evaluation and dissemination of the project

Anticipated Benefits

- Experimentation with new forms of tele-media based learning is obvious, because it will improve the learning process itself and support the tele-service curriculum.
- Enrichment of lessons by new tele-medial learning subjects and methods
- Improvement of teaching and learning offers by common utilisation of distributed and scarce resources.
- Support of co-operation between regionally and nationally distributed learning sites.

Products as Measurable Output of the Project

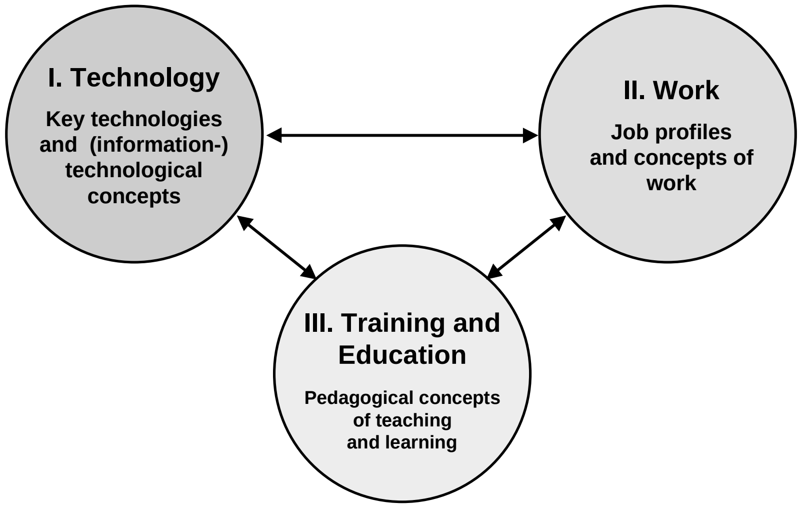
1. Technical concept
2. Pedagogical concept
3. Teaching units and learning material for tele-service in mechatronics
4. Documentation of teaching projects
5. Evaluation and Dissemination

Teaching Projects, Scenarios and Case Studies

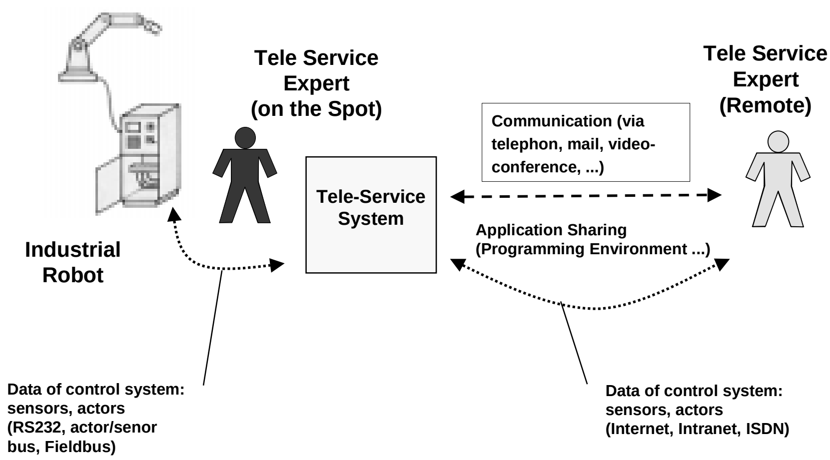
Examples

1. Tele diagnosis and maintenance in a virtual electropneumatic laboratory
2. Virtual and real CNC (Computerized Numerical Control) workshop
3. Control of a tele robot
4. Tele configuration and tele programming of an automation system
5. Distributed modelling of an automation system
6. ...

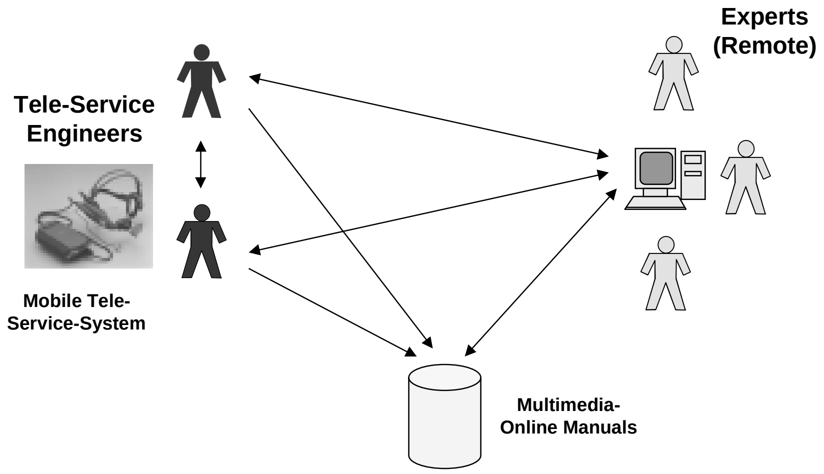
Focuses of Research



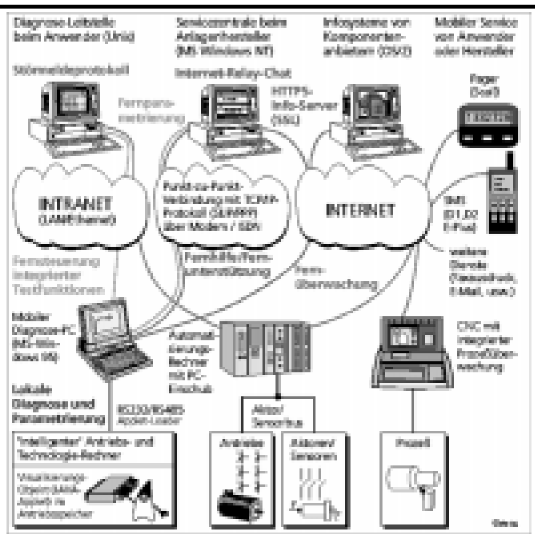
Use-case: Repair of a Robot System



Use-case: Using Mobile Service-Tools and Online Manuals

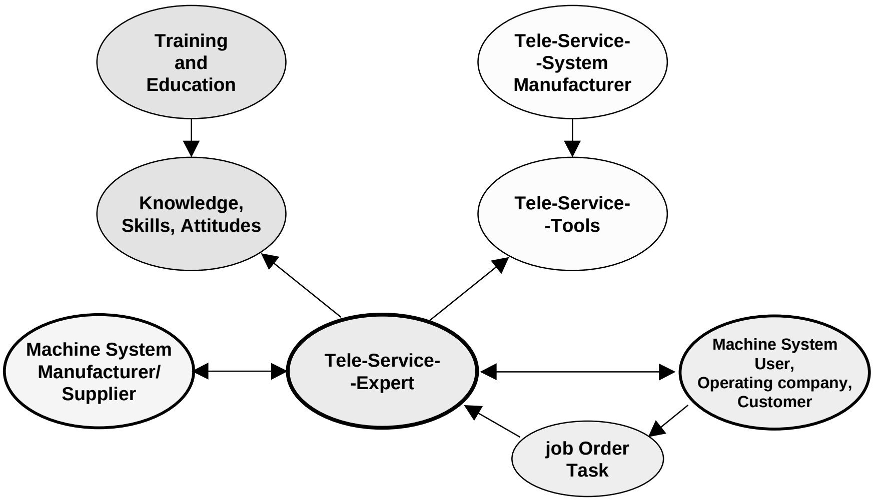


Example Configuration



Tele-Service-System (IPK 1998)

Tele-Service: Constellation of actions



Types of Tele-Service

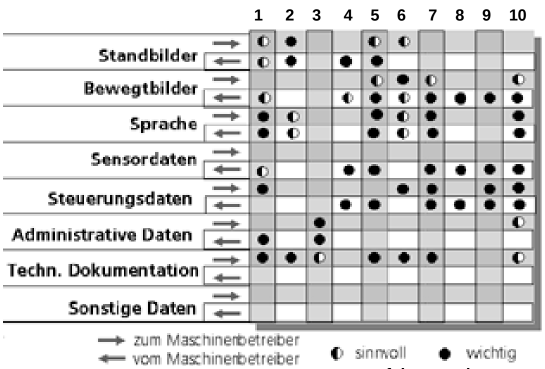
- **Passive:**
  - **Remote recording**
  - **Remote monitoring**
  - **...**
- **Active:**
  - **Remote parameter assignment**
  - **Remote programming**
  - **Remote control**
  - **Remote maintenance**
  - **...**

Remote Sensing (Passive)

Remote Action (Passive and Active)

Types of Data and Media in Tele-Service

Still pictures
Dynamic pict.
Speech
Sensor data
Control data
Admin. data
Tech. Docs
Others



=> to operating company
<= from operating company

useful important

(Westkämper 1998)

1. Inbetriebnahme
   Start-Up, Installation
2. Ersatzteilbeschaffung
   Replacement part
3. Ersatzteilbereitstellung
   Replacement part supply
4. Inspektion/Monitoring
   Service /Monitoring
5. Diagnose
   Diagnosis
6. Instandsetzung
   Repair
7. Maschinentuning
   System tuning
8. Prozeßüberwachung
   Process monitoring
9. Prozeßführung
   Process control
10. Prozeßtuning
    Process tuning

Universität Bremen

Research Centre Work - Environment -Technology (artec)

Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

Contract No.: D/99/2/07331/PI/II.1.1.a/FPI

TELESERVICE IN INDUSTRY

Dieter Müller

Work Package:	**W20 Technical and Pedagogical concept**
Deliverable:	**D21 Technical Bases: Teleservice in Industry**
Date of Delivery:	21. April 2000
Deliverable Type:	Restricted

Abstract: This document describes teleservice work organisation, techniques and tools

Keyword List: Teleservice, Remote service and maintenance, Teleservice tools and systems

Contents

Teleservice in industry
- The technology and its applications -

1 Introduction

The present study is a summary analysis of *teleservice*. The term teleservice refers to the distributed installation, operation, maintenance and repair of networked mechatronic plant and machinery. The intention of our analysis is to provide a practical guide to issues regarding teleservice work organisation and techniques. The study is based on literature research, participation at relevant conferences and workshops, as well as the exchange of detailed information with teleservice providers and customers.

The results of the analysis will provide the basis for designing appropriate vocational training concepts and suitable learning environments.

2 Services provided by the mechanical engineering and plant construction industries

Services provided by mechanical engineering and plant construction companies traditionally involve the elimination of plant malfunctions and the performance of repairs within the scope of normal warranty agreements and warranty commitments. In many cases, the services rendered are grudgingly seen by mechanical engineering and plant construction companies as secondary, ancillary work. However, there are signs that this attitude is changing – globalisation and a growing dependence on exports on the part of European mechanical engineering and plant construction companies is producing a situation in which worldwide customer service provision to ensure plant availability is seen as an additional factor for distinguishing oneself from competitors (Hermsen/Zuther 2000, p. 5ff). This trend is reinforced by the increasing similarities between many products. The result, in markets characterised by a high level of competitive pressure, is that the decision to buy depends not only on quality considerations, but also on the level of service provided (Maßberg et al 1998).

Another factor behind the rapid rise in the importance of service is the pace at which the complexity of plant and machinery has been increasing. That pace has been significantly accelerated by the growing use of *mechatronic systems*[1]. Mechatronics is characterised by an integrated, interdisciplinary approach to project planning, design and development of complex multi-technical equipment, systems and plant (Eversheim/Schernikau/Niemeyer 1998). Quite often, mechatronic plant and systems can only be installed and operated in conjunction with

[1] The term *mechatronics* is derived from the terms MECHAnics, elecTRONics and informatICS.

support services, because they require specialist know-how and, in the case of faults or repairs, skilled customer support by the manufacturer's specialists.

In the context of these trends, service has developed from a purely technical service for customers to a discipline comprising a broad range of industrial services.

This trend has been corroborated by empirical studies for several years already. The following table shows the results of a survey carried out in 138 companies from various sectors in Germany, and published as early as 1993 (Simon 1993). It shows that services and customer orientation are considered by companies to be more important than other factors such as price, technology, etc. It can be assumed that service is considered the most important deliverable from a customer-centred perspective.

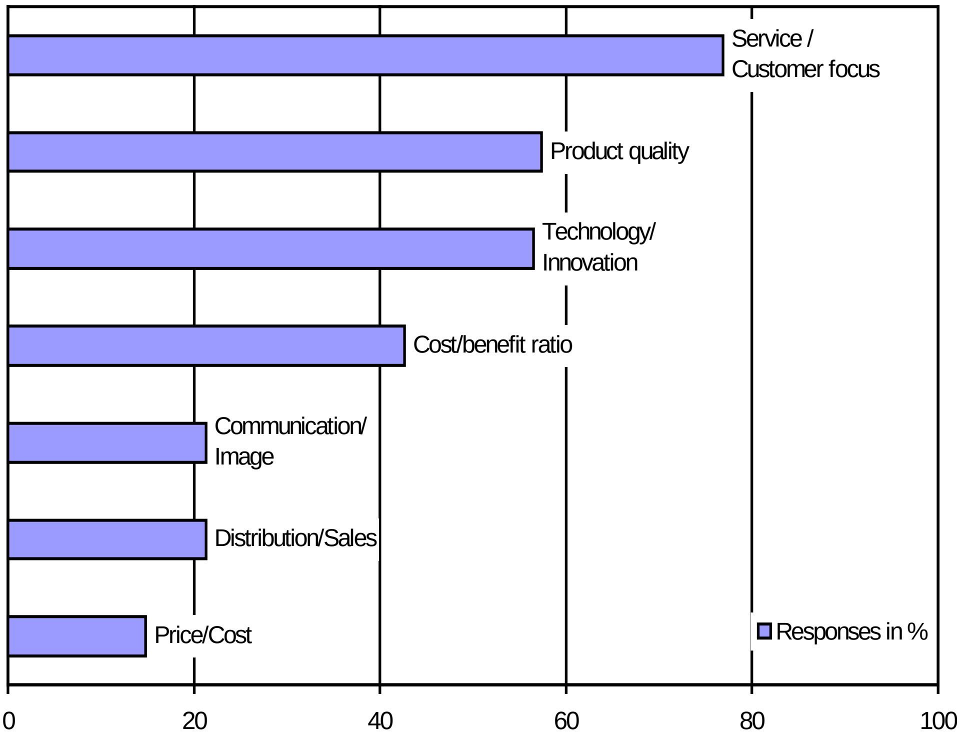


Table 2: Future opportunities for effective competitive differentiation in the long term (Simon 1993, p. 12)[2]

[2] The result of a survey of 138 companies from different sectors of German industry. 30%, 23% and 22% of the companies were from the electrical, chemical and mechanical engineering industries, respectively. The remaining 25% were distributed among various other sectors.

3 The importance of teleservices

Against the background of the changes described in the foregoing, makers of plant and machinery increasingly realised the importance of services that enable customer proximity over large geographical distances, on the one hand, while also being practicable for the manufacturers, on the other.

Aided by the development of broadband communication networks and the growth of the Internet as a global, universally available telecommunications medium, the use of teleservice has therefore been increasing. Teleservice is primarily seen as an efficient means for remote identification of faults and errors, and for initiating the relevant action. In one survey conducted by *VDI-Nachrichten*, remote diagnosis was named as the key service of the future (see Table 3). This particular survey did not yet include other forms of service support through teleservice (e.g. service hotline, advisory services, training).

Services		%
1	Remote diagnosis	26
2	Training	12
3	Buying and selling of used parts and machines	12
4	Active marketing of tools	11
5	Modernisation	10
6	Active marketing of spare parts	9
7	Machine hire, rental service	9
8	Advisory services	8
9	Preventive maintenance	8
10	Increasing personal safety	8
11	Service hotline	6
12	General overhauling	5

Table 3: Increase in importance of various services, in % (VDI 1999)

3.1 Teleservice – history and definition

The origins of teleservice can be traced back to the year 1975. Kearney & Trecker, the American producer of machine tools, coined the term teleservice to describe the use of data transmission in the customer service context (Hermsen/Zuther 2000, p. 15). This involved support to eliminate faults and to service NC machines using the telecommunications technologies available at the time (slow telephone connections). With the growth of the Internet, perspectives have recently been widened as far as both teleservice in the narrower sense as well as the various fields of application are concerned. Hudetz/ Harnischfeger define teleservice as follows:

"By TeleService is meant ... the support of customer service provision by means of information and communication services and components that enable the remote diagnosis of machines and the elimination of faults. TeleService is deployed when installing and commissioning plant and machinery, when curing disruptions and for uploading new software releases. In the future, new fields of application for teleservice will also include the support of processes and the provision of advisory services to customers" (Hudetz/ Harnischfeger 1997, p. 17).

Maßberg and Hermsen describe teleservice as a service "that enables all customer contact in connection with the planning, installation and operation of plant and machinery to be carried out more simply, faster, from any place and more cost-efficiently using modern communications and information technologies, combined with multimedia tools. The prerequisite is that manufacturers, customers and the plant/machinery be extensively networked by computer" (Maßberg/ Hermsen 1998, p. 40).

To an increasing extent, network-based interaction between manufacturers and customers is seen as the key, central element in the service provision chain. The technological basis is provided by telemedia-aided tools for distributed cooperation[3], e.g. in the form of shared access by plant construction company and plant operator to machine controls, process visualisation or technical documentation. (see Fig. 1).

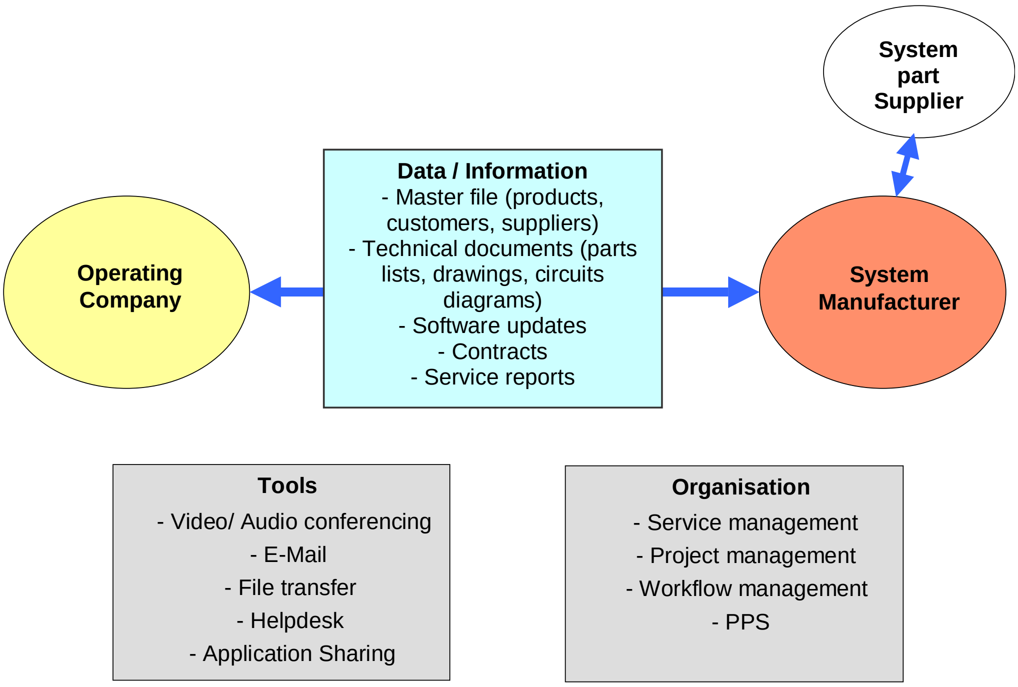


Figure 1: Components of teleservice

[3] Teleservice in this sense is a field of application for the Computer Supported Cooperative Work (CSCW) concept.

3.2 The role of teleservice in the life cycle of a plant

Teleservice is not confined to single fields of application, such as remote diagnosis and maintenance, but may cover the entire life cycle of a plant. Teleservice can essentially be used for all services in which a technical system is connected to a telecommunications network. Westkämper (1998) lists the following teleservice functions of relevance in the mechanical engineering field: (1) commissioning, (2) procuring spare parts, (3) supplying spare parts, (4) inspection / monitoring, (5) diagnosis, (6) maintenance and repair, (7) tuning machinery, (8) monitoring processes, (9) process management and (10) process tuning.

Hermsen/Zuther (2000) differentiate between different teleservices in the phases of *product development*, *production* and *assembly*, *commissioning* and *product use*. During the *product development* phase, communication between the plant manufacturer and the subsequent plant operator can be improved using teleservice, thus avoiding costly ‘design loops’. A similar principle operates during *production* and *assembly*: problems that first arise on the building site in many cases can be solved by tele-cooperation. *Commissioning* can also be carried out more quickly: experts from the plant manufacturer can be integrated into the commissioning process more easily and provide support to plant operator staff on site. During the *product utilisation phase*, any disruptions that occur can be dealt with faster and more efficiently over a teleservice network. Integrating the companies responsible for performing maintenance and repair work ensures that such work is properly carried out. Improvements can be made to process optimisation, or when shutting down a plant in order to switch product, because the exchange of experience between the plant manufacturer and the operator can be designed for greater efficiency using teleservice aids. The following graph shows the main points in the life cycle of a plant where teleservice is applied.

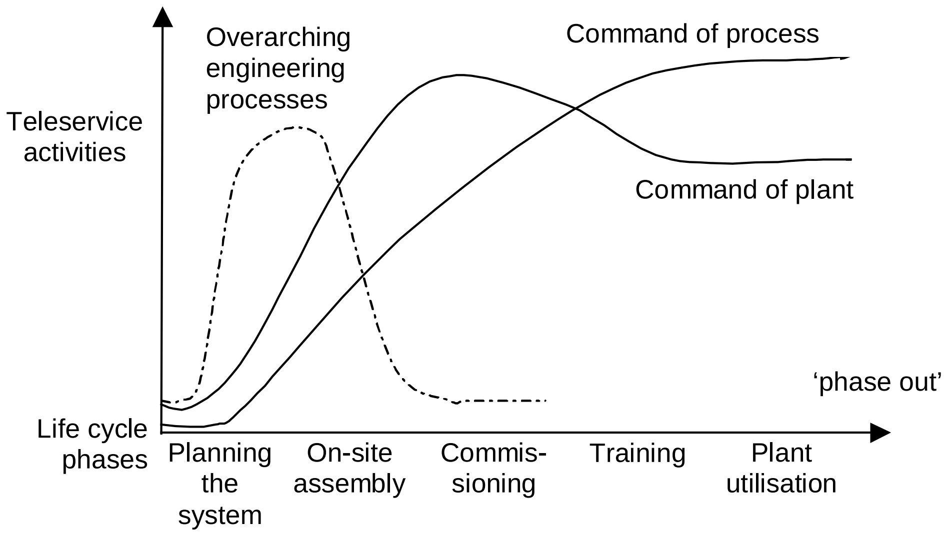


Figure 2: Use of teleservice during the life cycle of a plant (according to Hermsen/Zuther 2000)

Teleservices can be basically subdivided into *passive* and *active* services. Passive services encompass diagnostic or process monitoring functions that indicate, but do not modify the state of a system. Active services interact directly with the system and include, for example, remote maintenance, remote programming, process management and remote parameterisation, control and repair. Passive services are the most prevalent, due to the risk of industrial accidents and unwanted interference in the case of active services (Hermsen/Zuther 2000, p. 16).

Teleservices	
Passive	*Active*
Remote recording	Remote parameterisation
Remote monitoring	Remote programming
...	Remote control
	Remote maintenance and repair
	...

Table 3-1: Active and passive teleservices

3.3 Benefits of teleservice for producers and operators

Teleservice enables the *manufacturer* to design his services more effectively, in that skilled local workers can be supported by a central panel of experts. Aassembly at the building site, commissioning and repairs are all speeded up. Accordingly, time-consuming journeys by experts to the customer can be reduced. At the same time, communication between the manufacturer and the user of the plant is improved. This helps to reduce service costs while increasing the availability of systems. Rough estimates indicate that 20 to 30 percent of after-sales expenses can be saved using teleservice (Hudetz 1997, p. 33).

For *plant users*, down-times of machines can be shortened by means of teleservice, because maintenance work, remote diagnosis and fault elimination can be carried out faster. In particular, there are no long periods spent waiting for service specialists to arrive. Because teleservice essentially enables simpler access to the manufacturer’s know-how, the productivity of the machinery user increases accordingly.

Operator	Manufacturer
Long-term reduction of operating expenses	Cost reduction (personnel and travel expenses)
Reduction of machine down-time	Increased availability of specialists within own company
Increased availability of plant	If necessary, the right specialist can be sent to the customer's site
Minimal service expense beyond warranty	Optimisation of service structures
Support during commissioning phase	Improvements to service efficiency
Individual support with process implementation and modification	Greater transparency of service procedures
Simple uploading of software updates	Customer ties are intensified
Enhancement of in-house competence to solve problems	Competitive leads are generated
Increased satisfaction of employees by expanding the knowledge base and broadening the range of tasks performed	Presence in distant economic regions
Internal training of employees	Increased level of service performance
Greater focus on supplier company	Reduction in response times
	More detailed information on plant disruptions are used to achieve continuous improvement

Table 3-2: Benefits of teleservice for manufacturers and operators (from Hermsen, Zuther 2000, p. 19)

As part of the 'Multimedia TeleService' research project (Maßberg/ Hermsen/ Zuther 2000), a number of companies were surveyed about the potential savings that can be achieved by using teleservice. The following diagram illustrates the results of the survey:

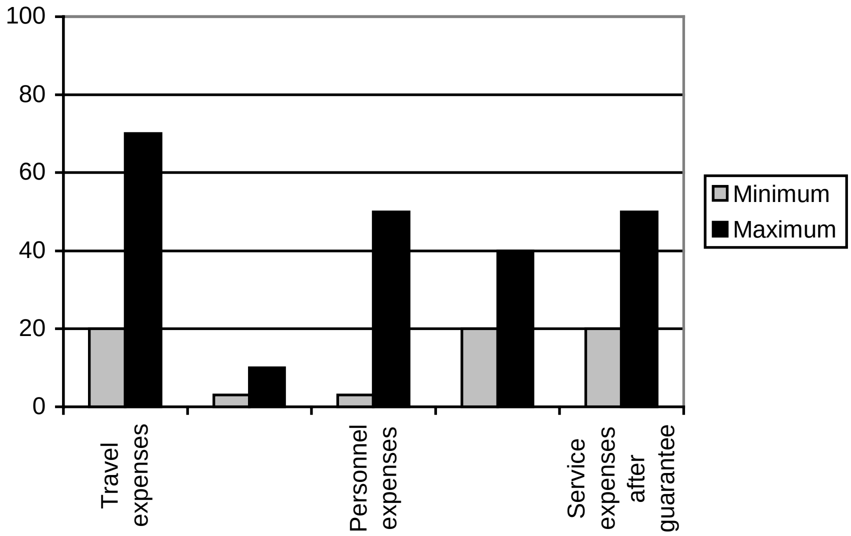


Figure 3: Estimated savings potentially obtainable with teleservice (Schaub/Hermsen/Spiess 2000, p. 41)

4 Teleservice data exchange

4.1 Relevant data for teleservice

In order to function properly, teleservice requires a good basis of data, including master and diagnostic data. Master data contains information on the manufacturer, customer, suppliers, the plant and the history of orders. Direct access to master data is the basis of teleservice provision. Continuous documentation of all service occurrences enables data to be searched and makes it easier to solve current problems. Diagnostic data contains information describing the state of a plant, of components and/or a process. They include machinery data, process data, status and error messages, sensor data, etc. Data for plant control include, for example, control programs, system programs or control/adjustment parameters. The data that have to be exchanged give rise to requirements that the machinery manufacturer and the operator must meet in respect of the availability, capacity and resources of their communications and IT components.

The requirements that have to be met by the teleservice and the associated exchange of data vary considerably depending on the specific field of application:

In *mechanical engineering*, visual inspections of machines and plant components play a key role. Video transmission of moving pictures and stills, as well as the exchange of visualisation data (e.g. of pressure and temperature changes over time) are important in this context.

In *control engineering*, visual control has only secondary importance, in contrast to mechanical engineering. Instead, what is important is access to particular control systems in a plant and to the malfunction logs. Accordingly, access to the control systems and appropriate access to and exchange of data must be provided.

Production engineering and *process engineering* are two areas in which optimal adjustment of the production process is monitored with regard to production targets (speed, quality, costs). Monitoring processes via teleservice therefore means that different requirements have to be met compared to the monitoring of control elements.

The following table, adapted from Westkämper (1998a), provides an overview of various teleservice functions and data in the mechanical engineering field:

		1. Commissioning	2.Identification of spare parts	3.Ordering spare parts	4.Inspection/ Moni-toring	5. Diagnosis	6. Maintenance	7. Machine tuning	8. Process monitor-ing	9. Process man-agement	10. Process tuning
Still pictures	**->**	o	+			o	o				
	<-	o	+		+	+					
Moving pictures	**->**					o	+	o			o
	<-	o			o	+	o	+	+	+	+
Voice	**->**	+	o			+	o	+			+
	<-	+	o			+	o	+			+
Sensor data	**->**										
	<-	o			+	+		+	+	+	+
Control data	**->**						+	+		+	+
	<-				+	+		+	+	+	+
Administrative data	**->**			+							o
	<-	+	+	+							
Tech. Docum.	**->**	+		o		+	+	+			o
	<-										

-> to operating company, <- form operating company, (o = useful, + important)

Figure 4: Teleservice functions and data (from Westkämper 1998a)

4.2 Diagnosability of plant and components

One prerequisite for teleservice is that the respective plants, machines or components be diagnosable. In order to diagnose malfunctions, it is essential to have online access to as much internal control data as possible, such as

- inputs/outputs
- data fields (settings, machine parameters, tool parameters ...)
- control programs and their respective statuses
- editing programs (NC programs)
- bus configuration, bus information,
- data from decentral components, and
- log data (error messages, etc.)

Where relevant, these data must be supplemented by audio-visual data showing the process and plant environment. This data access requirement is the reason for using machine components with appropriate hardware and software interfaces, open control design and a communication network with the requisite capacities.

Analysing malfunctions in a complex plant is a complicated business in many cases: detailed knowledge about the process, the plant and its components are necessary. Faults and malfunctions can be classified into various groups:

- systemic errors (cause is located in the plant/components)
- process errors (technological errors affecting the plant)
- operating errors (operating, input errors).

5 Basic technologies and standards

5.1 Open control structures in automation engineering

Teleservice is based on a constant flow of information between the process itself and the human-machine interface. The human-plant/machine and human-process linkage points are particularly important. It is via these linkages that a human agent can intervene in a system or a process. Based on this fundamental principle, a typical structure has developed within industry that comprises three relatively independent and hence separately operable levels:

- the plant management/factory level: WAN (Wide Area Network)
- the process management/cell level: LAN (Local Area Network)
- the field level: FAN (Field Area Network)

The networks and buses for these levels have been standardised to a large degree. The following diagram shows the structured levels for communication systems[4].

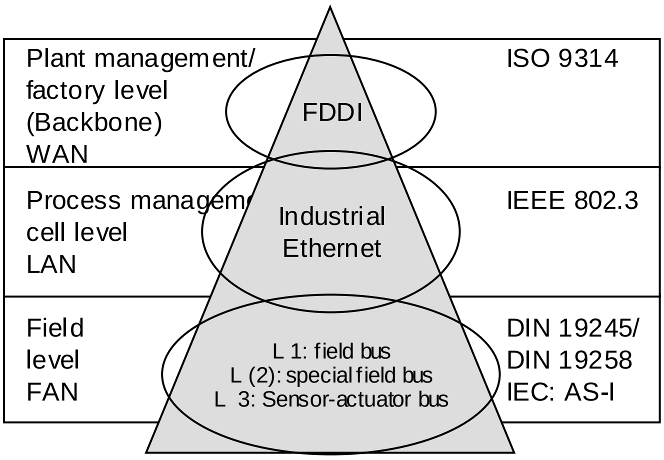


Figure 5: Multi-level communication (Kriesel/Telschow 2000, p. 211)

In recent years, ‘Industrial Ethernet’ has become increasingly common at the process management level. Industrial Ethernet is an Ethernet system with the following characteristics:

- industrial-standard cables and connectors,
- industrial-standard switching modules,
- compliance with industry requirements regarding ambient conditions and fail-safe operation,
- fast, almost deterministic response times (unlike classical Ethernet),
- use of switching technology.

[4] The level-based structure for communications systems must not be confused with the 7-layer ISO/OSI reference model that at the time provided a framework structure for any bus system (Kriesel/Telchow 2000, p. 211).

Automation experts assume that Industrial Ethernet will quickly assert itself as far down as the field level, and that it will take over functions normally performed by classical field buses. Industrial Ethernet provides a high level of support to standardised communications solutions, from the sensor/actuator level to the Internet, thus facilitating the implementation of teleservice functions in heterogeneous automation settings.

Within this context, leading German automation companies have come together in the *IDA* initiative (Interface for Distributed Automation). The aim of *IDA*, besides improving collaboration of industrial installations, is to enhance ‘machine intelligence’ – modular entities in the factory, such as control units, operating equipment, drive systems or robots, are to be capable of cooperating autonomously. At present, such cooperation is organised by central control computers at the middle MES (Manufacturing Execution System) level. In future, these MES controller computers will disappear and the respective functions will migrate to the lower field levels where machine control is located. The field level will then be able to interact with the ‘Enterprise Resource Planning’ (ERP) software itself. The basis for such interaction is provided by the *IDA* standard. It describes a real-time communications structure linking the controlling computers, on the one hand, and providing standardised interfaces for applications, on the other hand. The *IDA* Group uses standards and protocols from the IT world, but adapts them to industry-specific conditions. Some manufacturers are now installing the first *IDA*-compatible control systems in their machines, and the US standardisation body Iaona (http://www.iaona.com) intends to adopt parts of the *IDA* standard later this year (See *Computer Zeitung* 2001, Issue no. 20, p. 14).

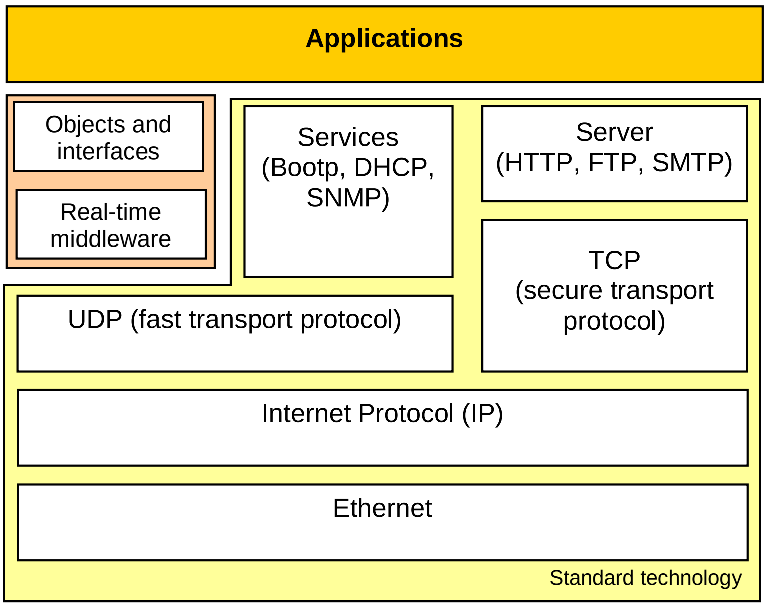


Figure 5: Structure of the IDA standard (Source: IDA)

The trends in automation engineering described in the foregoing make it easier to implement open systems for control, in terms of both the internal and external openness of machine control systems (see Table 3). This, in turn, will foster and speed up the spread of teleservice in practice.

Internal openness	**External openness**
Open software interfaces (open both to the process and to the human-machine interface) Configurable hardware and software	Programs compliant with standards Standardised communications interface Integration within IT environment

Table 3: External and internal openness of machine control systems

5.2 OLE for Process Control (OPC)

OPC (OLE[5] for Process Control) has become the established standard in the applications layer for the exchange of production data using Ethernet-TCP/IP. Originally developed for linking operating interfaces and software tools like SCADA[6] or production control systems to controllers and network cards, OPC is also being used to an increasing extent to regulate the exchange of production data over Ethernet-TCP/IP.

The OPC standard mainly defines a functional interface between two software systems. A production data server – also termed an OPC server – provides a methods interface that must be operated by a data user, the OPC client. Such a methods interface is then implemented on top of a (semi-) standardised component model such as CORBA[7] or COM, which regulates communication between two software systems. By implementing the OPC standards on the OPC server and the client side, a vendor-independent link is created between two software tools.

If the component model supports Remote Procedure Calls (RPCs) – i.e. enables server functions to be requested by a client over Ethernet-TCP/IP – then OPC also provides the option of exchanging production data over Ethernet-TCP/IP. Many

[5] In the Windows operating system, OLE (Object Linking and Embedding) is the interface for the internal exchange of data between objects in different Windows applications, thus enabling such objects to be linked and embedded. OLE technology is based on (D)COM ((Distributed) Component Object Model), which enables the (distributed) handling of objects. 'ActiveX' is the general term embracing the OLE/COM/DCOM family of technologies.

[6] SCADA (Supervisory Control And Data Acquisition): systems for process visualisation and control.

[7] CORBA (Common Object Request Broker Architecture) is a component of OMA (Object Management Architecture) and specifies the creation and use of distributed objects. There are many CORBA-compatible applications owing to the possibility of using different platforms. For example, CORBA-compatible objects in the Internet can be addressed in WWW browsers using IIOP (Internet Inter-ORB Protocol – a component of CORBA).

different companies are now marketing OPC servers and clients based on the DCOM (Distributed Component Object Model) that forms part of the Windows operating system. Such systems enable an item of process data to be used on any Windows platform at any company location over the corporate Intranet or even the Internet.

5.3 CANopen

CANopen[8] is gaining in importance as a new technological standard for networking controllers at field level (see CiA). CANopen can be viewed as the further development of first-generation field bus systems. Many of these bus systems are based on a Single Master structure. In order to regulate data transport on the bus, it is necessary to have a central governing instance called an 'arbiter'. In the classical control architectures, this is implemented in the controller. The existence of a central arbiter generates enormous obstacles if the aim is to have independent, decentral entities and to network, autonomously plan, operate and commission them without a central controller.

CANopen overcomes these obstacles and paves the way for decentralised automation. It does so by taking the central arbiter and distributing it across the network at every single network user's workstation. This is made possible by the arbitration mechanism known as CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance). By using this message-based, prioritised collision avoidance method, each network participant may actively request permission to broadcast.

CANopen thus becomes a multi-master network. It is now possible, without having to have a central controller or a central arbiter, to form functional units comprising several CANopen participants and to plan and launch these separately. It is now easier than it previously used to be to form modules by distributing controller functions at the field level, and to create communication ports for teleservice down to the field level.

[8] CAN (Controller Area Network) was originally developed by Bosch and Intel for fault-free networking in road vehicles (Kriesel/Telchow 2000, p. 215).

6 Sample tools and systems

6.1 Basic teleservice requirements

The structure and functionality of teleservice systems are derived from the requirements of teleservice providers and users, as described in the preceding sections. Accordingly, teleservice systems are predominantly used on mobile systems operated by service technicians and in cooperation between several partners (manufacturer/customer, manufacturer/supplier/customer, manufacturer consortium/customer, etc.).

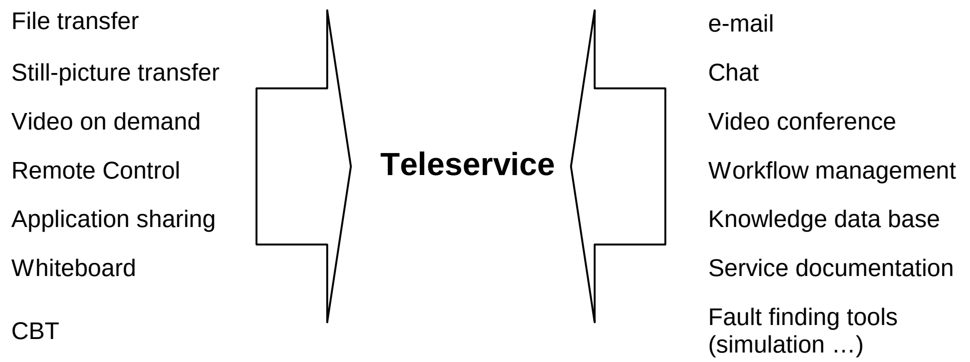


Figure 6: Basic teleservice functions/tools

The basic functions of teleservice systems (see Figure above) can be easily achieved nowadays with conferencing systems or application sharing software (NetMeeting, pcANYWHERE, etc.). Special systems are needed to perform complex functions. Two examples of teleservice systems are described in the following.

6.2 Teleservice system 'TeLec'

A teleservice system for stationary machine tools and plants was designed in a research project entitled 'Multimedia TeleService (TeLec)' and implemented in the form of a prototype (Maßberg/ Hermsen/ Zuther 2000). The following diagram shows the structure of the system.

The TeLec system is modular in structure and designed for different organisational environments (manufacturers, operators, service technicians, etc.). The manufacturer system has the greatest functional scope. In addition to a communications switchboard, this particular module also provides functions for administration, evaluation and forwarding of service jobs. The operator system is limited to communication, diagnostic and data procurement functions, but can be extended if required and provided personnel with the relevant skills are available.

For service technicians in the field, the TeLec system provides a mobile client. This enables both access to the manufacturer and the operator system (access to plant, with additional audio and video components). In addition to standard functions, the software is also divided into four basic modules that are logically connected with each other: TELservice, TELstamm, TELreports and TELflow (see Figure).

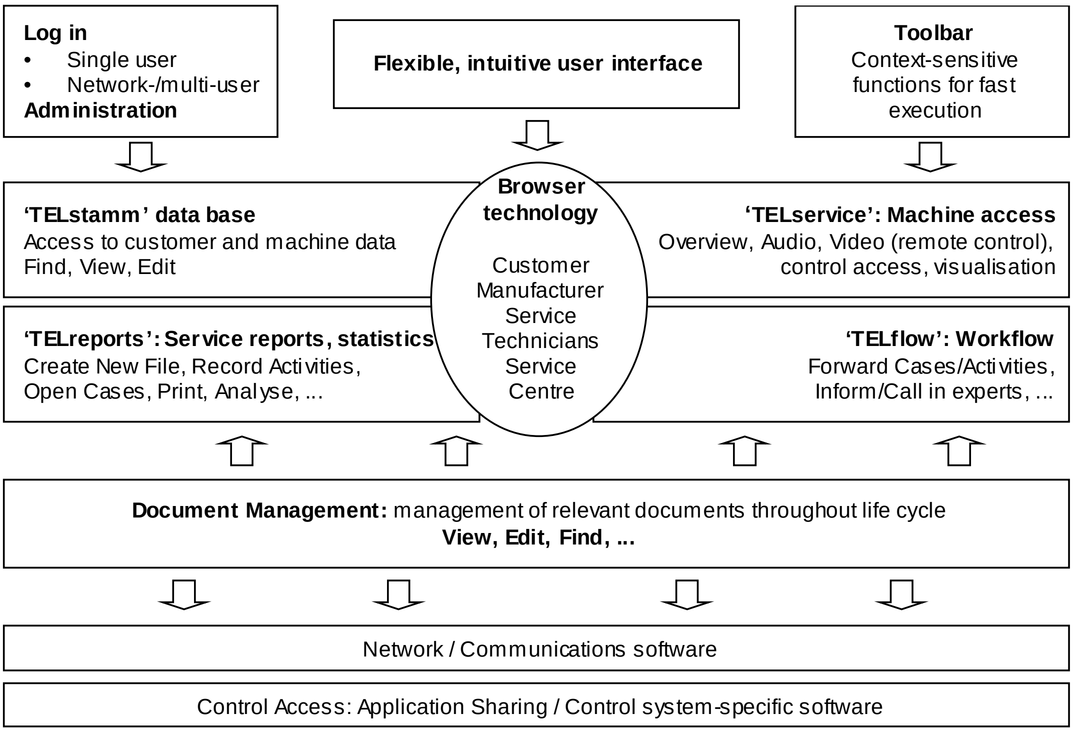


Figure 6: Structure of the modular TeLec system (adapted from Zuther 2000, p. 80)

The main functions of the modular TELec system are, of course, to support core teleservice functions, such as video/audio transmission, establishing connection to remote control systems, or process visualisation. The software supports the H.320 (ISDN), H323 (LAN) and T.120 (Application Sharing) communication standards. The data used for connections or for selecting the transmission medium (POTS, ISDN, satellite, Internet, GSM, ...) are included within the system. A remote-controlled camera can be used, if so required. The functions for audio and video transmission are based on the systems made by AlgoVision Systems GmbH, Bremen. Algovision has launched a mobile, notebook-based teleservice system with analogue functions that is used by teleservice users (www.algovision.de)

Figure 5: Notebook-based teleservice system from Algovison

6.3 IPK machine diagnosis system

The technical status of teleservice systems is now relatively advanced, as shown by the following plant configuration developed at the Fraunhofer Institute for Production Plant and Design Technology in Berlin (IPK 1998). This is an Internet-based machine diagnosis system for servicing production plant.

The application is aimed at implementing distributed software objects in the memory of an 'intelligent' drive computer, in order to provide PC-based visualisation devices with consistent access to configuration parameters of the drive. The benefit of such a configuration is that specific visualisation functionality is available in the memory of the automation components. Access to these components is effected in a standard manner for each system using a load routine available on a visualisation platform (PC, workstation, etc.). This distribution of software enables a service technician with a basic device, for example a PC notebook, to address components of the machine or plant without first having to check whether specific software necessary for data access is available on his computer. The diagnostic functionality is extended in this drive system by functions for automatically notifying about malfunctions on the displays of mobile telephones (D1, D2, E-Plus networks) using the 'Short Message Services' standard (SMS), and on so-called 'pagers' (e.g. Scall).

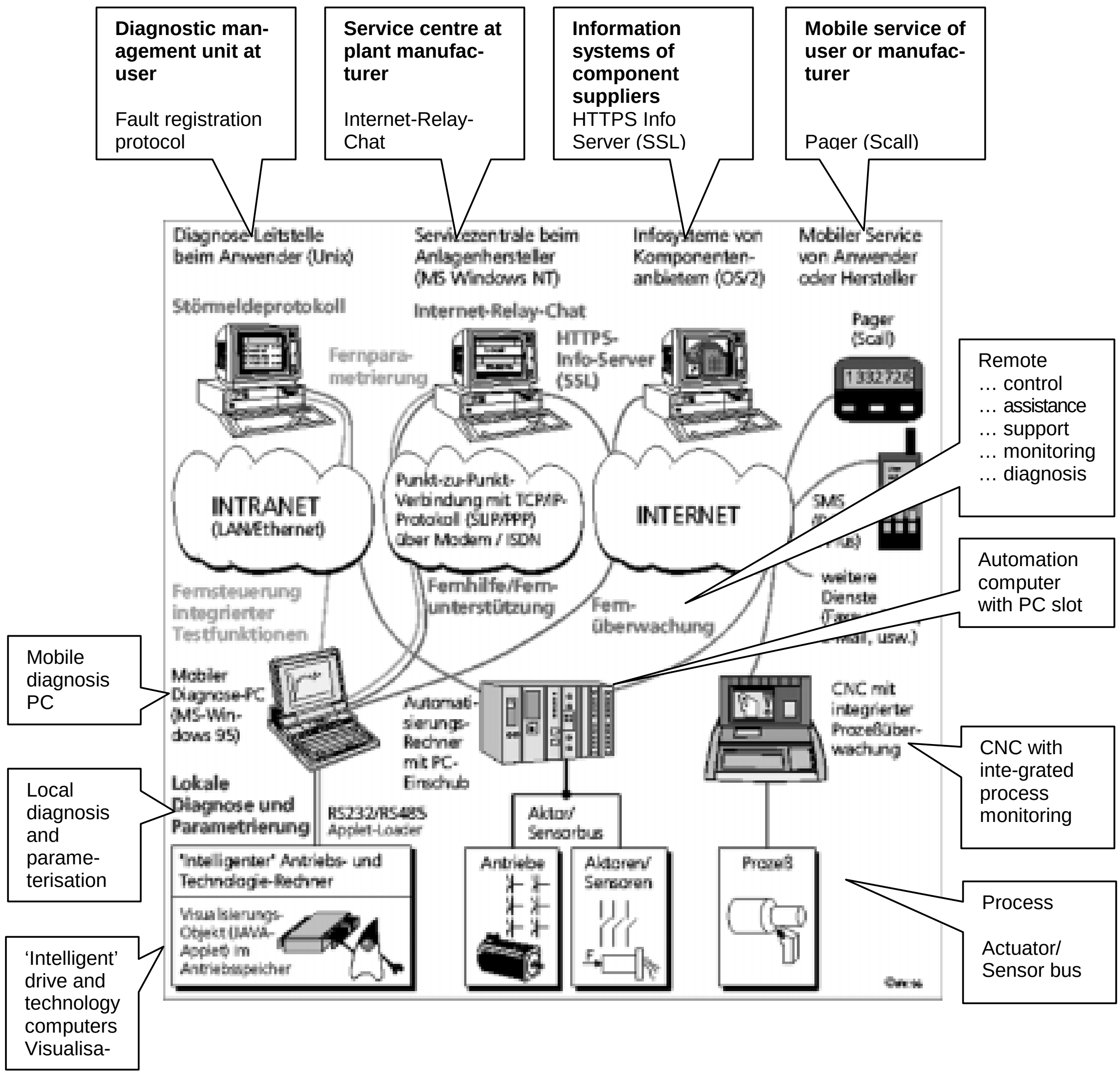


Figure 6: Telemedia machine diagnosis system (IPK 1998)

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8 Appendix

Multimedia-based comunication technologies in teleservice - basic functions

File transfer

The ability to transfer data between two members of a network is an elementary function in communications technology. In the teleservice context, program code is often transferred by control systems, mostly in order to load a new version (update) of a program into a control system. Technical documents (e.g. drawings, service instructions, electronic manuals, etc.) are exchanged by file transfer.

Still-picture transfer

Transferring still pictures is basically only a special form of file transfer. In this case, the file is a still. In the teleservice context, the picture may be a photograph of a particular detail on a machine, visualising the condition of a faulty plant

Remote Control

Various objects can be subjected to *remote control*: e.g. cameras, single programs, or an entire plant. Other activities can also be triggered remotely – for example, it makes sense in teleservice to request a still picture from a remote system and to transfer that picture for precise analysis.

Application sharing

In Application Sharing, two geographically separated users work on a file using the same application. The file and the application in question exist physically on only one of the two communicating computers, but are displayed simultaneously on both. Modifications to the file can be seen immediately on both workstations. In teleservice, *Application Sharing* is used, for example, to troubleshoot for errors in control programs and to correct those errors once they have been detected.

Whiteboard

A whiteboard is an electronic board on which geographically separated communication partners can write and draw. A whiteboard is a useful facility in teleservice wherever problems are to be raised and jointly discussed on the basis of a sketch (e.g. manufacturer and operator of a plant are looking for a fault on the basis of a sketch of the plant).

Chat

The Chat function enables different communication partners to exchange short messages directly. These messages are displayed on the monitor screen. This enables a dialogue to be conducted – albeit in very reduced form.

Universität Bremen

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Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

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TRAINING FOR TELESERVICE

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Abstract: This document describes basic pedagogical concepts and training requirements for teleservice

Keyword List: Remote action oriented learning, learning concepts and methods, learning scenarios, learning environment

Contents

Training for teleservice

1 Introduction

One important objective in the RADIO project is to develop and test new learning concepts for telemedia-aided maintenance and repair of complex mechatronic plant and networked production facilities (teleservice). In the present study, vocational training concepts for the teleservice field are presented and explained. Against the background of experience gained in the RADIO project, we describe practical examples and provide recommendations on how distributed learning between different groups or locations can be realised in vocational training on the basis of telemedia-aided learning ('Remote Action').

2 New training needs in the service field

2.1 New work content

Numerous studies have shown that, in the future, telemedia-based work systems will be enormously important in the context of geographically distributed commissioning, installation, maintenance and repair of plant and machinery. Remote maintenance, telediagnosis, remote support, maintenance and repair are all catchwords for the various concepts that are generally subsumed under the term *teleservice* (for a detailed overview, see Deliverable 21). Besides new technical concepts, teleservice involves a modified service organisation due to the use of telemedia-based systems.

Before teleservice functions can be exploited, the skilled personnel employed in this environment must conform to a skill profile with many new elements. Service experts assume that, in the teleservice sector, not only engineers but also technicians and skilled workers will need new, additional skills and qualifications (see Schmidt 1999, p. 18). The first to be affected are service experts in the field of mechatronic systems and plants, because in many cases, due to their complexity, these can only be installed and operated in conjunction with support services[1].

As teleservice becomes increasingly important, there is also a growing need to train employees in maintenance departments, in production, in customer service

[1] With the definition of the occupational profile for *mechatronic technicians*, a new vocationally trained occupation was established in Germany in 1998 to cover this particular range of tasks. Training for this occupation is centred on MECHAnics, elecTRONics and informatICS. According to the framework syllabus, the required knowledge and skills are not to be conveyed in isolation from each other, but in an integrated manner that gives special consideration to the fostering of occupational competence (see framework syllabus, 1998).

and in other fields. In initial and continuing vocational training, therefore, it is essential to train not only the competent use of teleservice technologies but also their implementation.

Proceeding on this basis, relevant literature and pioneering approaches were evaluated as part of this pilot project with regard to new training requirements. One key source of information was the ‘Multimedia TeleService’ research project (Maßberg/ Hermsen/ Zuther 2000), which was conducted on behalf of the Federal German Ministry for Education and Research, with involvement by research institutes and major industrial enterprises. Further pointers were obtained from other key publications (e.g. BMWi, Reichwald/ Möslein 1997, Schmidt 1999, Westkämper 1998a, 1998b). The current status of teleservice among professional users and manufacturers was also explored[2] in order to obtain specific information about skilling requirements in the teleservice field (see overview in the Appendix).

The outcome of this analysis is summarised and discussed in the following section, in four separate points and with specific reference to occupational *competence*.

2.2 Occupational competence in the teleservice field

Occupational *competence*[3] is a multi-dimensional concept based on the assumption that different sub-competences do not exist in isolation from each other, but are always networked with each other (see Laur-Ernst 1984). In relation to activities in the teleservice field, the following fields of competence can be identified as being of central importance:

1. Professional competence in the mechatronics field
2. Professional competence in the telemedia services field
3. Tele-cooperation competence
4. Foreign language competence
5. Intercultural competence
6. Customer focus

1. Professional competence in the mechatronics field

Professional competence in the field of mechatronics is the basic foundation for teleservices. This type of competence generally relates to the assembly and main-

[2] To prepare for the visits to users of teleservice, a set of guiding questions were developed (see Appendix).

[3] By occupational competence is meant “a person’s being able and prepared to act in occupational situations in an appropriate, expert manner following due personal reflection and with a sense of social responsibility” (Bader 2000). In the debate over modern forms of initial and continuing vocational training, fostering occupational competence has become a core aim of vocational training and education (in Germany).

tenance of complex machines, plants and systems in the field of plant construction and mechanical engineering, and in the companies that purchase and operate such mechatronic systems (for an overview, see for example the training profile for mechatronics technicians in the Appendix).

2. Professional competence in the telemedia services field

Service activities have always been an important element in plant construction and mechanical engineering. What is new is the application of teleservice systems for error analysis and possibly for helping customers to help themselves. The plant construction company (and to a certain extent the user of such plant) needs trained personnel that possesses not only traditional service know-how, but is also able to handle telemedia systems for diagnosis, maintenance, monitoring and repair. As far as service know-how in the narrower sense is concerned, the following are important areas of skills:

- knowledge about potential and probably causes of malfunctions in mechatronic systems (thinking in terms of cause-effect chains)
- knowledge about system-related service procedures.

In order to handle service tasks in the telemedia environment, the teleservice expert must also be able to combine classical service know-how with knowledge about telemedia technologies. The main aspects here are:

- installing and using teleservice systems, service software and remote diagnosis systems,
- creating and operating communication access points,
- acquiring data for teleservice purposes,
- providing teleservices in different network and communication structures.

Teleservice tasks are more complex than conventional servicing, in that teleservice experts must also have a command of telemedia technologies in addition to traditional service technologies. As in other IT professions, skills such as networked thinking or systemic thinking are gaining in importance within the complex formed by traditional service technologies and telemedia environments. Systemic thinking involves handling both “indeterminateness and complexity” (Dörner 1995) as well as problems that are bound up with side-effects and remote impacts.

3. Tele-cooperation competence

In contrast to ‘traditional’ skilled maintenance workers, personnel in teleservice are deployed in a relatively broad range of activities that also spans different sectors of industry. They typically work in locally distributed teams and coordinate their work amongst themselves: “In this occupational field, users and appliers use ... their ability to achieve objectives in (tele-)cooperation with others, and to cooperate in virtual and supranational forms of organisation” (BMWi, p. 89). Telemedia communicative competence means being able to overcome communication problems and loss of information due to disorganised or incomplete data and information. This requires not only competent handling of telemedia systems for diagnosis, maintenance, monitoring and repair, but above all the ability to communicate effectively with others (e.g. customers, users, appliers) with the help of computer-aided means of communication. Skilled teleservice workers must solve the 'mutual knowledge problem', for example by integrating the know-how of others in order to accomplish the set tasks using appropriate aids (e.g. electronic conferencing or groupware systems). Special focus must be placed on the option of accessing distributed information from suppliers, customers and manufacturers over the Internet. What one finds in practice are different variations of the service process (structural and workflow organisation) using different tools.

4. Foreign language competence

In the provision of teleservices, the human being remains the central and most important element of the entire service process, and clear communication between those involved in teleservices is the most important prerequisite for a successful service process. Besides normal communication problems, one should not underestimate the role of language barriers that may arise when performing teleservices.

Language problems may be inevitable in certain service situations. A typical teleservice situation might be the following: experts from the German company that manufactures a complex production system, on the one hand, and skilled workers and engineers at a Korean operator company, on the other hand, are communicating with each other between the two countries about how to solve a service problem. They use a videoconferencing system to communicate. A skilled worker or engineer in Germany cannot be expected to understand Korean. Nor can the skilled workers in Korea speak German. They have to try and communicate in English. Although there is the option of calling in an interpreter to help, this is usually very difficult to arrange in practice, because in many cases the interpreter does not have the specialist knowledge relevant in this situation, with the result that misunderstandings arise during such communication. Good training in foreign languages, especially in English, seems imperative in the context of globalisation. This is also true today for skilled workers in the service field.

5. Intercultural competence

In addition to adequate foreign language competence, 'intercultural competence' is also important in order that service personnel be aware of cultural differences between European and other countries, for example in Asia or South America.

6. Customer focus

Because teleservices are primarily immaterial, the quality assessment made by customers is highly dependent on those employees who perform such services. For this reason, skilled teleservice workers must also be trained in customer orientation – to a greater extent that production workers, for example. Such training mainly focuses on communication training and customer-centred action.

To summarise: in addition to system-related and technical know-how, teleservice particularly requires occupational competence, also referred to as *non-technical skills*.

3 Learning concepts

3.1 Didactical principles

The educational concept in RADIO is geared to a learning concept that is based for its part on the following didactic principles or premisses. These are: (1) action orientation, (2) teamwork, (3) focus on business/work processes, (4) focus on customer orders and (5) focus on design.

1. Action orientation

The didactic principle of action orientation applied to vocational training – also to formal, school-centred learning: learning and work assignments should be so designed that active actions and activities on the part of learners are initiated and fostered. The range of action extends from involvement in specifying the task set, (co-)planning the project mission, working on the project without supervision and in a cooperative spirit, up to and including the evaluation of the project outputs.

2. Teamwork

Teamwork is the core element of teleservice. The ability of students to work in teams must therefore be fostered and trained. However, since teamwork or the ability to work in teams can only be experienced and practised within a system that is itself organised in a team-centred manner, organisational structures in the school context must be so designed that teamwork is both transparent and possible for the learners concerned. Due to the fact that learning and cooperation do not come about automatically, schools and instructors have to strive for and accept an experimentation stage. This enables the initiation of development processes that lead from the prevailing 'go-it-alone' mentality to cooperative forms of working and teaching. These forms have to be provided in a different context that the familiar, mono-disciplinary and systematic context, and conveyed to students using methods that stimulate motivation. This necessitates the formation of teams, interdisciplinary cooperation, and the performance of project work.

3. Focus on business/work processes

Unlike the situation in the traditional service organisation, in which separate functional entities (individuals or departments) were designated and responsible for the outputs from those entities, in teleservice all those involved in the processing of orders are responsible for achieving successful results and a high level of customer satisfaction. The responsibilities for a particular set of tasks is therefore overlapped by this shared responsibility for achieving the objective of an overall business process. For vocational education and training, what this means is that priority must be attached to knowledge of the interrelationships in the business and work process, and that all specialised knowledge is conveyed in relation to its particular context.

4. Focus on customer orders

The focus on customer orders is the term given to a didactic principle, according to which the occupational learning process is centred on real orders in the operational context. The objectives pursued are:

- to sensitise trainees for quality, customer-centred work,
- to enhance the sense of responsibility for one's occupational activity,
- to acquire knowledge and occupational competence in the overall context of a real or semi-real assignment.

5. Focus on design

Competence in design is expected of employees to an increasing extent. The prerequisite for conveying design competence is that learners be confronted, at an early stage in the action- and project-centred learning process, with the technological and operational scope for action and design that they are increasingly expected to exploit in a world where corporate organisation is continually developing.

Design-centred training does not reduce a particular learning task to a predefined specification for which solutions can only be confirmed as correct or wrong. Instead, design-centred learning involves open assignments of practical relevance in which it is possible to discuss what the most expedient solution would be. Only then is it possible, within the learning process, to weigh up different solutions, criteria for solutions and evaluation criteria against each other and to assess the results of the project in terms of their appropriateness. Realistic learning assignments within training therefore foster the design competence of learners.

3.2 Learning scenarios and arrangements

Against the background of the educational concepts discussed in the foregoing, we now describe some *application scenarios* and ideas for *teaching projects* that can serve as the basis for learning arrangements.

Telediagnosis and tele-maintenance in the virtual electropneumatics laboratory

A malfunction has arisen in a remote, electropneumatically controlled system. On the basis of a display path diagram, a group of learners is to diagnose this malfunction and draft proposals for eliminating it. In the first step, the students analyse the display path diagram and transfer their results to circuit status tables. A logic plan or electropneumatic circuit diagram is subsequently produced with the help of a computer and efforts made to locate the fault by simulation. Results are then swapped over the Internet with a different group of learners that also eliminate the fault in the real system. E-mails and audio conferences are used as support in order to ensure a continuous exchange of information between the learner groups.

The virtual CNC workshop

The NC program for a workpiece to be milled must be written on the PC and the milling procedure subsequently simulated. The software required is run either locally, from a host computer or downloaded over the Internet from another technical college so that it is locally available. The real milling process can be started and stopped telematically, and the production process is monitored using live video. In certain circumstances, the video camera with zoom function enables the learners to acquire even better insight into details of the machining process than is possible in a real workshop, because the location of the camera can usually be chosen for greater benefit than personal ‘on site’ access would permit.

Distributed modelling

With the help of a distributed modelling environment, technical college students perform an assignment in the field of control engineering. Firstly, a real system is constructed using components typically used in industry. A computer-based model is generated synchronously and made available over the Internet to other groups of learners. The latter then try to verify the model by means of simulation and discuss their results in a computer-aided conference. Various technologies such as WWW and VRML are used in order to describe to describe and visualise the model. The main focus in working on this assignment then consists in all groups of learners producing a solution that is subsequently implemented on the real system.

Controlling a telerobot

Remote control of a mobile telerobot causes problems in path finding, in locating objects and in circumventing obstacles. These problems are caused by the dynamics of the system, by transmission delays or by incorrect data and control algorithms. In order to solve these problems, it is necessary that learners be able to correctly program and configure a distributed regulation system comprising on on-board controller located in the respective robot. To do this, they have to design a control algorithm and implement it in the remote regulation unit. Practical testing of the control program is carried out on the real system, whereby the workroom is monitored by a video camera.

Tele-configuration and programming an automation facility

In the learning field entitled ‘Designing and producing mechatronic systems’, students must reconfigure and reprogram an automation system. Use is made of available materials and simulation software. In the final step, exercises are performed on a real system provided by a different learning location. Access to the real system is obtained by loading control programs and parameters into the system by means of data transmission. This procedure is monitored by a group of learners or an individual person ‘on site’, who then provides feedback on whether the exercise was a success or a failure.

Some of the *application scenarios* described above were specified in greater detail for training purposes and subsequently implemented as part of the RADIO project (see Section 5).

4 Media for teaching and learning

4.1 Requirements to be met by teaching and learning media

Based on the educational premisses outlined in the 'Learning concepts' section, the content of teaching and learning media for teleservice should be able to illustrate

- the interdisciplinary structure of mechatronic systems,
- the processual nature of mechatronic procedures,
- the systemic integration of mechatronic components in functional procedures and the structure of service technology,
- the behaviour and purpose of the technology deployed.

In order to develop occupational competence, media should support the learning process in such a way that the requisite scope arises for independent and comprehensive action and that the necessary proximity to reality is established.

4.2 Basic requirements for teleservice

In order to convey and acquire teleservice skills, it is essential to be furnished with an adequate basic supply of appropriate teaching and learning media. These including training materials such as learning programs (CBT), self-teaching materials and bibliographies. These training materials can be provided over the Internet or a training-related Intranet. In the RADIO project, the *BSCW*[4] (Basic Support for Cooperative Work) groupware system proved very useful. For practical exercises during lessons, communications systems and the relevant hardware and software are required. In general, the following communications technologies can be used:

1. *Asynchronous technologies:* WWW portals; News, discussion boards; e-mail

2. *Synchronous technologies:* chat; videoconferencing; application sharing; whiteboard; remote control software

4.3 Simulations and virtual laboratories

Computer-based simulations are an appropriate way of practising the use of equipment, machines, technical systems and other types of apparatus. Simulation

[4] The *BSCW System* is based on the concept of 'shared workspace'. The members of one workgroup set up these shared workspaces on a *BSCW* server and use them to organise and coordinate their various tasks. Such a shared workspace can contain different types of (electronic) objects, such as documents, tables, graphics, WWW pages or links to WWW pages. The members of the workgroup can transfer objects from their local computers to the workspace, or vice versa, for example to read or edit a document (http://bscw.gmd.de).

has proven to be a good technique, especially when the objective is to become familiar with and drill specific behavioural responses to malfunctions or emergencies in complex situations. The didactic importance of simulation is above all the reduced risk in the event of incorrect response, and the opportunity to experiment and practise without exposure to risk. The relevance of simulation from the training psychology perspective extends not only to cognitive, but also and very significantly to meta-cognitive skills, psychomotoric and affective training objectives. By combining simulator training and learning-by-doing on real-life systems, it is also possible to reduce the problems of transferral between virtual and real systems.

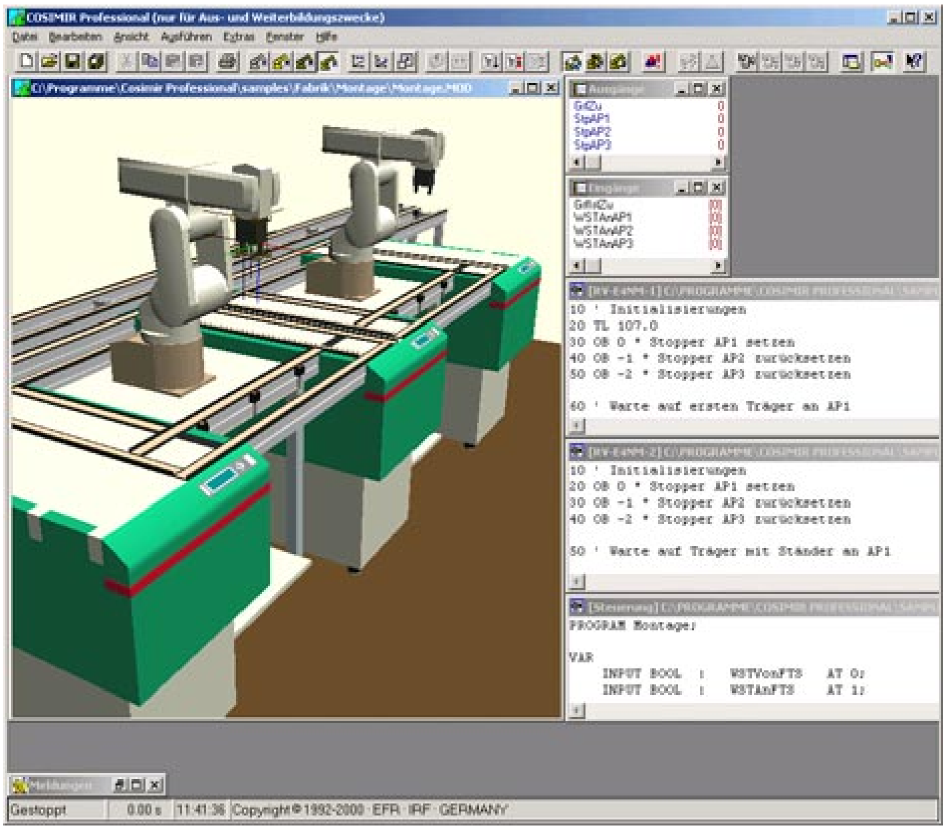

Figure 1: Simulator

In the higher education field, a number of pilot projects are being conducted that focus on remote, network-based use of robotic and machine-tool laboratories. In the joint 'Virtual Laboratory' project, for example, students can perform laboratory experiments over the Internet (VVL 1999). A real laboratory is provided at one site and is connected to several virtual laboratories at other sites. The virtual laboratory is a simulation of the real laboratory and enables learners to acquire experience and knowledge of process modelling, programming, monitoring and process management for virtual and real systems. The real, material laboratory can be remotely controlled using telematics methods, and can be used both locally and globally. The experiments are taken from various fields of mechanical engineering, robotics, image processing, automation engineering and computer science. The principal aim of the joint 'VVL' project is to reduce dependence on time and place during one's studies and to develop teaching and study materials for further education in the sciences, whereby joint utilisation of distributed resources is a key aspect. Results from the VVL project indicate that remote utilisation concepts can be transferred to training and skilling in the teleservice field.

In the RADIO project, teaching units were therefore planned and implemented that use forms of remote utilisation such as virtual laboratories. Two examples are described in Section 5.

4.4 The DERIVE learning environment – an example

Based on the so-called Mixed Reality concept[5] in the DERIVE[6] project, a learning environment is now under development that will help vocational schools and technical colleges in delivering mechatronics courses. The envisaged system enables participants to cooperate within complex real and virtual mechatronics systems that consist of parts which may be distributed all over the world. The learning environment includes a supportive web database with multimedia learning sequences providing theoretical background information, exercises and help in handling training assignments. Mechatronic hardware equipment can be connected to the virtual environment with a special sensor-actuator coupling called *hyper-bond* (Bruns 2000). Real electropneumatic circuits can be directly imported into the virtual world via image recognition facilities. The DERIVE learning environment integrates equipment seamlessly and supports full hardware-in-the-loop functionality, thus enabling real mechatronic systems to be created as subsystems of complex virtual systems.

Tele-cooperation functionality in the learning environment allows users to carry out training projects for teleservice, i.e. remote diagnosis and maintenance of mechatronic systems. This is confirmed by initial evaluation results.

[5] *Mixed Reality* is based on the real interactions between physical and virtual components.

[6] DERIVE (Distributed Real and Virtual Learning Environment for Mechatronics and Teleservice) receives support from the European IST Research Programme. In addition to the Work, Environment and Technology Research Centre (ARTEC) at the University of Bremen, the following partners are involved in the project: Festo Didactic GmbH & Co. (Denkendorf), Stockport College – College for Further and Higher Education (Great Britain), Escola Superior de Technologia e Gestao – Instituto Politecnico de Leiria (ESTG, Portugal), Schulzentrum des Sekundarbereichs II Im Holter Feld Bremen and the Institut für Arbeitspsychologie at the Eidgenössischen Technischen Hochschule Zürich (IFAP-ETHZ, Switzerland). Further information: www.derive.uni-bremen.de.

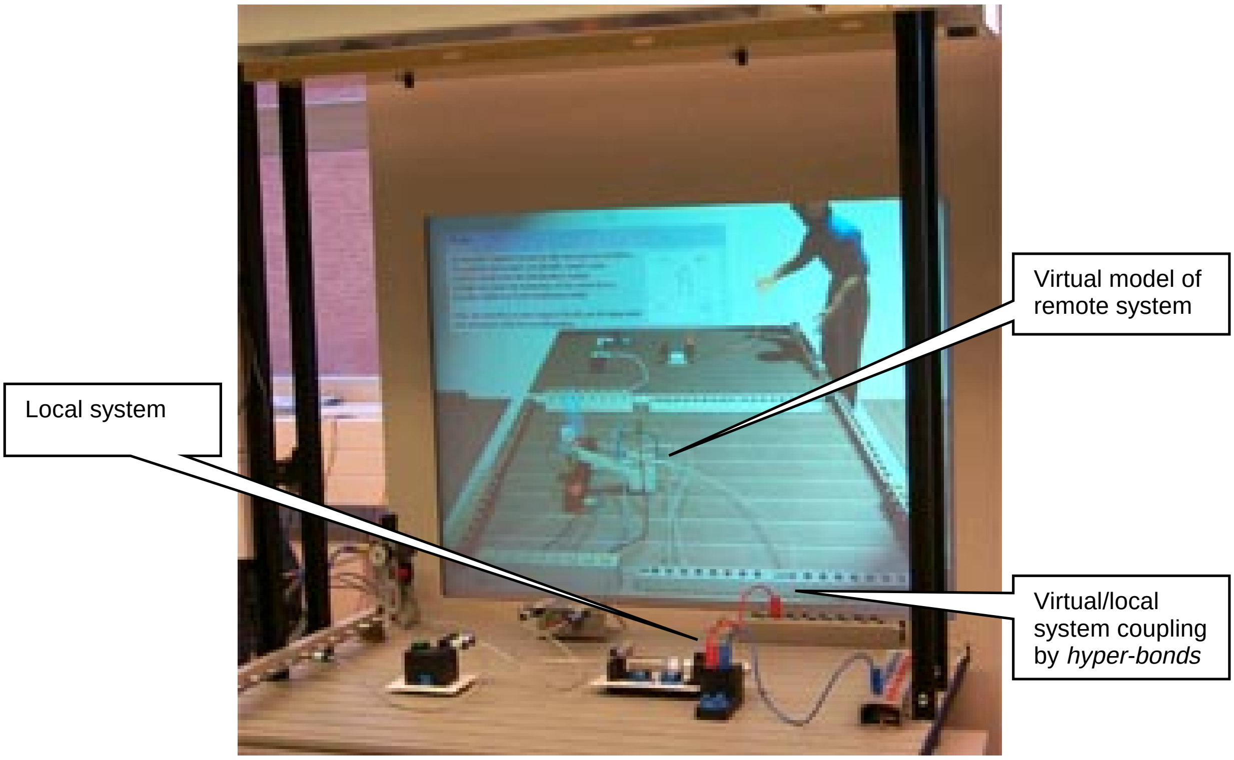

Figure 2: The DERIVE Learning Environment

5 Sample teaching units and lessons

5.1 Teleservice and tele-cooperation

The teaching unit entitled ‘Teleservice and Tele-cooperation’ was planned and carried out in a Bremen technical college by trainee technical college teachers from the University of Bremen[7], in conjunction with the RADIO project and an undergraduate course at the university. The lessons were given as part of the vocational training and education on mechatronics technicians (in their second year of training). The lessons primarily addressed aspects of teleservice. The topic of the unit was ‘Teleservice and Tele-cooperation’. The teaching project has not been fully documented and evaluated as yet, so the lesson plans are described below in the form of keywords only.

Learning content and objectives of the unit

The following contents and objectives were to be presented and attained on the basis of action-oriented learning:

General learning objective:

Acquisition of technical and communicative competencies in connection with occupationally relevant media.

Particular learning objectives and content:

- Electropneumatic variables, how they are interrelated and how they can be visualised
- Controlling operational processes with the help of information technology
- Analysing, evaluating, documenting and reflecting on workflows and their outputs
- Programming simple movements and control functions
- Using in-company communications systems (teleservice)
- Teamwork / communication / presentations
- Customer-manufacturer relations

Teaching methods

The objective of the unit is to be achieved by simulating a teleservice scenario in which the students can playfully explore their skills in taking action and making decisions in a variety of roles (including those of teleservice experts and skilled workers). In group discussions, the students are to exchange and evaluate the experience they acquire.

[7] Rainer Pundt, Jörg Tuppak (2001): Materialien zur Unterrichtseinheit ‘Teleservice’. Bremen

Media

- Computers (networked) with appropriate software (Microsoft NetMeeting, programming software for PLC)
- Headsets/ web cameras/ loudspeakers
- Beamers (for presentation of results)
- 2 digital cameras, video camera with tripod
- Overhead projector
- Noticeboard, media kit

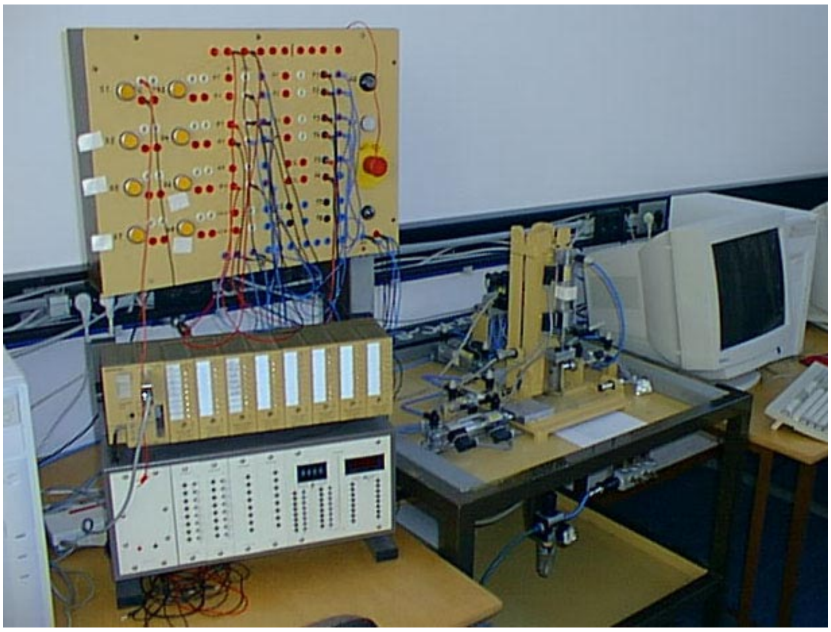

Figure 3: Mechatronic system for teleservice learning tasks

Organisation of groups and rooms

The lesson is given in two adjacent classrooms for automation engineering that are linked in a local network (LAN)[8].

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[8] Class composition: 23 trainee mechatronics technicians, 2nd year of training (all male), of which 17 are from secondary modern school, 4 with *Abitur* and 2 from lower secondary school. The class is split into two double groups for the laboratory exercises (Group 1 and 2 = 12 students, Group 3 and 4 = 11 students). The students have only minimal prior knowledge of teleservice.

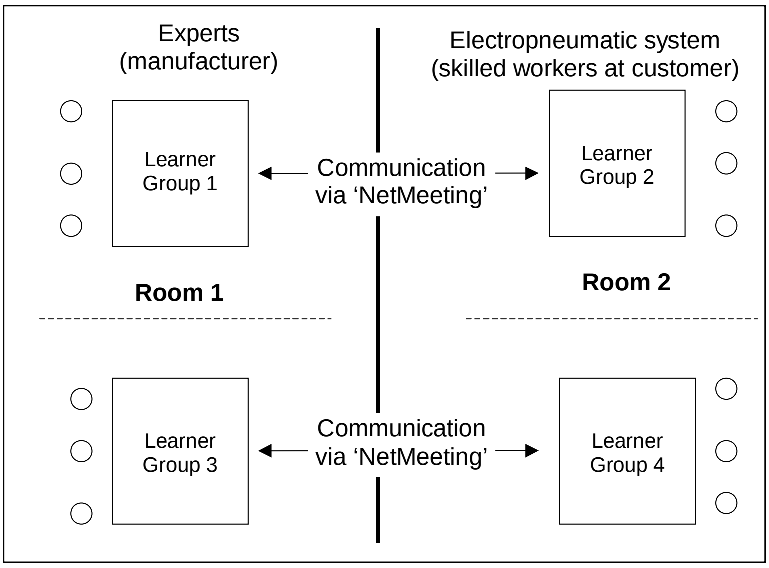

Figure 5: Organisation of groups and rooms

Sequence of lesson

The following overview shows the sequence of activities within the lesson:

Phases	Learning activities
Phase I Introduction and entry into topic	Presentation of the content and organisation of the teaching unit Presentation of evaluation results from previously distributed questionnaire, with possible changes content of teaching unit Teleservice – what, how, who, why? Practical example: short presentation of real applications, distribute handout about communication and teleservice/tele-cooperation
Phase II Execution	*General block (laboratory)* Becoming acquainted with, conducting and describing basic communicative processes when interacting with the PC, on the basis of described scenarios; in groups (max. 3 students in each) Saving results
	Practical block (laboratory) Function modification in an PLC-controlled electropneumatic system using teleservice – as well as ongoing documentation of the experience gained; groupwork with brief exchange of experience afterwards
Phase III Reflection	Presentation and analysis of the problems that arose for each group in the general and practical blocks, and various problem-solving strategies Subsequent evaluation in plenary session

Figure 4: Students in action

5.2 Troubleshooting with the help of teleservice systems

The teaching unit entitled 'Fault-finding Using Teleservice Systems' was prepared and tested in a Bremen technical college as part of the training course for mechatronics technicians[9]. The objective of this unit was to develop ways of using a telemedia learning environment and to subject these approaches to practical tests in the specific teaching situation.

Contact with users and manufacturers of teleservice systems

To obtain an overview of the current state of development of teleservice systems, contacts were established during the planning phase with manufacturers and users of teleservice systems. One of those contacts was with the 'AlgoVision' company in Bremen (www.algovision.de). In the field of tele-cooperation, the latter company has launched on the market a hardware/software product with the following functions: (1) File transfer (2) image transmission, (3) remote control of cameras, (4) application sharing, (5) chat and (6) linking automation software.

During a product presentation lasting several hours, the system way used to start up and control a small electropneumatic system from a remote computer using a stored program control (PLC). In addition to application sharing, video monitoring of the electropneumatic system by video and audio communication between experts (at the remote computer) and system operators (at local computers) were also possible.

Experience with the teleservice system made by AlgoVision[10]

1. Installation of the AlgoVision system: The test of this system, each end comprising a card with hardware compression, ISDN interface, a camera and a headset, was carried out on two computers. An ISDN PABX system was used to connect the two computers. Communication over ISDN for the teleservice workspace seemed to make more sense than communicating over the Internet. Depending on whether channels are bundled, ISDN connections guarantee a particular transmission speed and are more reliable on the whole. No problems were encountered while installing the software. However, it was necessary to adapt the school's PABX system to accommodate the teleservice system.

2. First steps with the AlgoVision system: The product tested was the 'Vision & Life' hardware/software package produced by AlgoVision (Version 4.1). Once the connection had been established between two computers, the audio volume could be adjusted and the video pictures positioned (own and other end's pictures). The

[9] The lesson was planned, delivered and documented by Hermann Gathmann and Hendrik Müller-Seidel, two technical college teachers.

[10] We are grateful to 'AlgoVision' for providing, at no charge, a system for testing and teaching purposes.

automatic answer function can be set by clicking on a button. A still picture can be created, printed and transferred by clicking on the mouse. Transmission quality is significantly improved by bundling channels. Before a program installed on one computer can be shared by two connected computers (application sharing), the program in question must be cleared for sharing. Both participants can then control the program by double-clicking on the mouse.

3. Testing the system in a small teaching scenario: One local and one 'remote' computer were connected by ISDN. The local computer was connected by means of a Programmable Logic Controller (PLC) to a small modular production system (MPS).

Using a PLC editor (WinSPS), a small control program was generated on the 'local' computer and transferred to the PLC. After starting the program, the behaviour of the system was tracked by students over the teleservice connection, as well as in video and sound from the remote computer. It was possible to make corrections and additions to the PLC program over the same connection, and to implement these changes successfully.

In a further experiment, the students had knowledge of electro pneumatics, but not experience with an PLC. The system to be tested did not operate properly and had to be repaired. During the troubleshooting phase, the students were able to exclude any fault in the electro pneumatic section and suspected a fault in the control program. They established a teleservice connection to an 'expert' (another student), and discovered with his help that one part of the program did indeed contain a 'bug'. The expert was able to provide fast and effective help in operating the manual programming device, because he was able to follow the keyboard input and the monitor display from the camera images. After making the corrections, the program was reinstalled and the system worked properly again.

The experience thus gained with the teleservice system were very positive on the whole. Installation the system was easy, and there were no problems operating the program. The quality of the video images could be adjusted to a certain extent. Transmission was over two channels, not quite wobble-free and was significantly delayed, but was satisfactory on the whole. If tougher requirements are to be met, then transmission quality can be greatly improved by bundling several channels. In summary, one can say that the students were greatly motivated by using a typical industrial-standard teleservice system and took an active part in the lesson.

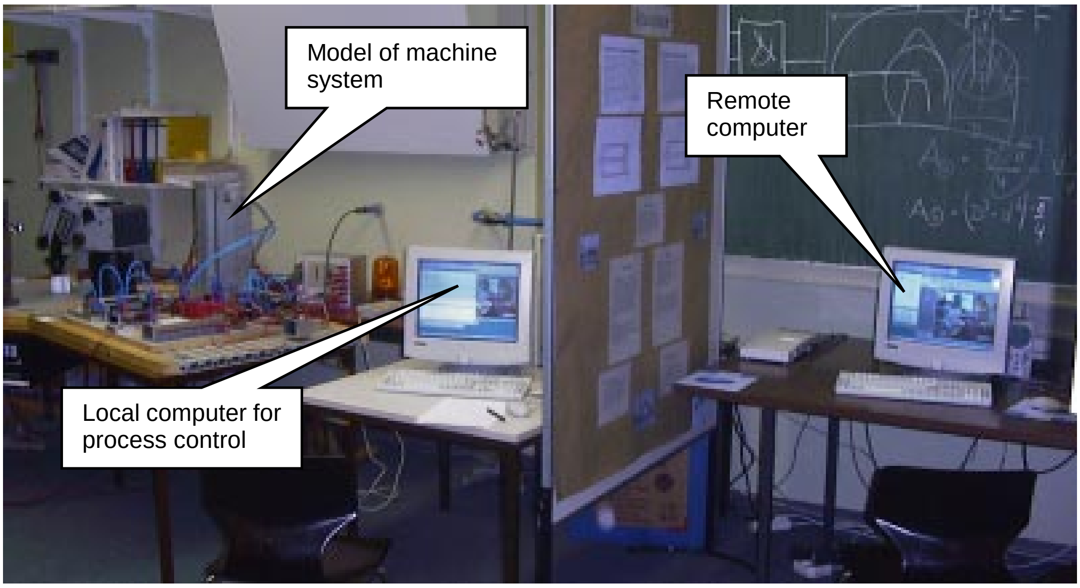

Figure 5: Using the AlgoVision system I

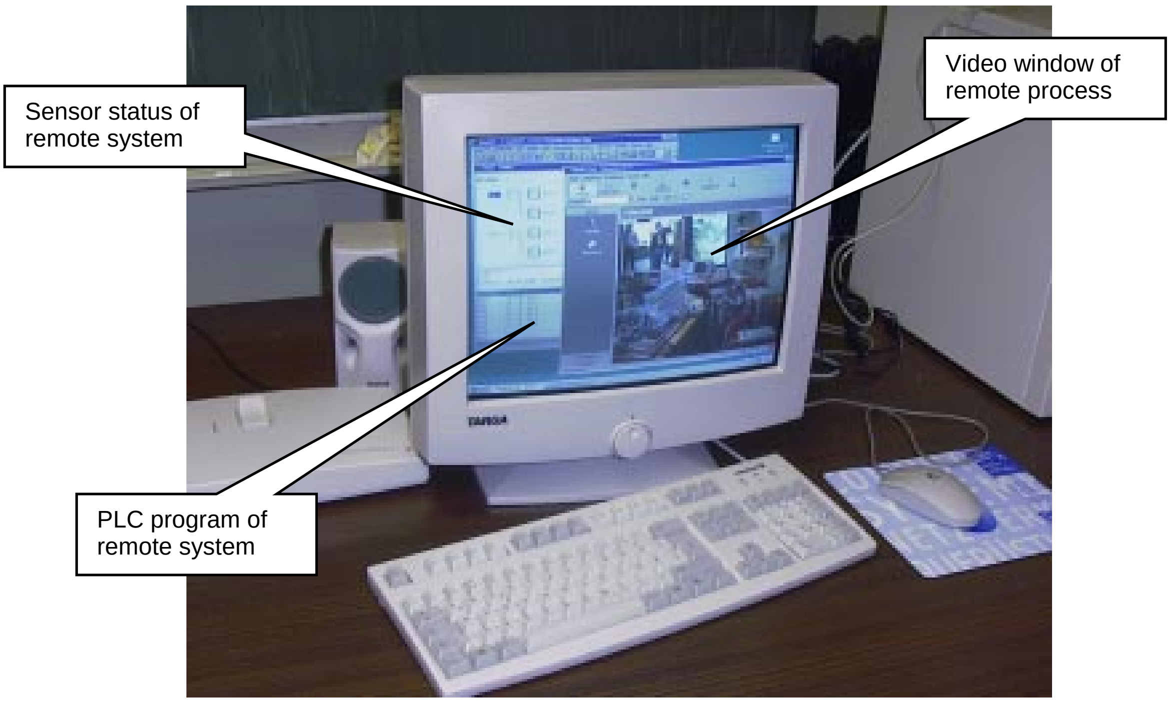

Figure 6: Using the AlgoVision system II

5.3 Summary

In both training units, unsupervised and autonomous learning played a key role. The open learning situation enabled training to be interesting and variable. The central focus was on the acquisition of functional and extra-functional skills, such acquisition being significantly supported in such open forms of learning through the use of *real* telecommunications and teleservice systems. Improving the visual clarity of complex interrelationships by using real systems was a predominant element of the learning process. The new media had a consistently motivating impact on the students. The action-centred lessons exhibited a definite improvement in student activities and the independent approach taken by students. These forms of learning, new to the students, enabled playful and risk-free experimentation.

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7 Appendix

Questionnaire: Teleservice in operation/within the enterprise

- Survey questions for companies that operate teleservices -

1. How do you communicate with plant operators when technical problems occur at the customer's end?
2. What tools, aids and methods do your service technicians use on site when they cannot solve a technical problem on their own and therefore have to collaborate with head office?
3. What information and/or data are exchanged in such a case?
4. In your view, what importance does teleservice have for your company?
5. In what areas is teleservice particularly important (distinguish, for example, between plant commissioning, inspection/monitoring, diagnosis, process support, maintenance, repair)?
6. To what extent, in your estimation, can teleservice-related tasks be performed appropriately by skilled workers?
7. What competencies (differentiated according to specialist, methodological, social and personal competence) do you expect from skilled workers in the teleservice field?
8. What training should a teleservice technician have received? What occupations does it make sense to deploy in teleservice?

Training profile: Mechatronics technicians

1. Name of occupation: Mechatronics technicians

2. Duration of training: 3½ years

Training is provided both in-company and at technical college

3. Field of work:

Mechatronics technicians work in the assembly and maintenance of complex machines, plants and systems, in the field of plant construction and mechanical engineering, and in the companies that purchase and operate such mechatronic systems.

Mechatronics technicians perform their activities without supervision at a variety of locations, primarily on construction sites, in workshops or in the service field, in compliance with the relevant regulations and safety rules and on the basis of documents and directives. They often work in teams. They coordinate their work with upstream and downstream departments.

Mechatronics technicians are skilled electronics workers within the scope of accident prevention regulations.

4. Occupational skills:

Mechatronics technicians

- plan and control work procedures, check and assess work results and operate quality management systems,
- process mechanical parts and assemble modules and components to form mechatronic systems,
- install electrical modules and components,
- measure and test electrical variables,
- install and test hardware and software components,
- construct electrical, pneumatic and hydraulic control systems and test them,
- program mechatronic systems,
- assemble and disassemble machines, systems and plants, as well as transport and make them safe,
- check and adjust the functions of mechatronic systems,
- commission mechatronic systems and operate them,
- transfer mechatronic systems to customers and instruct the latter in their use,
- perform maintenance and repair work on mechatronic systems
- they work with English-language documents and can also communicate in English.

Fields of learning: Mechatronics technician as a trained occupation

		Approximate time in hours		
No.	**Field of learning**	1. year	2. year	3./4. year
1	Analysing functional interrelationships	40		
2	Making mechanical sub-systems	80		
3	Installing electrical production equipment in compliance with safety engineering aspects	100		
4	Investigating the flows of energy and information in electrical, pneumatic and hydraulic modules	60		
5	Communicating with the help of information technology systems	40		
6	Planning and organising work procedures		40	
7	Implementing simple mechatronic systems		100	
8	Designing and producing mechatronic systems		140	
9	Investigating information flow in complex mechatronic systems			80
10	Planning assembly and disassembly			40
11	Commissioning, troubleshooting and maintenance			160
12	Preventive maintenance			80
13	Transfer of mechatronic systems to the customer			60
	Totals	320	280	420

Overview: Contacts with companies, training institutions, etc.

- 31.01.2000 Visit to *AlgoVision* Systems GmbH, Bremen (Internet: www.algovision.de). Main focus: Presentation of the 'NewMedia280 system' for data, image and voice transmission.
- Participation on the final workshop of the *TeLec* (multimedia teleservice) project
- 13.03.200 Visit to the Bremen branch of Siemens AG
- 27.03.2000 Visit to *LSW* Maschinenfabrik GmbH, Bremen (user of products made by AlgoVision GmbH)
- 15.05 2000 Visit to Delmenhorst Technical College (visit to a solar energy laboratory with measurement data capturing and process simulation, use of products made by Siemens AG)
- 10. / 11. 07.2000 Continuing training event at *Technotransfer* GmbH in Erfurt
- 12. / 13.10.2000 Participation at the VDI event entitled 'Wireless-controlled communication', in Düsseldorf
- Visit to the *'Didakta 2000* education fair'

Department of Computer Science - Τμήμα Πληροφορικής
University of Cyprus - Πανεπιστήμιο Κύπρου

Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

Contract No.: D/99/2/07331/PI/II.1.1.a/FPI

TOOLS AND METHODS: ENABLING TECHNOLOGIES FOR TELE-SERVICES

Symeon Retalis & George A. Papadopoulos

Work Package: **W20 Technical and Pedagogical Concept**
Deliverable: **D23 Tools and Methods**

Date of Delivery: 31. October 2000

Deliverable Type: Restricted

Abstract: This document describes novel technologies for developing tele-service systems.

Keyword List: Tele-service systems, Tele-learning, Tele-training, tele-working

CONTENTS

ENABLING TECHNOLOGIES FOR TELE-SERVICES

1. Introduction

1.1 Scope of the study

The purpose of this study is to present a state-of-the-art survey on the available novel technologies for developing tele-service systems. The survey addresses topics such as the use of tele-training and tele-teaching techniques, groupware, Computer Supported Collaborative Work (CSCW) and cooperative distributed information systems, and the issues involved in the design and development of distance learning concepts.

1.2 Structure of the study

Section 2: Presents definitions of the key terms, such as tele-training, tele-working, collaborative learning, etc. that are being mentioned in this study

Section 3: Identifies the key characteristics of the novel technologies that are being used in education and training. The use of WWW, virtual reality and asynchronous multimedia conferencing are being examined with an attempt to illustrate their potential for learning effectiveness.

Section 4: Provides an overview of the main tools that can be used for building learning environments based on the WWW.

Section 5: Describes the main characteristics of the integrated learning environments and offers links to studies where comparisons are being made.

Section 6: Illustrates the current trend in building educational portals and web-based information systems.

Section 7: Looks at methods for design and development of tele-training environments. More specifically, it proposes the use of guidelines that have been produced within a project that concerned the establishment of a virtual learning institute.

Section 8: Provides a summary of the report

2. Definitions

In this document, we emphasize on tele-services that concern education, training, working and information provision. Services such as electronic commerce, etc. are not subjects of our study.

2.1 Tele-learning

Tele-learning means the use of networked computer environments and tools for education and training. Tele-learning supports five core principles of collaboration, access, active learning, multiple perspectives, and knowledge work. It is a fundamentally important technological and social innovation for education and training at all levels in a knowledge-based society [Tele-Learning Network of Centres of Excellence, http://www.telelearn.ca/g_access/profile.html].

The need for tele-learning stems from the fact that the conventional mode of teaching and learning faces major problems:

- Lecture attendance decreases. The main reason is that some of the students have already job and family obligations.
- It is difficult for students to ask questions and receive answers outside of the instructor's appointed office hours.
- There is low interaction in the classroom. Students are often overly shy and prefer not to ask questions in the classroom.
- The curriculum of a course –especially on technology related subjects- changes so rapidly that a textbook quickly becomes obsolete.

2.2 Tele-training

Tele-training is training at distance using Telematics, where *Telematics* is the simultaneous deployment of electronic computing and communication technologies. Tele-training improves existing distance learning and training methods by allowing more interaction (than classical distance learning) and more autonomy (than classical training methods).

It is impossible to discuss about new opportunities for the employment of people, without reference to Training. In this sense, vocational training is one of the proceedings for professional integration by which a person is shaped through his/her interaction with the environment, in a way that he/she can secure employment [The Working Group n°12, of the H.E.L.I.O.S II E.U. Action Program]

2.3 Tele-working

Tele-working is defined as a way of working in which the work is carried out at a distance from the employer or contractor for whom it is intended. Importance is placed on the concepts of location independence and the increasingly important role of telecommunications as an enabling factor [From *Review of Experiences and Prospects for Tele-working – 1991* (RCEPT-91), Andrew Page and David Brain, EC DGXIII Publication.]

There are advantages for both workers and employers in tele-working:

- The employer does not have to provide office space and other facilities, such as dining areas and parking, often in a major city at great expense, for a workforce.
- Workers do not have to drive to work, reducing total work times (in big cities by a couple of hours), reducing the employee's expenses, reducing city traffic loads and congestion and reducing the need for parking spaces.
- The employee may not have to work fixed hours to suit other employees and building security, and may therefore be able to set their own hours.
- Employees do not have to worry about their dress, their tea and lunchbreak times, and not being able to complete an important task due to office hour deadlines.
- Employees with children don't worry about childcare or arrangements for sick children.
- An employee may be able to work more hours in a day (no transport times etc), therefore be more productive, and therefore increase their level of remuneration.
- Employees do not have to live in a particular area to meet transport commitments. Indeed, an employee may choose to live in the country, a different city completely, or perhaps even a different state or nation, subject to telecommunications costs.

Tele-working is seen as a natural evolution of decentralisation in the information economy, and in this context, emphasis is placed on education and training and the development of high-value added applications as a primary strategy for successful competition.

In 1995, the Institute for the Future predicted 40% of employees in the US would be tele-workers by the year 2000 – yet the tele-working revolution hasn't happened yet. According to the 1993 BT manual Tele-working Explained 'Tele-working is not a new idea. Nearly 25 years ago, during the 1970s oil crisis, it struck American academic Jack Nilles that instead of people commuting to work, the work could commute to them by telephone – telecommuting. But tele-working has failed to live up to the grand, expansive predictions made in the 1970s. AT&T predicted then that 'all Americans could be homeworkers by 1990… [*The Tele-working Handbook: New ways of Working In The Information Society – 1996,* Imogen Bertin and Alan Denbigh, Tele-work, Tele-cottage and Telecentre Association.].

2.4 Collaborative Learning

It is important to note that there is a huge literature on collaborative and co-operative forms of learning. For a general review, see [Webb, N & Palincsar, A-M (1996). Group processes in the classroom, In Berliner, D & Calfee, R, eds, Handbook of Educational Psychology, New York: Macmillan, 841-873] and for a short and incisive overview of theoretical positions and evidence, see [Dillenbourg, P., Baker, M., Blaye, A. and O'Malley, C. (1995) The evolution of research on collaborative learning In Reimann, P. and Spada, H. (Eds) Learning in humans and machines Elsevier Science Ltd, Oxford 189–211].

According to McConnell: "In the very broadest sense, cooperative learning involves working together on some task or issue in a way that promotes individual learning through processes of collaboration in groups" [McConnell, D., Implementing computer supported cooperative learning, Kogan Page, London, 1994].

McConnell also claims that collaborative learning can give rise to valuable outcomes which have not (until recently) been much in evidence in academic learning: increased competence in working with others, self-assurance, etc. Hiltz defines collaborative learning as: "… a learning that emphasises group or cooperative efforts among faculty and students. It stresses active participation and interaction on both students and instructors. Knowledge is viewed as a social construct, and therefore the educational process is facilitated by social interaction in an environment that facilitates peer interaction, evaluation and cooperation" [Hiltz S.R, Wellman, B., Asynchronous Learning Networks as a Virtual Classroom, Communications of the ACM, Vol. 40. No. 9, September 1997].

3. Technology & Tele-learning services

The pervasiveness of networking learning technologies (NLTs), i.e. computer networks and hypermedia systems (Internet and World Wide Web in particular) have stimulated a vast quantity of investigations into the opportunities and challenges that might be offered or met into the field of services provision. When deciding to use NLTs, the service providers, the policy makers and mainly the educational managers should be guided by "technological determinism" and not by "technolove".

NLTs are certainly a catalyst for change, helping to bring about a new revolution in the provision of services and more specifically to education and training; a revolution that deals with the philosophy of how one teaches, of the relationship between teacher and student, of the way in which a classroom is structured, and the nature of curriculum.

In this study we examine three different networking learning technological platforms such as: the World Wide Web, the Virtual Reality and the Asynchronous Multimedia Conferencing.

The main reason for not presenting other technologies such as "plurimedia" (text books, audio/video material) or multimedia is that these technologies tend to become obsolete for providing large scale tele-learning services where there is need for communication, collaboration and work practice.

3.1 The World Wide Web & Tele-training

World Wide Web (WWW) has been used in various ways in tele-learning. Various models of WWW based Open Learning (OL) systems have been developed. According to the services they provide, such models can be categorised as follows:

- Information-based models (WWW is used for retrieving information like Virtual Museums, digital libraries, etc.)

- teaching media based models (WWW is used only for dissemination of educational material to distance students, i.e. course descriptions, educational software, etc.)
- enriched classroom models (OL techniques with the aid of WWW being used complementary to traditional classroom-based teaching)
- virtual classroom models (WWW is used with emphasis on collaboration and computer mediated human interaction)

According to systems theory, a web-based Open Learning system consists of components (i.e. sub-systems) such as the technological infrastructure, the actors involved in the teaching and learning process (instructors/tutors, learners, technical/administrative staff), the course material and the learning places, i.e. where learning takes place including university, workplace, home, etc. [Wasson, B. Advanced Educational Technologies: The Learning Environment, Computers in Human Behavior, 13, 4 (1997)]. Each learning place supports different learning methods and requires different settings in order for the learning objectives to be achieved [Ford, P., Goodyear, P., Heseltine, R., Lewis, R., Darby, J. Graves, J., Sartorius, P., Harwood, D., King, T., Managing Change in Higher Education: A Learning Environment Architecture. London: Open University Press (1996)].

The system's components are closely interwoven. When one deals with one component, he or she must take into account the other components as well, holding the picture of the whole system in mind. For example, the designer of the course material need to take into consideration the technological infrastructure and the restrictions imposed by it, the roles of the actors in the OL system as well as the places where learning will take place, because those also impose restrictions and require specific settings [S. Retalis, E. Skordalakis. "An Approach for Solving Instructional Problems Using Networked Technologies", Computers in Human Behavior, (to appear in December 2000)].

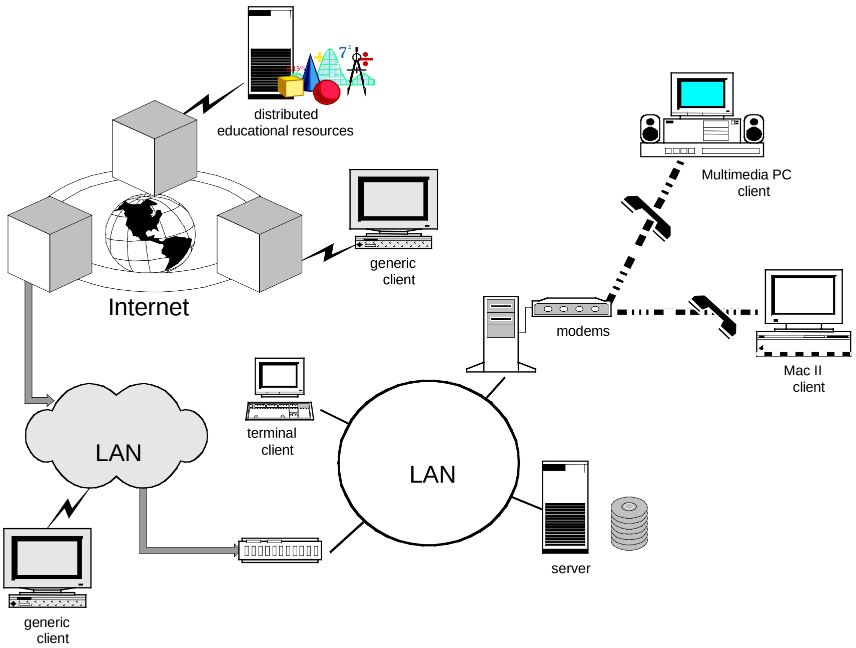


Figure 1 Components of a Web-OL system

Figure 1 illustrates graphically a Web–OL system. The technological infrastructure used should be a WWW server and the Internet for human-human interaction. The server hosts the on-line learning material, the details about students and instructors (personal data and records) as well as the data used basically for administration (course management).

The actors and their roles in this model are shown in Table 1:

Table 1. Actors' roles

Actor	**Roles**
Learner	• Navigates freely within the learning resources • Explores information resources • Asks questions • Collaborates with other classmates in team projects • Seeks feedback • Interacts with other learners either face-to-face or via e-mail
Instructor/tutor	• Organises content into learning resources • Gives lectures • Brings up discussion topics • Provides corrective feedback (either face-to-face or computer mediated e.g. via e-mail) • Advises and tutors students • Assess the students
System Administrator-Course manager	• Creates and manages project teams • Displays and updates information about the course • Administrates the actors network

This model should be designed as learner-centred. The roles of the actors in a Web–OL system should be based on the cognitive theories of instructions that emphasise the centrality of the learner's activity. The learners are expected to seek and choose from information available at their own pace, according to their own needs, and preferences and the instructor is a facilitator and a guide of the learning process.

3.2 Virtual reality and education

The virtual reality (VR) environments which are designed specifically for education typically fall into three categories [Roussos M., Issues in the Design and Evaluation of a Virtual Reality Learning Environment, Master of Science in Electrical Engineering and Computer in the Graduate College of the University of Illinois at Chicago, May 1997, available at http://www.evl.uic.edu/mariar/THESIS/]:

- The networked text-based virtual environments, which are highly interactive but not immersive.
- The desktop virtual reality simulations, where interactivity is usually limited but varies according to the control given by the program, and immersion also varies but is not easily provided.

- The immersive VR environments, where immersion is high, but interactivity may be limited

An excellent report on the use of VR in education is the following:
[Youngblut C., Educational Uses of Virtual Reality Technology, Institute for Defense Analyses, IDA Document D-2128, January 1998, available at http://www.hitl.washington.edu/scivw/youngblut-edvr/D2128.pdf]

VR is good at delivering multiple, even believable, representations, and in so doing, seems an attractive medium for displacement learning strategies. If the representations used are too far from the target domain, however, they run the risk of being viewed as a separate reality. If they are too numerous, they run the risk of overwhelming the learner in feature matching. Finally, virtual reality is such a new area that any project in this field is guaranteed to be an experiment in user interface design.

3.3 Asynchronous multimedia conferencing systems

The widespread use of information and communications technologies (ICT), and particularly the use of the World Wide Web, has made feasible many new forms of collaborative distance learning activities, that take advantage of the capacity to integrate communications with information access and organisation, within a commonly accessible hyperlinked environment. Asynchronous computer mediated communications, and especially asynchronous text-based communications, have long been established as having value in supporting the collaborative distance learning process, due to the fact that they offer flexibility in the use of time as well as space.

It is nowadays of critical importance to facilitate the acquisition of working skills that learners or practitioners can apply in their employment. Asynchronous multimedia conferencing (AMC) is a useful way of supporting the acquisition of such skills and real world knowledge [C. Sgouropoulou, A. Koutoumanos, P. Goodyear and E. Skordalakis, "A Web-based System for Asynchronous Multimedia Conferencing", Proceedings of RUFIS '98]. The use of AMC can help because it supports:

- the creation of vivid representations of working practices (e.g. concise digitised video demonstrations and explanations by experienced practitioners),
- the collaborative ‘discussion’ and ‘critique’ of these sharable representations, over time and anywhere in space, by learners, teachers and other practitioners, using audio, video and/or textual ‘annotations’ on a digitised video resource.

In fact, a few systems for AMC exist today, and they require proprietary hardware and software platforms. The Software Engineering Laboratory of the National Technical University of Athens (NTUA) has developed WebOrama, a Web-based system for ordered asynchronous multimedia annotations. WebOrama serves as an integrated system that facilitates the exchange of representations of working practices and the creation, management and presentation of asynchronous multimedia annotations on those working practices. In order to do so, it facilitates the creation of an audio-visual representation of a working practice by an expert practitioner, which will serve as base material for an asynchronous, multimedia discussion. Furthermore, the system provides a means for exchange and review of the base material and the capture and hyperlinking of multimedia annotations to this material.

More details on WebOrama along with Asynchronous Multimedia Conferencing can be found at: http://www.softlab.ece.ntua.gr/research/research_projects/sharp/start.html.

WebOrama has been developed and tested within a Socrates ODL project, called "SHARP: Shareable Representations of Practice".

4. Classification of tools for web-based tele-training

There is no standard schema for classifying the tools that can be used in web-based tele-learning. However, we created a classification, which is shown in Figure 3, taking info consideration that the WWW can be used for:

- information distribution
- delivery and access to learning material
- student assessment
- class management
- communication

In this section, few indicative links to web sites where one can find tools that belong to the aforementioned categories will be given. The main sources that had been used for finding those links are TUCOWS [http://www.tucows.com], NONAGS [http://ded.com/nonags/main.html] and few others.

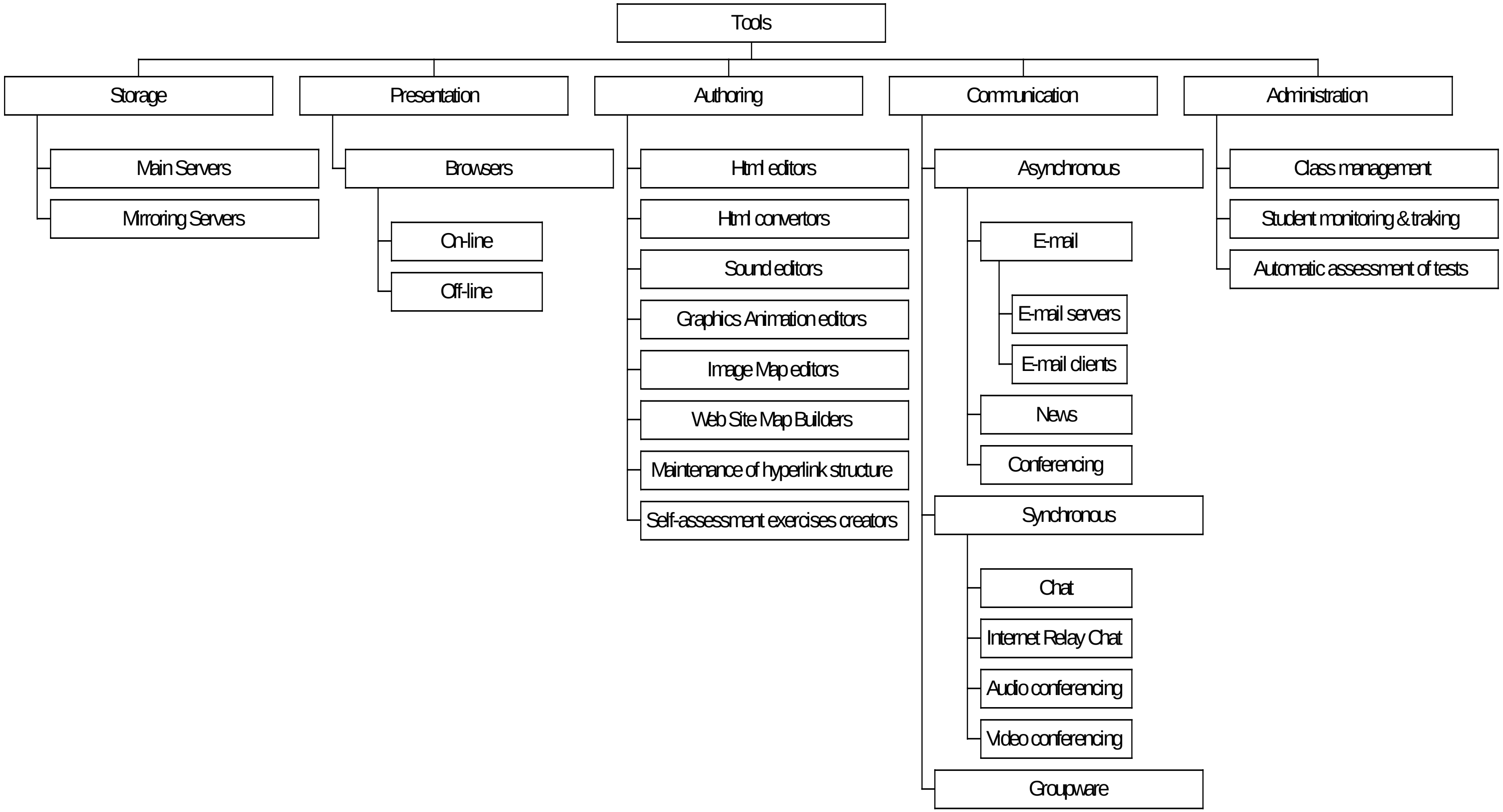


Figure 3. Classification of tools for web-based tele-training

4.1. Storage Tools

4.1.1 WWW servers

Comparison between the web servers can be found in: http://webcompare.iworld.com

Name	Platform	URL	Cost
Apache	Unix	http://www.apache.org	Free
BOA	Unix	http://www.boa.org	Free
CERN Server	Unix	http://www.w3.org/hypertext/WWW/Daemon/Status.html	Free
Fnord	Windows 95/NT	http://www.wpi.edu/~bmorin/fnord	Free
HyperWave	Unix, Windows 95/NT	http://www.iicm.edu	Commercial
Java Web Server	Unix, Windows 95/NT	http://www.sun.com/software/jwebserver/index.html	Free
JigSaw	Unix, Windows 95/NT	http://www.w3.org/pub/WWW/jigsaw	Free
Microsoft Internet Information Server	Windows 95/NT	http://www.microsoft.com	Commercial

4.1.2 Mirroring Tools

Name	Platform	URL
NetAttache	Windows	http://www.tympani.com
Teleport Pro	Windows	http://www.tenmax.com
W3mir	Unix (need for Perl interpreter)	http://www.ifi.uio.no/~janl/w3mir.html

4.2 Presentation and Delivery tools

4.2.1 On-line WWW browsers

Extensive catalogue of web browsers with comparative tests can be found at: http://www.browserwatch.com

Name	Platform	URL
Amaya	Unix	http://www.w3.org/pub/WWW/Amaya/
Arena	Unix	http://www.w3.org/hypertext/WWW/Arena/

Cello	Windows 95/NT	http://www.law.cornell.edu/cello/cellotop.html
Chimera:	Unix	http://www.cs.unlv.edu/chimera/
HotJava	Unix, Windows 95/NT	http://java.sun.com/HotJava/index.html
Internet Explorer	Unix, Windows 95/NT	http://www.microsoft.com/ie/
Netscape Navigator	Unix, Windows 95/NT	http://www.netscape.com

4.2.2 Off-line WWW browsers

Name	**Platform**	**URL**
FreeLoader	Windows 95/NT	http://www.freeloader.com
HotCargo Express	Windows 95/NT	http://www.documagix.com
NetAttache	Windows 95/NT	http://www.tympani.com
Web Buddy	Windows 95/NT	http://www.dataviz.com
Web VCR	Windows 95/NT	http://www.netresultscorp.com
WebMirror	Windows 95/NT	http://www.maccasoft.com/webmirror/
WebWhacker	Windows 95/NT	http://www.ffg.com/
WebZIP	Windows 95/NT	http://www.spidersoft.com

4.3 Authoring Tools

4.3.1 Html editors

Name	**URL**
Adobe PageMill	http://www.adobe.com/prodindex/pagemill/main.html
AOLPress	http://www.aolpress.com/download/aolp20_32.exe
Arachnophilia	http://www.arachnoid.com/
Dreamweaver	http://www.macromedia.com
HomeSite	http://www.allaire.com/
Hot Dog	http://www.sausage.com/
HotMetal	ftp://ftp.ncsa.uiuc.edu/Web/html/hotmetal

4.3.2 Html Converters

Name	**Format file which will be coverted to Html**	**URL**
Latex2html	Latex	http://cbl.leeds.ac.uk/nikos/tex2html/doc/manual/manual.html
Rtftohtml	Rich-text fromat	http://www.logictran.com/

4.3.3 Mapping Web Site

Name	**Platform**	**URL**
ClearWeb	Windows 95/NT	http://www.clearweb.com/
Cmap	Unix (need Perl interpreter)	http://www.stars.com/Software/Perl/
SiteTree	Windows 95/NT	http://www.kobixx.com
WebMapper	Windows 95/NT	http://www.netcarta.com

4.3.4 Maintenance tool for hyperlink structure

Most documents made available on the World-Wide Web can be considered part of an "info-structure". As it grows, an info-structure becomes complex and difficult to maintain. Such maintenance currently relies upon the error logs of each server (often never relayed to the document owners), the complaints of users (often not seen by the actual document maintainers), and periodic manual traversals by each owner of all the webs for which they are responsible. Since thorough manual traversal of a web can be time-consuming and boring, maintenance is rarely or inconsistently performed and the info-structure eventually becomes corrupted. What is needed is an automated means for traversing a web of documents and checking for changes which may require the attention of the human maintainers (owners) of that web [Roy T. Fielding, Maintaining Distributed Hypertext Infostructures: Welcome to MOMspider's Web, First International World-Wide Web Conference (WWW94) in Geneva, Switzerland, May 25-27, 1994].

Name	**Platform**	**URL**
MOMspider	Unix	http://www.ics.uci.edu/WebSoft/MOMspider/

4.3.5 Search Engines

Name	URL
Alta Vista	http://altavista.digital.com/
Yahoo	http://www.yahoo.com/
Lycos	http://www.lycos.com/
Excite	http://www.excite.com/
Meta crawler	http://www.metacrawler.com/
Info seek	http://guide.infoseek.com/

4.3.6 Self-assessment exercises creator

From http://motted.hawaii.edu

Name	URL
Course Test Manager	http://www.course.com/downloads/ctm.html
CyberProf	http://www.howhy.com/home/
ExamMail	http://www.oyston.com/ExamMail/home.html
HTML to QUIZ	http://landau1.phys.virginia.edu/teaching/quiz/home.html
Javascript QuizMaker (Attotron Biosensor Corporation)	http://www.attotron.com/pub/Quizmaker.html
Online Exercises	http://math.uc.edu/WWW-test/demo/demo.html
Question Mark	http://www.questionmark.com
Quiz Factory	http://www.learningware.com/quizfactory/
Quizmaker (Personalized Programming Service, Inc.)	http://www.ppsisoft.com/catalog/Catalog9.html
WhizQuiz	http://whizquiz.isis.vt.edu/
WinAsks Professional	http://www.SmartliteSoftware.com/e_winask.htm

4.4 Communication tools

4.4.1 Asynchronous communication

4.4.1.1 E-mail servers

Name	Platform	URL
SendMail	Unix	http://www.metainfo.com/download/sendmail
Windmail	Windows 95/NT	http://www.geocel.com/windmail
MS Exchange Sever	Windows NT	http://www.microsoft.com

4.4.1.2 E-mail client

Name	Platform	URL
Microsoft Outlook	Windows 95/NT	http://www.microsoft.com
Netscape Communicator	Unix, Windows 95/NT	http://www.netscape.com
Windmail	Windows 95/NT	http://www.geocel.com/windmail

4.4.1.3 Mailing Lists

Name	Platform	URL
CREN List Proc	Unix, Windows 95/NT	http://www.cren.net/www/listproc/listproc.html
LISTSERV Classic	Unix, Windows 98/NT	http://www.lsoft.com/listserv.stm
Majordomo	Unix	http://www.greatcircle.com/majordomo

4.4.1.4 Web-based Mailing Lists

Name	Platform	URL
WebHelp	Unix	http://www.vicnet.net.au/webhelp/
AgriBiz	Unix	http://www.agribiz.com/agInfo/resMail.html

4.4.1.5 News

Name	Platform	URL
Agent	Unix, Windows 95/NT	http://www.forteinc.com/agent/agent.htm
Grabber	Unix, Windows 95/NT	http://www.trontech.com.au/grabber
News Rover	Unix, Windows 95/NT	http://www.NewsRover.com
NewsBin	Unix, Windows 95/NT	http://www.newsbin.com/
SnipSnap Pro	Unix, Windows 95/NT	http://www.snipsnap.com/

4.4.1.6 Text based asynchronous communication

Name	Platform	URL
CoW	Unix	http://thecity.sfsu.edu/COW2
FirstClass	Windows 95/NT	http://www.softarc.com
Hypenews	Unix, Windows 95/NT	http://www.hypernews.org/HyperNews/get/hypernews.html
Motet	Unix	http://www.sonic.net/~foggy/motet/index.html
Webboard	Windows 95/NT	http://webboard.ora.com
WWWboard	Unix	http://worldwidemart.com/scripts/www.board.stml

4.4.2 Synchronous communication

4.4.2.1 Text based synchronous communication

4.4.2.1.1 Chat Systems

Name	Platform	URL
ACD Notes Pro	Windows95/NT	http://www.acdsystems.com
ChatSpace	Windows95/NT	http://www.chatspace.com/
Chat	Unix	http://www.cabinessence.com/cgi/chatpro.shtml
The Chat Server	Unix, Windows95/NT	http://206.191.52.145/

The Palace	Unix, Windows95/NT	http://www.thepalace.com

4.4.2.1.2 IRC

Name	**Platform**	**URL**
Active Worlds Browser	Unix, Windows95/NT	http://www.activeworlds.com/
Internet Tele Cafe	Unix, Windows95/NT	http://www.telecafe.com/telecafe/
Microsoft Chat	Unix, Windows95/NT	http://www.microsoft.com/ie/comichat/default.htm
MIRC	Unix, Windows95/NT	http://www.mirc.com
PIRCH	Unix, Windows95/NT	http://www.bcpl.lib.md.us/~frappa/pirch.html/
XiRCON	Unix, Windows95/NT	http://www.xircon.com/

4.4.2.2 Synchronous communication via sound

Name	**Platform**	**URL**
Internet Phone	Unix, Windows95/NT	http://www.vocaltec.com
Netmeeting	Windows95/NT	http://www.microsoft.com
NetscapeCooltalk	Unix, Windows95/NT	http://www.netscape.com/
RealAudio	Unix, Windows95/NT	http://www.realaudio.com

4.4.2.2.1 Synchronous communication via video

Name	**Platform**	**URL**
Audiovision	Unix, Windows95/NT	http://www.smithmicro.com/
Avistar Conference	Unix	http://www.avistar.com/avistar/
CineVideo/Direct	Windows95/NT	http://www.cinecom.com/
Communique!	Unix, Windows95/NT	http://www.insoft.com/
CuSeeMe	Unix, Windows95/NT	http://www.cu-seeme.com
HoneyCom	Windows95/NT	http://www.honeysw.com
ICUII	Windows95/NT	http://www.icuii.com/

InPerson	Windows95/NT	http://www.sgi.com/
SeeQuest	Windows95/NT	http://www.sharkmm.com/
TeamVision	Unix, Windows95/NT	http://www.iclnpbg.co.uk/

4.4.3 Groupware

A groupware tool enables collaboration over the Web. Such a tool is a "shared workspace" system that supports document uploading, event notification, group management and much more.

Name	**Platform**	**URL**
Action WorkFlow	Unix, Windows 95/NT	http://www.actiontech.com/
BSCW	Unix	http://bscw.gmd.de
Collabra	Windows 95/NT	http://www.collabra.com
GMD Sepia	Windows 95/NT	http://www.darmstadt.gmd.de/publish/ocean/sepia/home.html
Groupkit	Windows 95/NT	http://www.cpsc.ucalgary.ca:80/projects/grouplab/projects/groupkit/
LinkWorks	Windows 95/NT	http://www.digital.com/info/linkworks/
Lotus Notes	Unix, Windows 95/NT	http://www.lotus.com/
TeamWare Workplace	Unix, Windows 95/NT	http://www.teamware.com

4.5 Administration Tools

4.5.1 Class management

Name	**URL**
CourseMap	http://www.sixthfloor.com/
EndNote	http://www.niles.com
MicroGrade	http://www.chariot.com/

4.5.2 Automatic assessment of tests

Name	**Platform**	**URL**
MicroTest III	Windows 95/NT	http://www.chariot.com/
QM Test Presenter	Windows 95/NT	http://www.questionmark.com/products.htm

Verbatim Blaster	Windows 95/NT	http://www.statpac.com/
WWW Survey Assistant	Windows 95/NT	http://or.psychology.dal.ca

4.5.3 On-line Student monitoring & tracking

Name	**Platform**	**URL**
DoubleVision	Unix	http://www.maxtech.com
Look@Me	All (Netscape plug-in)	http://www.farallon.com/www/look/download.html
Remotely Possible	Windows 95/NT	http://www.avalan.com

5. Integrated Learning Environments

Integrated Learning Environments (ILEs) are course management software systems that synthesise the functionality of computer-mediated communications software (e-mail, bulletin boards, newsgroups etc) and on-line methods of delivering course materials (e.g. the WWW). To date, several different packages have appeared from both leading commercial vendors and university-based projects.

The users of the system can be classified in four categories:

- The *learners* who will use the system in order to participate through distance (in place and/or time) to the educational process. In fact, the learners are the main users of the system, in the sense that it (the system) is being developed in order to fulfill some of their needs and resolve their problems.
- The *teachers*, being the instructors and their assistants, who will use the system in order to supervise and assist their students (notify for important issues on an electronic notice board, engage in discussions in electronic fora, communicate and exchange personal messages with students, collect, assess and return deliverables, etc.).
- The *developers* of the instructional material who will co-operate closely with the instructors of the lessons in order to create the instructional material that will be integrated in the system. This material will be structured as hyperdocuments, amended with electronic representations of examples, simulations, etc., as well as questions and exercises that will be used by students for self-assessment. Most of the times designers and teachers are the same persons.
- The *administrators* of the system who will undertake the support of the users of the system and will safeguard its proper operational status.

The users requirements classified by type as well as the process of their collection and documentation are shown in Figures 2.

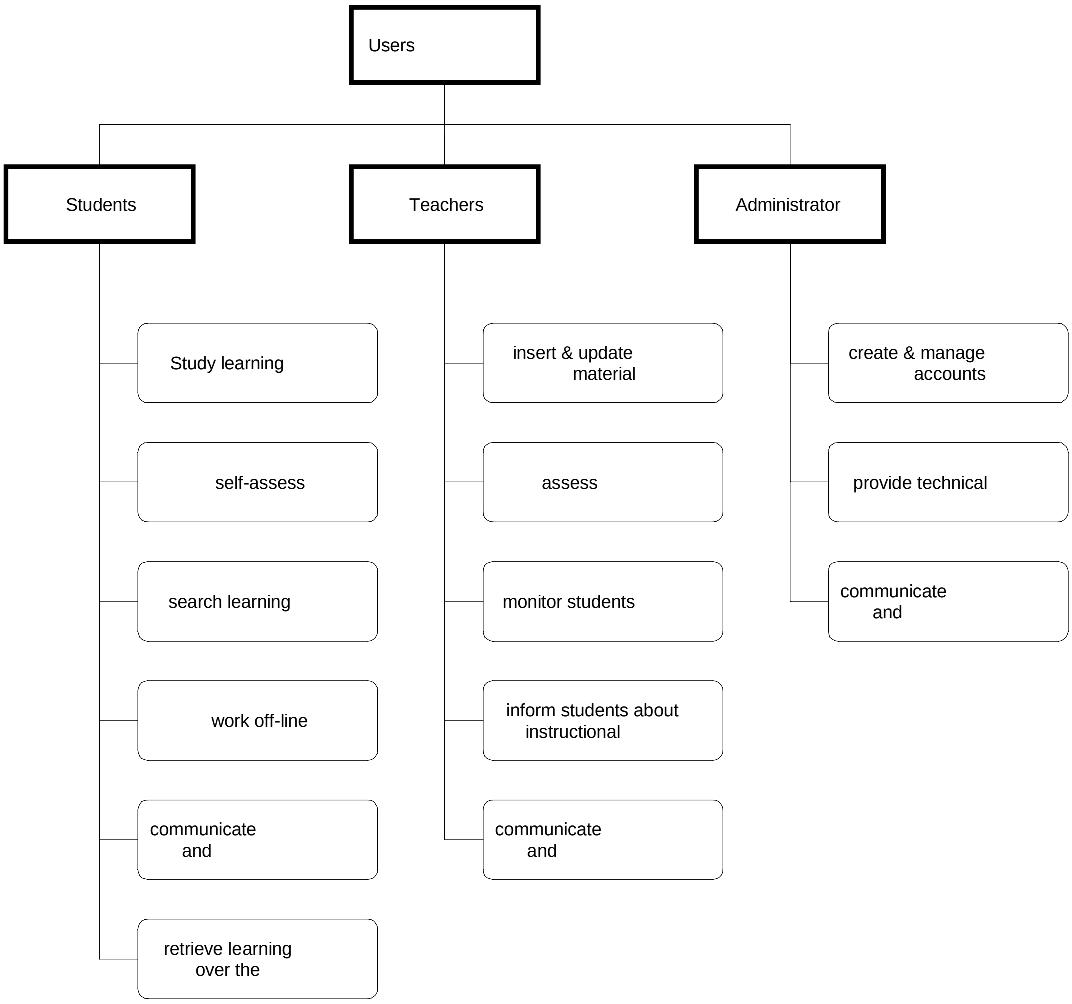


Figure 2. Functional system requirements of an ILE according to types of users

An ILE should provide a number of features that can support the development and execution of four basic tasks via a simple, friendly and unified user-interface:

- *Information distribution*, e.g. announcing the tips of the day, calendar, glossary, etc.
- *Management of learning material*, e.g. customisation of the user interface to the needs of the teacher, updating the learning material, etc.
- *Multiple communication facilities*, e.g. asynchronous and synchronous communication. The system must provide the students with a means of submitting questions and the teachers with a means of answering them. It should implement a communications channel, in which all students and teachers will participate and discuss matters related to the course electronically. The content of these discussions,

as well as all questions and answers, will be stored in a database in order to be available for reuse on next deliveries of the course.
- *Class management*, e.g. on-line marking of students' assessments, tracking learners' participation, management of learners profiles, etc.

There is a wide selection of products that can help developers in building web-based tele-training and tele-learning systems. The web site, which contains links to most of them, is the following: [Rafael H. Scapin, Course Server Software for Online Teaching, February 2000, http://www.if.sc.usp.br/~rafael/wbt.htm]

This section will not present an exhaustive review nor comparison but it will focus on comparing few products that meet most of the aforementioned requirements giving priority to the following:

1. Its features are all integrated into a unified homogenous environment
2. Its is based on WWW
3. If they are evolving

The following data was based on the work presented in [McCormack, C., Jones, D., Building a Web-Based Education System, Wiley Computer Publishing, 1997] as well as in other resources. In Table 2, some products are shown.

Table 2. Products for building Web-based educational systems

Name of Product	Company	Platform Requirements
LearningSpace http://www.lotus.com/products/learningspace.nsf	Lotus	Supported server platforms: Microsoft NT (Intel, DEC Alpha); IBM OS/2; IBM AIX; IBM System 390; Hewlett-Packard HP-UX; Sun Solaris (SPARC, Intel Edition). Supported Domino versions: LearningSpace 2.5 requires a Domino 4.5x or 4.6, 4.61 server.
Toolbook II http://www.asymetrix.com/products	Asymetrix	Pentium/166 MHz processor minimum; 200 MHz recommended. Windows NT 4.0 or higher. Web server software that supports HTTP and CGI 1.1 Database Management Software with ODBC-compliant drivers Librarian for SOLARIS UNIX SunSPARC station or compatible. Solaris Operating System (2.4 or later). Web server software that supports HTTP and CGI 1.1 Instructor and Assistant 80486/66 MHz processor minimum. Microsoft Windows 3.1, Windows 95,

		Windows NT 3.5 or higher.
TopClass http://www.wbtsystems.com	WBT Systems Inc.	Unix, Win NT platform
Virtual-U http://virtual-u.cs.sfu.ca/vuweb	Virtual Learning Environments	Sun OS 4.1.x or Solaris 2.5 or higher at least 500 MB of free storage on hard disk 24 MB or more of RAM Web server: NCSA HTTPD 1.4, 1.50a, 1.52 Perl 4.0 Script Language
Web-CT http://www.webctcom	University of British Columbia	WebCT server must be running the UNIX operating system (Solaris, SunOS, Irix, FreeBSD, Linux, AIX, HPUX, and Digital UNIX/OSF1 are supported)

The selection of an ILE is mainly based on the following criteria:

1. *Popularity*. This product must have been used by other universities with good results.
2. *Maturity*. Evaluation of the product should show that it is user friendly, and its features are well developed and integrated into a "whole".
3. *Support mechanisms*. The company that sells the product should provide technical support and well documented releases of new versions.
4. *Cost*. The budget available for purchasing this product should not be exceeded. Moreover, if the project succeeds, then this product will be used in a more broad scale for development of an educational system. Thus, it is very crucial to estimate if such an investment is cost effective for the future as well.
5. *Openness*. The learning material that will be incorporated into this product can be extracted and used with minimal modifications in other educational settings. Therefore, the developed material should be re-usable (with minimal modifications, if at all) after the completion of the project.

Extensive and detailed evaluation and comparative studies on ILEs can be found at the following web sites:

- Bruce Landon, Randy Bruce, and Amanda Harby, online educational delivery applications: A web tool for comparative analysis, March 2000 http://www.ctt.bc.ca/landonline/
- Sandy Britain & Oleg Liber, A Framework for Pedagogical Evaluation of Virtual Learning Environments, University of Wales – Bangor http://www.jtap.ac.uk/reports/htm/jtap-041.html

6. Integrated solutions for Tele-services

A Portal is an entry point or starting site for the World-Wide Web, combining a mixture of content and services and attempting to provide a personalized "home base" for its audience with features like customizable start pages to guide users easily through the Web, filterable e-mail, a wide variety of chat rooms and message boards, personalized news and sports headlines options, gaming channels, shopping capabilities, advanced search engines and personal homepage construction kits.

A Campus Portal puts useful, engaging information and services within comfortable reach, making it easier for students, faculty, and staff to do all the things they must do and want to do in the course of their daily lives. It can bring an institution a sweeping new innovation for building and sustaining relationships with students, faculty, friends, and alumni.

Portals offer services such as:

- Search engines
- Tools for producing learning modules
- Learn to Learn facilities
- Helpdesk
- Standardised templates for making learning/presentation concepts
- Language adaptations
- Statistics
- Synchronous and asynchronous communication

One of the best software products that can be used for building portals is Zope (http://www.zope.com). It is a highly object-oriented Web development platform that covers much more of the problem domain for Web application developers. It provides clean separation of data, logic and presentation, an extensible set of built-in objects and a powerful integrated security model. The Zope infrastructure relieves the developer of most of the onerous details of Web application development such as data persistence, data integrity and access control, allowing him/her to focus on the problem at hand.

Zope provides all of the necessary tools to integrate data and content from nearly any source into powerful, coherent and maintainable Web applications:

- Through-the-Web management
- Integrated access control
- Content management
- Enterprise data access
- Built-in search tools
- Built-in communication tools
- Powerful data sharing
- Safe delegation

Generic portals for citizens have been very popular lately. All major Internet sites have developed them. They all provide a news service, thematic link collection and personalisation of the interface. Vertical portals and corporate portals have lately been developed. In short, these are more specialised portals that can provide more meaningful content to better targeted audiences. Corporate portals, in particular, have turned out to be powerful integrative instruments to all kinds of systems, such as databases and directories within a company. They are gradually overtaking Intranets.

7. Designing tele-training based on novel technologies

It is important to mention that involvement in a tele-training programme which is based on novel technologies is a learning experience for all concerned ("tutors" as well as "learners"). Both the teacher and each student are challenged by new roles, functions, and tasks they need to perform. The dominant change is from teaching and presentation of knowledge to more student active learning. For the instructor it is characteristic to change from "a sage on the stage" to " a guide on the side". The learners will also experience a different role from that of a traditional student. The role changes from passive receptacles to constructors of their own knowledge. Students become complex problem-solvers rather than just memorises of facts.

There is huge literature on guidelines of designing and running a tele-training programme using novel technologies. One such report is the "Guidelines for ODL in a Virtual Learning Institute (VLI)" composed by the partners of MECPOL - Models for European Collaboration and Pedagogy in Open Learning, a Socrates ODL project nr 35318-CP-2-96-1-NO-ODL-ODL. It is very valuable and can be purchased via the WWW [http://hugin.hsh.no/prosjekt/Mecpol/].

There are also a number of projects which have dealt with the establishment of an ODL programme, such as "EuroCompetence: Defining competence gaps in organisations and individually and construct flexible study programmes to fill the gaps" and a lot of others.

Moreover, there are no solid and widely accepted methodologies for developing an tele-training programme. This is an area of active research, nowadays.

8. Conclusions

The novel technologies and especially the WWW, the Virtual Reality and the Asynchronous Multimedia Conferencing, as an aid in tele-learning services are a current research issue. Like any other technologies, they have advantages and disadvantages. Implementations that capitalise on the strengths and added value of the technology and that circumvent or adjust for its limitations can be expected to be successful in terms of learning outcomes.

Technisches Bildungszentrum Mitte
Bremen (D)

Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

Contract No.: D/99/2/07331/PI/II.1.1.a/FPI

TEACHING UNIT 'REMOTE DIAGNOSTIC INTERFEROMETRY' (COURSE CONCEPT)

Karl-Heinz Bramsiepe

Work Package:	**W30 Teaching Unit "Teleservice" – Module 1**
Deliverable:	**D31 Course Concept**
Date of Delivery:	03 August 2001
Deliverable Type:	Restricted

Abstract:	This document specifies course design for the teaching sessions to be used in the product evaluation.

Keyword List:	Remote Diagnostic, Teaching Unit

Contents

1. Introduction

The central idea of the project RADIO is to offer the possibility of calling locally distributed learning systems via data networks. New approaches in telematic research linked to the possibilities offered by tele-observation, remote control, remote installation and remote maintenance of real systems and machines will be taken into consideration. In this way students will be in a position to carry out practical exercises, experiments and learning tasks at machines and systems which are not available "on-the-spot".

When the project started it was decided to have a special focus on the learning field of teleservice in *mechatronics*. Although the subject is absolutely important for this field it was found that other professions are also affected of the teleservice trend. So for some IT-professions, which are new in Germany since August 97 (IT means information- und telecommunication), learning in a net technical environment and dealing with teleservice-environments is fundamental. The following teaching unit therefore was carried out also by students who learn the special profession called Informations- und *Telekommunikations-Systemelektroniker.* Also the curriculum for this profession has a lot of contents which are identical with the contents of teleservice. Teleservice corresponds to basic needs in vocational education of electronic workers.

There a two concepts in Germany in the last years which characterize the debate about the future of vocational training: Vocational learning should be arranged in a way of „handlungs- und projektorientiert“, which means that the learning should be done by the students –action oriented and in the way of project oriented learning. In view of the technical advance vocationals schools are looking for new ways of delivering the curriculum to local industry in a way that increases participation and removes barriers to education with a high degree of opening of the learning arrangement toward real life situations.

What is the reason for the choice of the teaching unit REMOTE DIAGNOSTIC INTERFEROMETRY?
This teaching unit gives students an idea of a teleservice-system and shows how a teleservice-system works and allows students to explore the use of communication tools used in teleservice applications. The unit is based around the use of an experiment in the area of physical basics and it gets the special learning effects from the sort of combination of virtual teaching and industrial application. Especially this physical experiment brings great motivation to the students, through which it is very suitable to the students.

The initial part of the course will look at the use of communication tools such as Netmeeting and Vicon and similar types of application and at customary standards for videoconferencing. They will learn about different ways of communication, application sharing and virtual reality environments, about Videoconferencing, Data conferencing, File transfer and snapshot. And then the students apply this knowledge to a concrete problem with the application described above.

For the analysis and execution of the two tasks of the physical experiment the students use a construction which is placed far away (here Bremen (D) and Stockport (UK)) and which they can only reach via electronic telecommunication.

If students stand still at the beginning of their instructions it is of course an advantage to take a task which on one hand refers to former (in this case physical) lessons and knowledges and on the other hand refers to a task which could be quite typical for industrial application. In this case the students have to realize remote access to an distant measuring construction.

The teaching unit consists of 3 parts with detailed information and work-sheets (incl. solution). Part 1 is useful to obtain knowledge about video- and data conferencing.

Part 2 deals with the execution of the physical experiment under teleser-vice conditions

- „Determining the radius of a convex lens with a big focal length through the help of Newton-circle by the use of monochrome source of light with a well-known wavelength".
- Determining the wavelength of an unknown monochrome source of light [in this case laser] by using convex lens with a well-known focal length.

Part 3 discusses the problems of teleservice and its social effects

Changes in the concept of work are based on increased group work, use of distributed autonomous production centers and complexity of mecha-tronic (electrical, mechanical, and informatical) products and manufactur-ing methods. These require new technical and social-communicative qualifications for skilled workers and engineers.

2. Course Concept

2.1. Unit Description

2.2. This teaching unit gives students an idea of a teleservice-system and shows how a teleservice-system works and allows students to explore the use of communication tools used in teleservice applications. The unit is based around the use of an experiment in the area of physical basics and it gets the special learning effects from the sort of combination of virtual teaching and industrial application.

Within the whole teaching unit „Teleservice" this part „Remote Diagnostic Interferometry" could stand at the beginning, because the special focus of this unit is, to show what is basically necessary for a remote diagnostic system and which specific requirements and difficulties could appear. The very practical focus of this unit is intended to help students get a hands on feel to teleservice using communication tools. For the aims and objectives of the unit look below.

The initial part of the course will look at the use of communication tools such as net-meeting and similar types of application. They will learn about communication, describing problems and application sharing. This knowledge will then be applied to a concrete problem with the application described above.

2.3. Aims

The aim of the unit is to allow students to gain an appreciate of the tools and infrastructure required for teleservice.

Detail:

- Students learn the different ways and possibilities to get connection between two ore more computers.

Students learn the basics about connections on the base of telecommunication.

- Students learn the technical basics about remote access and remote action and how to transfer data and picture from place A to place B. -
- They learn how programs/systems like Netmeeting and Vicon work.
- Students learn the functions of webcams.
- Students learn the social effects on working under the conditions of teleservice.

2.4. Objectives

At the end of the course students will be able to

- Realize an telecommunication connection and using application sharing to monitor and control remote systems.
- Perform simple maintenance functions on remote hardware.
- Make modifications to software in remote systems.
- Use collaborative tools to consult with experts in the solution to problems.

2.5. Pre-requisite Knowledge

The students will need to be familiar with physical basics as mono-chrome source of light and NEWTON-circle. The knowledge of basics of computer supported Network, basics of telecommunication and hardware-requirements will be useful.

2.6. Time

The estimated time to complete this unit is about 10 hours.

2.7. Evaluation Aims

Evaluation of the lessons will be centered on the effectiveness of the tools used for teleservice. These will be extracted by questionnaires and comments from students, teachers and remote experts. The learning outcomes will be considered achieved if the students are able to complete the tasks associated with the unit.

2.8. Material

The teaching material can be found in the following sections.

3. Teaching Material

3.1. Author

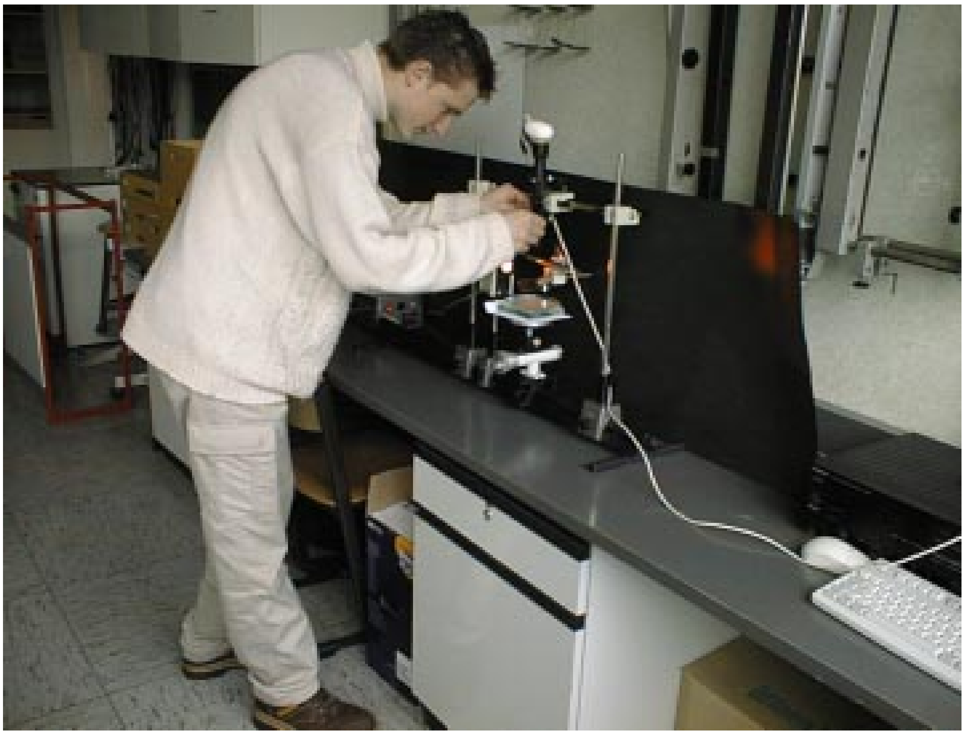
Karl-Heinz Bramsiepe TBZ Mitte Bremen

3.2. Overview

This unit is concerned with the carrying out of the physical experiment “Interferometry”, which means

Determining the radius of a convex lens with a big focal length through the help of Newton-circle by the use of monochrome source of light with a well-known wavelength and

Determining the wavelength of an unknown monochrome source of light [in this case laser] by using convex lens with a well-known focal length. On this base the analysis of the results of the measurements are done at a distant place and the data have to be transferred to this place.



4. Session 1 - Basics about video- and dataconferencing

4.1. Objectives

At the end of the session the student will be able to

- Describe the technical basics about remote access and remote action and how to transfer data.
- Access remote systems using desktop sharing.
- Monitor the operation of distant actions.

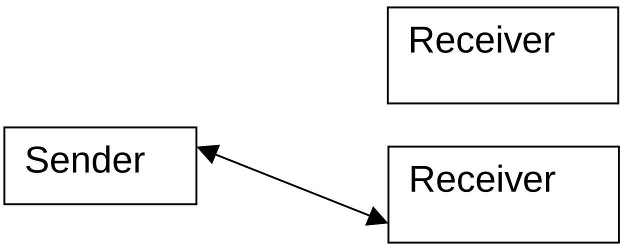
4.2. Tasks

- Define the Hardware requirements of the PC, which means that the PC has enough power for the use of video- and data conferencing.
- Define the software requirements.
- Requirements for the camera for video- and data conferencing.
- Installation of a webcam.
- Basics about application sharing, whiteboard and file transfer.
- Define the tasks for measurement.

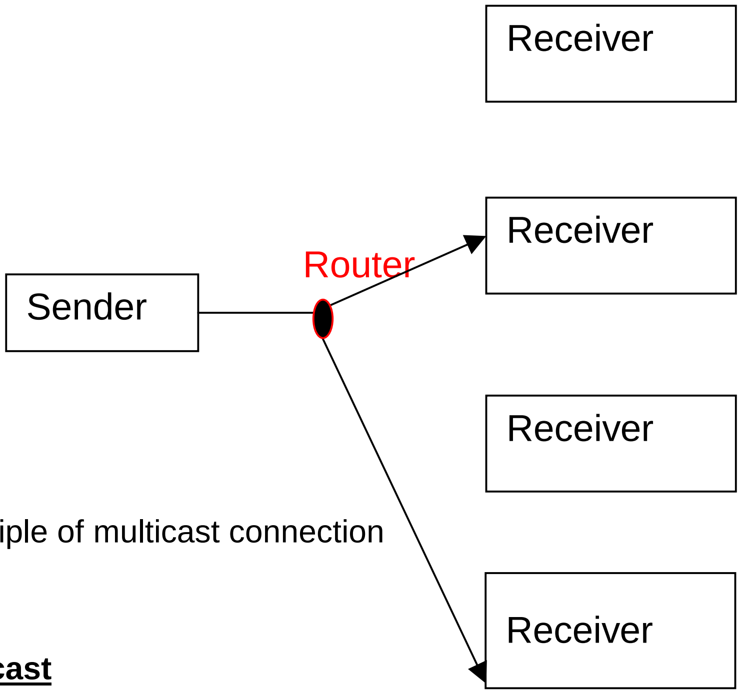
4.3. Task 1 - Basics about application sharing, whiteboard and File-transfer

In this part basics about application-sharing with MS-Netmeeting and function of the whiteboard as well as filetransfer is object of the lesson.

Unicast

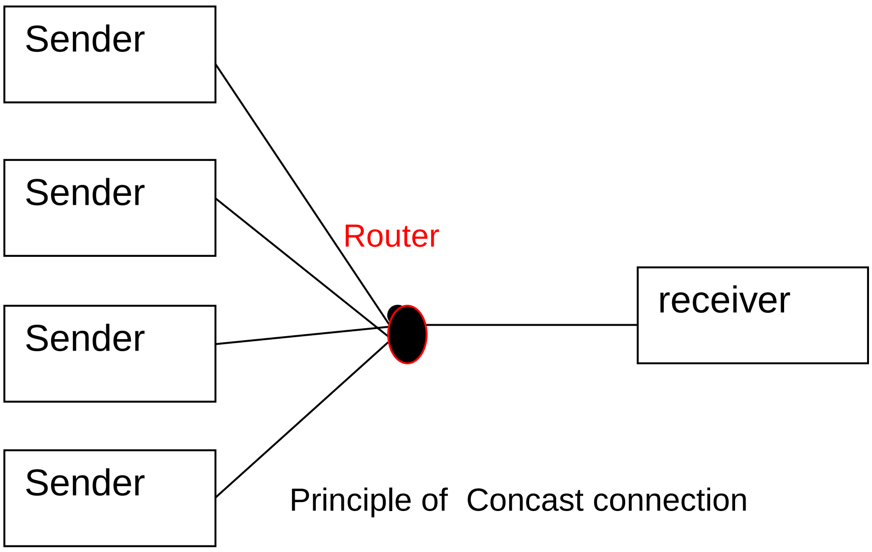


Multicast



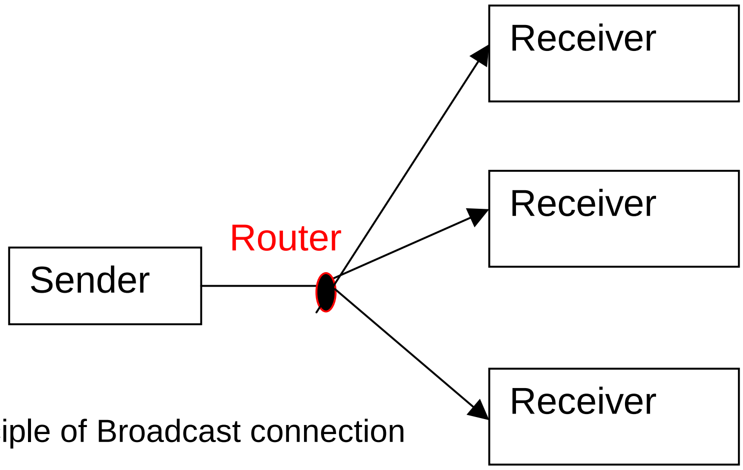
Principle of multicast connection

Concast



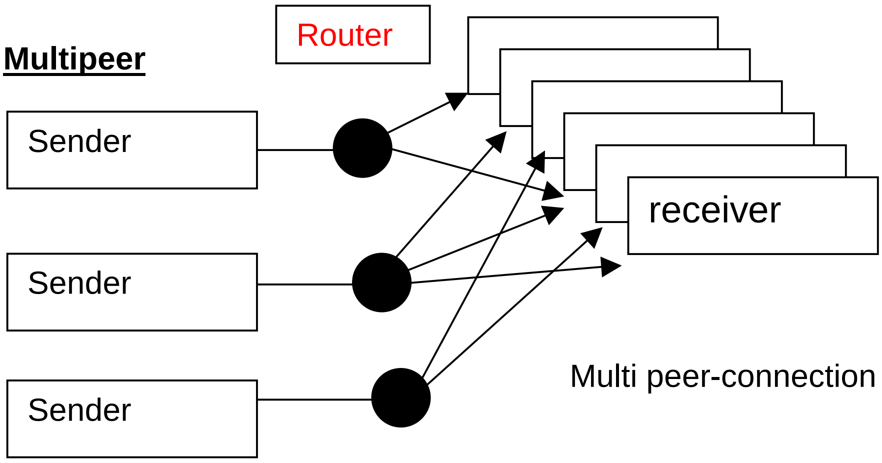
Principle of Concast connection

Broadcast



Principle of Broadcast connection

Multipeer



Multi peer-connection

4.4 Hardware- and software requirements

In this task is to explore the system-hardware and software used for the measurement and conference-system. It is to clarify which sort of requirements are necessary or available for a communication done by a videoconference system.

4.4.1 **Minimum requirements for videoconferencing:**

Guaranteed **Bandwidth** for users and applications: Quality of Services (QoS). QoS is a requirement for wide-area networks. Bandwidth, delay and delay variation requirements are at a premium in the wide area. The importance of end-to-end QoS is increasing because of the rapid growth of intranet and extranet applications.
Two industry standards provide for the integration of QoS for these differentiated applications - the first standard ist RSVP (Reservation Protocol working on layer 5,6 and 7), implemented widely by TCP/IP based multimedia applications today, and the second is the emerging 802.1p and 802.1Qstandards. Guaranteed bandwidth assures certain classes of traffic a specific bandwidth. Priority queuing works by applying a set of filters or access list entries to each message the router forwards. Specific features which are available today include priority queuing, custom queuing, policy routing and weighted fair queuing.
Standards for videoconferencing.
In order that the videoconference system works all participants have to use the same transmission protocol as H.32x-standards.
Compression process
It is recommended to use a compression process as MPEG and JPEG to reduce the bandwidth (look at the **Videokonferenz-Glossar)**.

Hardware-requirements:

How good the transmission of the video and audio data could be sent

depends also on the videoconference-hardware. The camera must be able to deliver good pictures. Within the transmission there will be a loss of data therefore a camera making good pictures is very important for the quality of the conference-system. Better than to use loudspeaker are to use headphones because it prevents the receipt of audio data by the microphone caused by feedback.

4.5 Working with NetMeeting and webcam

MS-NetMeeting is a multimedial communication-programme which supported application-sharing, file transfer and video-phone. IT works on the base of Windows 9x or 2000. NetMeeting uses the ITU-Standard H.323 for the video-transmission and that means only point-to-point-connection. Multi-point-connections have to been realized with special server.
The quality of the video-picture depends on the following adjustments:
General Screen-resolution
Adjustment of the picture size
Adjustment of the camera resolution
Fitting of the transmission quality (Relationship of the quality to the vertical refresh rate)
Last but not least: Surroundings as background, lighting conditions, etc.
Alternatives to webcams: Digital cameras or digital camcorder with video-capture-cards.

Compatibility:

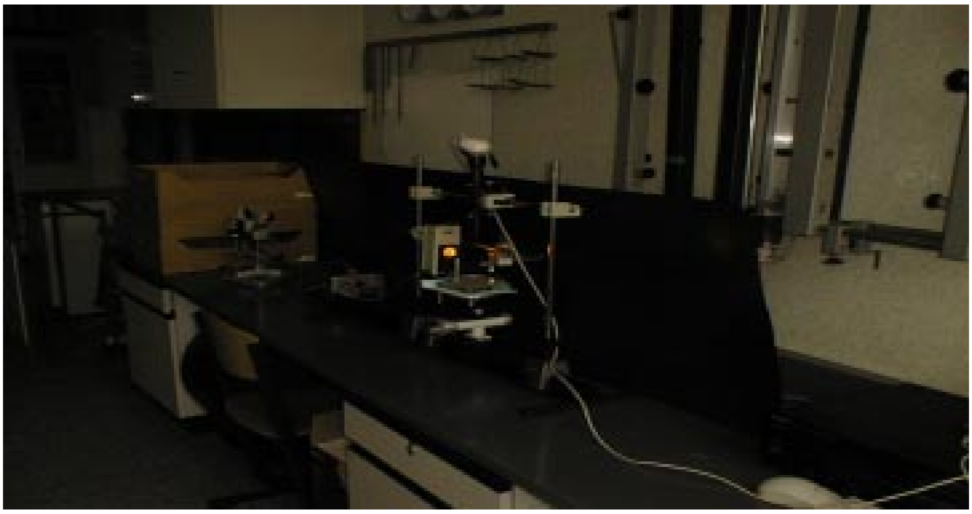
The software must be compatible to all the hardware and software-components.

5. Session 2 - Interferometry: Remote Diagnostic

5.1 Objectives

Two task of physical measurements have to be done and realized in a distant way. First there is to install the videoconferencing system so that the measurements can be done from a distant place. After that there are to carry out to measurements:

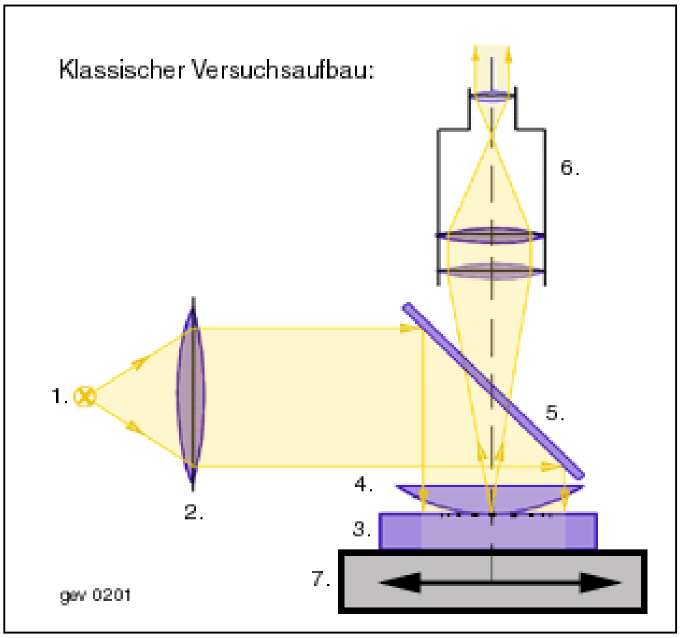
5.2 Task 1: Determining the radius of a convex lens with a big focal length

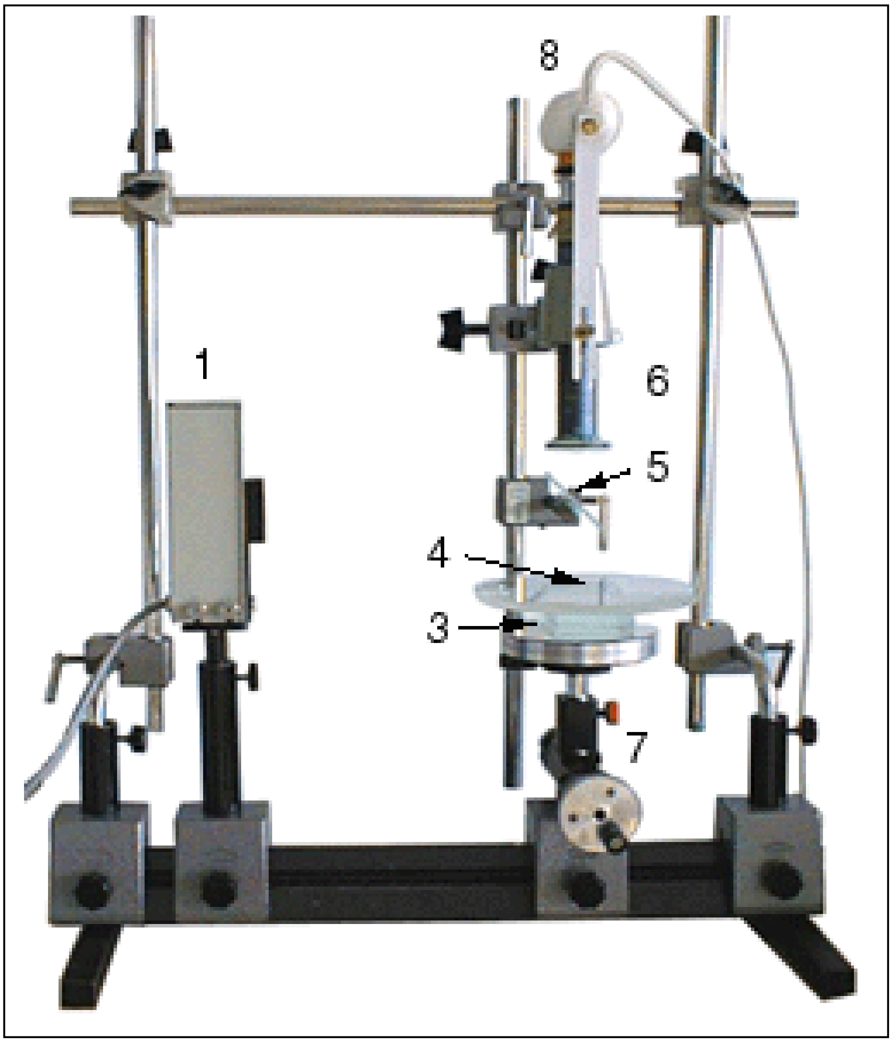


through the help of Newton-circle by the use of monochrome source of light with a well-known wavelength. For the experimental arrangement is used a sodium-discharge lamp with a well-known wavelength.

5.3 **Tasks 2**: Determining the wavelength of an unknown monochrome source of light [in this case The unit is based round a physical experiment with two tasks for the students:

Task 1: Determining the radius of a convex lens with a big focal length hrough the help of Newton-circle by the use of monochrome source of laser] by using convex lens with a well-known focal length. For this task the sodium-discharge lamp is replaced by a laserpointer. (for the tasks look at the worksheet or look under the address http://www.phyta.net/newton.htm.





5. **Installations**

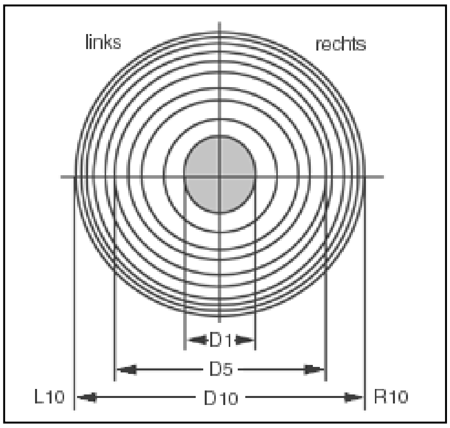
   Web-camera and software have to be installed.

   Connection to the measurements have to be realized.

6. **Monitoring the NEWTON-circle.**

   The desktop of the remote machine has one ore two windows. One is connected to the web-camera which is fixed to the ocular to take pictures of the Newton-circles. The other window could be opened to have another web-camera to look at the physical experiment at all.

Starting the monitor software/Configuration of NetMeeting



NetMeeting uses TCP/IP! During the installation of NetMeeting it must be said which sort of connection is chosen: Modem, ISDN, DSL or network.
Then NetMeeting has to adapted to the PC that means the video- and audio-transmission has to been optimized.

For more information please look at the measurement-tasks in the Annex.

Appendix

Gebräuchliche Standards für Videokonferenzen

Kompressions-Standards

MPEG	Motion Picture Experts Group. Ein ISO-Standard für Bewegtbild- und Audiokompression, welcher sowohl verlustbehaftete als auch verlustlose Kompression erlaubt. Wird eingesetzt für das Abspielen von Multimedia-Images von CD-ROM, für Pay-TV, Broadcasting und ist auch für die Videokommunikation geeignet.
JPEG	Joint Photographic Experts Group. Ein ISO Standard für die Kompression, Speicherung und für das >übertragen einer Vielfalt von Standbild-Formaten (nicht nur das NTSC-Original). JPEG kann in Verbindung mit ITU-T-Standardformen CODECs (Kodierer/Dekodierer) eingesetzt werden und beinhaltet sowohl verlustbehaftete als auch verlustlose Modi. Der sogenannte „Motion-JPEG“ ist eine proprietäre Art der Bewegtbildübertragung und ist kein Standard.

H.2xx-Standards

H.221	ITU-T Empfehlung bezüglich der Rahmenstruktur audiovisueller Teledienste
H.223	ITU-T Empfehlung: Multiplex-Protokoll für Multimediakommunikation mit niedrigen Bitraten.
H.230	ITU-T CODEC-Empfehlung bezüglich der Steuerung der Rahmensynchronisierung und der Kontrollsignale audiovisueller Systeme.
H.231	ITU-T MCU-Empfehlung für Brücken mit Kanälen vis zu 2 Mbps.
H.242	ITU-T CODEC-Empfehlung für ein System, welches die Verbindung zwischen zwei audiovisuellen Terminals ermöglicht, die digitale Kanäle bis zu 2 Mbps benutzen.

H.243	ITU-T Empfehlung: Prozedur zum Aufbau von Kommunikationsverbindungen zwischen drei oder mehr audiovisuellen Terminals, die digitale Kanäle bis zu 2 Mbps benutzen.
H.245	ITU-T Empfehlung: Kontroll-Protokoll für Multimedia-Kommunikation.
H.261	ITU-T CODEC-Empfehlung für einen Video-CODEC, der audiovisuelle Dienste mitn*64 kbps ermöglicht. Bewegungs-Kompensation sowie Feldabtastung (loop filter) sind nur optionale Erweiterungen des Standards. Benutzer, die einen ITU-T CODEC-für den Bereich 384 kbps in Erwägung ziehen, sollten sich vergewissern, daß der Hersteller diese Optionen implementiert hat.
H.261 Annex D	ITU-T CODEC-Empfehlung für die simultane Übermittlung von Grafikdaten im Bereich Nord-Amerika. Andere Bereich können auch JPEG benutzen.
H.263	ITU-T CODEC-Empfehlung: Video-Kodierung für die Kommunikation audiovisueller Dienste im Bereich niedriger Bitraten. Erweitert die Fähigkeiten des H.261-Standards, da die Qualität von niedrigauflösenden Bildern in der Größe einer Kreditkarte auf außergewöhnlich detaillierte und qualitativ hochwertige Images erweitert wird. H.263 ist rückwärts-kompatibel zum QCIF (Quarter Common Intermediate Format) und optional auch zum CIF und SQCIF des H.320 Standards.

2b) Vergleich der Video-Fähigkeiten der H.320 und H.324-Standards:

Bildformat	Auflösung in Pixel	Videomodus	
		H.320/H.261	H.324/H.263
SQCIF	128 * 96	Optional	Erfordert
QCIF	176 * 144	Erfordert	Erfordert
CIF	352 * 288	Optional	Optional
4CIF	704 * 576	Nicht def.	Optional
16CIF	1408 * 1152	Nicht def.	Optional

2c) H.32x-Standards

H.320 Spezifikation	ITU-T CODEC Empfehlung, die verschiedene Empfehlungen mit dem Ziel zusammenfaßt, eine generelle „Videotelefon-Systemspezifikation zu erzeugen.
H.321	ITU-T Empfehlung, die ATM basierende Local Area Networks beschreibt.
H.322	ITU-T Empfehlung, die Videotelefon-Systeme und Terminals für LAN mit garantierter Bandbreite (Quality of Service) beschreibt. Dieser Standard bezieht sich direkt auf den Entwurf IEEE802.9a, in dem auf LANs mit geringer Antwortzeit, wie sie für die Videokommunikation benötigt werden, eingegangen wird.
H.323	ITU-T Empfehlung, die Videotelefon-Systeme und Terminals für LAN ohne garantierte Bandbreite beschreibt. Siehe hierzu das Grundlagendokument der Firma Databeam.
H.324 Spezifikation	ITU-T Empfehlung, die ein Terminal für die Multimedia-Kommunikation bei geringen Bitraten beschreibt. Diese beinhalten verschiedene Empfehlungen wie einen Video-CODEC für „low-speed"-Verbindungen über V.34 an analoge Telefonleitungen, sowie ATM, ISDN mobilen Anbindungen. Kompatibilität mit H.320, Netzwerk-Codeumsetzung, Multipoint-Unterstützung und Continuous presence werden zur Verfügung gestellt.

3) Kodierungs-Standards

HDTV	High-Definition TeleVision. Fernsehstandards, die über ein Darstellungsverhältnis von etwa 2:1 verfügen, und qualitativ besser als PAL oder NTSC sind.
Huffman Kodierung	Eine verlustfreie Kodiertechnik, die den Informationsgehalt eines Bildes statistisch ermittelt. Die Huffman-Kodierung wird im H.320 und anderen Videokommunikations-CODECs, sowie im Gruppe-3 Fax und im JPEG-Format verwendet.

4.) T.12x-Standards

T.120 Spezifikation	Eine generelle ITU-T Übersichts-Empfehlung, die die Übertragungsprotokolle für Multimediadaten beschreibt. Sie beinhaltet Mehrschichts-Protokolle, die die Multimedia-, MCU- und CODEC-Kontrollfähigkeiten beträchtlich steigern. Damit wird ein hochentwickelter MCU-Betrieb weit über dem in den Standards H.231 und H.243 beschriebenem ermöglicht.
T.121	ITUT-T Empfehlung, die eine generische Vorlage für Anwendungen beschreibt.
T.122	ITUT-T Empfehlung, die Multipoint- Kommunikationsdienste (MCS) für audiografische und audiovisuelle Konferenzen beschreibt.
T.123	ITUT-T Empfehlung, die die Protokoll-Stacks für audiografische und audiovisuelle Telekonferenz-Applikationen beschreibt. In der Definitionsphase.
T.124	ITUT-T Empfehlung, für eine generische Konferenz-Kontrolle für audiografische und audiovisuelle Terminals.
T.125	ITUT-T Empfehlung, die die Spezifikationen des Multipoint- Konferenzdienstes beschreibt.
T.126	ITUT-T Empfehlung, die die Protokoll-Spezifikationen für Standbildkonferenzen beschreibt.
T.127	ITUT-T Empfehlung, die die Protokoll-Spezifikationen für Multipoint-Datenübertragung von Binärdateien beschreibt.
T.128	ITUT-T Empfehlung für die Kontrolle audiovisueller Multipoint-Multimediasysteme.

4.) Was brauche ich für Videoconferencing?

Videoconferencing kann eine kostenintensive Angelegenheit sein, es geht aber preiswert. Es kann z.B. eine Webcam 3 von Creative an den USB-Port angeschlossen werden und überträgt von dort bereits fertig aufbereitete Bilder. Eine Grabberkarte zur Videodigitalisierung kann somit entfallen. Erkauft wird das einfache Handling und die einfache Montage mit erhöhter Prozessorbelastung.

Will man nicht nur sprechen und sehen, sondern auch Dokument austauschen oder Programme gemeinsam bedienen, sollte eine Lösung mit eigenen Hardware-CODEC eingesetzt werden. So bietet die Winnov Videum Karte bereits eine Anschlussmöglichkeit für bis zu drei Kameras.

Es wäre auch möglich, eine spezielle Dokumentenkamera anzuschließen, die zur besseren Positionierung auf einem Schwanenhals ruhen sollte damit sie eine höhere Standbildauflösung zulässt.

Mit einer Videoschnittkarte und einem Camcorder kann man direkt – auch unter Windows 95/98 – unkompliziert ins Videoconferencing einsteigen.

Optimal wäre ein Pentium-Rechner mit moderner CPU und mit einer speziellen Konferenzkarte, die Video- und Audiokomprimierung hardwareseitig erledigt. Bei diesem System haben wir Zusatzfeatures wie einstellbarer Teilbildausschnitt oder Parallaxenausgleich. Dieser wird um so wichtiger, je größer der Monitor ist.

Je größer der Monitor, desto stärker befindet sich die Kamera außerhalb der Blickrichtung. Auf der Gegenseite entsteht so ungewollt der Eindruck, als ob man am Gegenüber vorbeisehe, was sich unbewusst negativ auf die Gesprächsatmosphäre auswirken könnte.

RADIO

'Remote Action in Distributed Learning Environments' (RADIO)

Liebe Schülerinnen und Schüler!

Im folgenden möchte ich gerne etwas über Ihre Erfahrungen mit Teleservice erfahren.
Beantworten sie bitte die folgenden Fragen:

K.-H. Bramsiepe

A) Für wie wichtig halten Sie das Thema Teleservice (hier synonym gebraucht für die beiden Bereiche Fernwartung/Ferndiagnose) für <u>Ihre</u> berufliche Praxis?

B) Für wie wichtig halten Sie dieses Thema für den IT-Bereich überhaupt?

A) Nennen Sie Beispiele für Fernwartung/Ferndiagnose aus Ihrer eigenen beruflichen Praxis?

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B) Erläutern Sie den Aufbau und die Arbeitsweise des von Ihnen benutzten Fernwartung/Ferndiagnose-Systems?

Gehen Sie vor allem auf folgende Punkte ein.
- Wie erfolgt der Zugang ?
– Wie erfolgt der Zugriff auf die Daten ?
– Wie erfolgt eine Änderung der Daten ?

<u>Skizze:</u>

A) Wo liegen die Vorteile solch eines Wartungs- und Diagnosesystems?

B) Wo liegen Ihrer Ansicht nach die Grenzen solch eines Wartungs- und Diagnosesystems ?

Unter welchen Voraussetzungen würde sich Teleservice stärker in den Betrieben und an den Arbeitsplätzen durchsetzen?

Wesentliche Grundbegriffe

WEBCAM:	Kamera , die es ermöglicht broadcast live videos über das Web zu senden.
Novell NetWare:	Netzwerk-Betriebssystem der Firma Novell (Vers.: 5.x)
MS Windows NT Server:	Netzwerk-Betriebssystem der Firma Microsoft (Vers.:2000)
LINUX:	Netzwerk-Betriebssystem
File Server:	Netzwerkrechner, auf dem das Netzwerkbetriebssystem abläuft und der seine Ressourcen Festplatte, Netzwerkdrucker etc. allen Netzwerkrechnern zur Verfügung stellt. Datenbestände können gemeinsam bearbeitet, Programme zentral auf ihm abgelegt und Datensicherungen über den Fileserver für alle Netzwerkrechner durchgeführt werden.
Worktation:	Eine Workstation ist ein PC, der durch den Einsatz einer Netzwerkkarte und einer Software in ein Netz eingebunden wird.
Protokoll:	Mit dieser Vorschrift werden sowohl die Formate der Nachrichten als auch der Datenfluss bei der Datenübertragung festgelegt (IPX/SPX = Transportprotokoll von Novell, TCP/IP = Internet-Protokoll).
UDP:	Das User Datagramm Protocol ist eine stark vereinfachte Variante des TCP. Es erfüllt ähnliche Aufgaben wie das TCP, wird jedoch wegen des

	wesentlich geringeren Protokoll-Overheads in multimedialen Konferenzen für die Übertragung der Audio- und Videostreams eingesetzt.
Internet:	Weltweiter Zusammenschluss von Computer-netzwerken. Jeder Rechner im Internet muss eine IP-Adresse haben: Beispiel 130.31.101.21.
ISDN	Das diensteintegrierende digitale Fernmeldenetz (ISDN) ist ein öffentliches Kommunikationsnetz, das schnelle und zuverlässige Dienste bereitstellt. Mit ISDN können Verbindungen zwischen entfernten Netzwerken aufgebaut werden, mit kurzen Verbindungsaufbauzeiten von durchschnittlich weniger als 2 Sekunden und mit einer Datenübertragungsrate von 64 kBit pro Kanal.
USER	Der User ist der Nutzer im Netzwerk. Grundsätzlich unterscheidet man zwischen dem Administrator und den übrigen Benutzern.
HTML	Hypertext Markup Language (HTML) ist die Standardsprache für das Erstellen von Hypermedia-Dokumenten im World Wide Web.
HTTP:	Hypertext Transmission Protocol (HTTP) ist die Standardsprache, in der World Wide Web-Clients und -Server miteinander kommunizieren.
7-Schichten-Modell:	Das "Reference Model for Open System Interconnection" besteht aus 7 Schichten und wurde 1983 von der Organisation ISO zum internationalen Stqandard erklärt. Das Modell will eine allgemeine Kommunikationsstruktur definieren.
Stream:	Die permanente Aussendung eines Datenstroms für die übertragung von Audio- und videoinformationen wird als Stream bezeichnet.

Technisches Bildungszentrum Mitte
Bremen (D)

Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

Contract No.: D/99/2/07331/PI/II.1.1.a/FPI

TEACHING UNIT 'REMOTE DIAGNOSTIC INTERFEROMETRY'

(Documentation of held course)

Karl-Heinz Bramsiepe

Work Package: **W30 Teaching Unit "Teleservice" – Module 1**
Deliverable: **D32 Documentation of held course**

Date of Delivery: 03 August 2001

Deliverable Type: Restricted

Abstract: This document specifies course design for the teaching sessions to be used in the product evaluation.

Keyword List: Remote Diagnostic, Teaching Unit

Contents

1. Introduction

In this deliverable the findings and experiences from the tele-service courses shall be presented. This deliverable has the focus on the results of the evaluation of the tele-service course in the use of teaching unit REMOTE DIAGNOSTIC INTERFEROMETRY described in deliverable D31. The deliverable also describes the social effects which was a central object of discussion with the students during the evaluation.

2. Evaluation of the questionnaire

At the beginning of the teaching unit several students got a paper with some questions to the topic tele-service. As all he students of the TBZ work within the dual system, which means working in a company for several days and then go to the vocational school (TBZ) for some days. We wanted to know if the students have already have had experiences with tele-service and if which kind of. What did they know about new approaches in telematic research linked to the possibilities offered by tele-observation, remote control, remote installation and remote maintenance of real systems and machines.

The questionnaire was not only given to the students who learn for the vocation "Mechatroniker/in" - mechatronic technician, but also to students who want to become an IT-Systemelektroniker/-in und a Fachinformatiker/-in. Although the subject is absolutely important for the field of mechatronic it was found that other professions are also affected of the teleservice trend

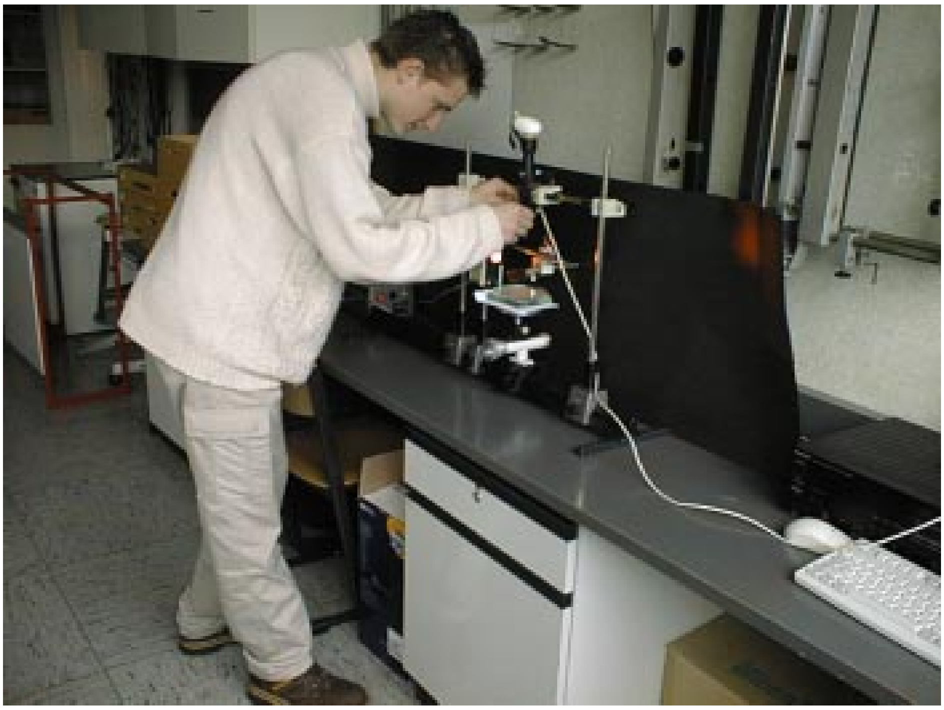
Surprisingly most of the students had knowledge und also some had already worked with remote controlled systems. But of course they could tell about several applications of tele-service-uses, like remote maintenance of copiers, of EDV-systems or systems for telecommunications or

remote diagnostic systems for machines etc. The distance access to PCs seems to be quite normal. If a PC provide remote diagnosis facilities it requires only connection to the telephone system/LAN for implementation. If photocopier system provide remote diagnosis facilities it is the same.
One result is that the subject of our project becomes importance for several and different professions.
But we found a gap between the chances that are offered by technical systems and the use in reality because the students know more than they have done on work.
What is the reason for this gap? It seemed that there are barriers and perhaps a social resistance against this remote systems. Perhaps there is not enough knowledge about the use and usefulness. And It is to be expected that the rapid increase in mobile communications means that the process to tele-service will go faster.

3. Evaluation of Resources

3.1 Tele-service requirements

Tele-service-systems can be simple or more advanced. There are lot of facets. In an advanced system the telecommunication devices are TCP/IP based networks and the hardware provides a web-based interface.
In considering the development of a basic course for tele-service it was necessary to consider the types of tools required by companies. In the last years more and more systems use remote access. This means that there first must be connection point to point or multipoint and that one of the necessary skill for the user is to be familiar with the hardware for data- and videoconferencing.



By doing the measurements the students got an idea of the basics of a teleservice-system. They have much more ideas what the necessary components are.

3.2 Experiences with NetMeeting

When we did our connections to Stockport college we saw the limitation of the system existing out of the Logitech webcam and MS-NetMeeting. Although the Internet has had significant influence on this project, it has to be recognized that the capabilities of the Internet will have an impact on the success of tele-service applications.

Referring to the 4 tries of Stockport College with different connection types between a remote computer and a controlled remote machine it was found that a general dial-up Internet access does not provide a suitable medium. In our case it is to say that the quality of the audio- and video-transmission was not good enough for people who expect a lot. There was a significant delay between the screen picture and the speech. Also the movements were It could be seen that bandwidth, delay and delay variation requirements are not at a premium in the wide area. But in our technical environment it was not possible to get guaranteed bandwidth for use. Quality of Services (QoS) requires special technical requirements like the CISCO IOS software provides.

Better results we got with the system of the company Vicon. But of course MS-NetMeeting is free because it is existing on a modern PC with an operating system of Microsoft. The vicon-system costs nearly 1.000 Euros. The advantage of the vicon-system is that die picture of the camera do not shake so much.

There was a big barrier getting connection to Stockport College for the first time. The system did not work as long as we used the private IP-addresses. When we took the public IP-address we got connection via Server of the University of Bremen to Stockport.

3.3 Course evaluation

The main focus of the evaluation were the social effects on the activities of skilled workers. The students have to face tremendous effects on the employment. Many facilities could be centralized. Manuel work will be replaced through computer-based work.

The general feedback on the course was quite good. The thematic was see as very important. Disadvantageous was that only 2 systems were available at the moment.

Further detailed evaluation of this course is required. To facilitate this the teaching unit is to incorporated into the lessons at the TBZ Mitte in Bremen.

Appendix:

'Remote Action in Distributed Learning Environments' (RADIO)

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STOCKPORT college

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Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

Contract No.: D/99/2/07331/PI/II.1.1.a/FPI

TEACHING UNIT 'USE OF TELESERVICE IN EMBEDDED SYSTEMS'

Ian Hadfield

Work Package: **W40 Teaching Unit "Teleservice" – Module 2**
Deliverable: **D41 Course Concept**

Date of Delivery: 31. March 2001

Deliverable Type: Restricted

Abstract: This document specifies course design for the teaching sessions to be used in the product evaluation.

Keyword List: Learning Environment, Learning Scenarios, Teaching Units

Contents

1 Introduction

1.1 Background

The *aim* of the RADIO project is to develop, test and evaluate concepts for the deployment of remote action in distributed learning environments. In this context the possibility of sharing facilities in laboratories, teaching rooms and workshops of vocational schools at different locations by means of remote action systems will be investigated.

The central idea of the project is to offer the possibility of calling locally distributed learning systems via data networks. New approaches in telematic research linked to the possibilities offered by tele-observation, remote control, remote installation and remote maintenance of real systems and machines will be taken into consideration. In this way students will be in a position to carry out practical exercises, experiments and learning tasks at machines and systems which are not available "on-the-spot". The concept is to be exemplified by problems in the learning field of teleservice in *mechatronics*.

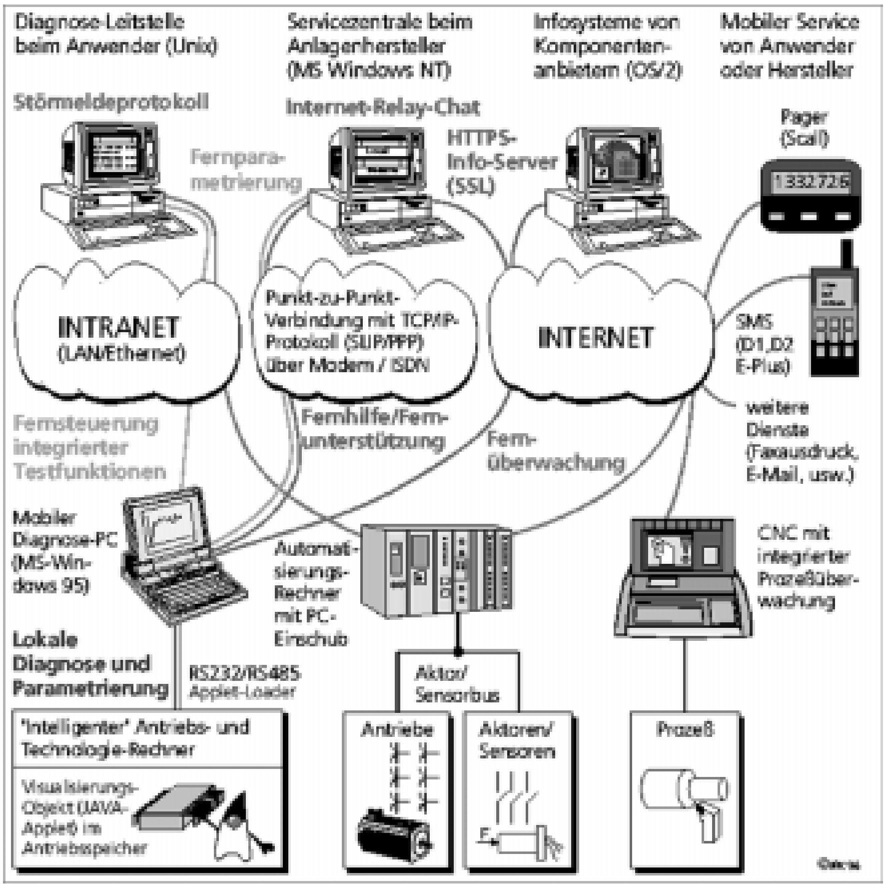


figure 1: Telesevice system (see IPK 1998)

Changes in the concept of work are based on increased group work, use of distributed autonomous production centers and complexity of mechatronic (electrical, mechanical, and informatical) products and manufacturing methods. These require new technical and social-communicative qualifications for skilled workers and engineers.

Fig. 1 shows a system for the diagnosis of machines which is based on the internet. It is used for the operation and visualisation at production systems.

Vocational training institutions often suffer from not being able to keep up with the speed of development of sophisticated equipment in mechatronics. Correspondingly the qualifications of teachers also fall behind. There is a strong need for co-operation between schools, research institutes and technology suppliers. This is especially true for areas of rapidly changing local industrial infrastructures. To bring diverse competencies and resources together, it is highly desirable to use telecommunication, Virtual Reality and Simulation to connect them.

The co-operation of colleges and vocational schools at different learning locations plays an ever increasing role. Co-operation between colleges and vocational schools in distributed learning locations, 'distributed learning environments' or 'educational partnerships' are the basis of various efforts. This is especially true in the field of dual vocational training systems where the quality of vocational training has improved substantially. The development of co-operations between companies and vocational schools will increase companies' willingness to train young people and at the same time improve the modernisation and innovation transfer between companies and vocational schools.

Up to now the different approaches to co-operation have been aimed at organisational co-ordination between distributed learning locations, development of vocational education plans and learning systems suitable for several learning locations as well as at the qualification of teachers and moderators. The discussion now focuses on the question of whether the effectiveness of the co-operation between learning locations might essentially be improved. Specifically, if it is possible to make distributed learning systems, learning media or other resources available via data networks included in virtual distributed learning environments. Above all, the deployment and utilisation of telemedial learning environments will be taken into consideration because they enable students to carry out practical exercises, experiments and learning tasks at machines and systems which are actually available at a different learning locations and not on the spot.

Vocational schools are constantly looking for new ways of delivering the curriculum to local industry in a way that increases participation and removes barriers to education. The systems proposed in this project will help to reduce these barriers and form part of the future requirements of vocational schools and organisations.

1.2 Scope of the study

This deliverable describes an introductory course in teleservice based around the use of embedded microcontrollers in the control and monitoring of mechatronic systems.

The course is designed to introduce students to working in the area of remote diagnosis and maintenance and is expected to take approximately 6 hours to complete. It demonstrates the need for engineers working remotely to consider the types of tools required and the areas of difficulty working remotely can pose.

The course also demonstrates the need to collaborate with local operators where hands on effects are required. In this area the course seeks to explore the types of communication tools required for effective remote diagnosis.

The course is based around a scenario of temperature monitoring and control. This is typical of a real mechatronic application and involves the control of heaters and cooling devices. The scenario uses a microprocessor system based on a 68020 single board computer. This level of equipment is not normally found in vocational schools where 8 bit microprocessor based systems are normally used and this gives students the opportunity to benefit from higher levels of technology.

In using the Internet as the network medium, the choice of communication and collaboration tools is of great importance. A number of tools were evaluated and this evaluation is described in the deliverable D42. Based on performance and cost the use of the integrated collaboration tool Net-Meeting was selected for use with this course. This is particularly important for schools where the use of tools integrated into popular operating systems means that they are freely available.

In support of the ideals of life long learning and the need for people to continually update their skills, it was decided that the course should be delivered in an online format. Thus allowing students to use the learning material from remote locations. It should be noted that although this course is developed for online delivery it is not intended to make use of the plethora of techniques available for this type of delivery. Of much more importance is the interaction between the student and the online hardware and software.

Using the Internet as the network medium also adds the dimension of Internet limitations. It is recognised that vocational schools have access to moderately fast Internet links. However, small and medium enterprise companies (SMEs) are not always so fortunate. Thus in testing the delivery of the material account has been taken of the type of Internet connection available to course participants. These have ranged from dialup modem access (56Kbps), to cable modem (512Kbps) and high speed (>2MBps).

The following sections present the course material in a written form. The course material is also available on line at http://radio.stockport.ac.uk/radio.

2 Course Concept

2.1 Unit Description

This teaching unit allows students to explore the use of communication tools used in teleservice applications. The unit is based around the use of microprocessor based systems in embedded applications. The unit has a very practical focus and is intended to help students get a hands on feel to teleservice using communication tools. The aims and objectives of the unit are detailed below.

The unit is based around a microprocessor controlled temperature control application. The application is typical of those found in manufacturing industries and is concerned with maintaining the temperature of a process at a set point, whilst displaying in real time the actual and set point temperatures. Students studying the unit will be expected to maintain the system, by changing the temperature set point, monitoring the operation of the system and upgrading the software of the system.

The initial part of the course will look at the use of communication tools such as net-meeting and similar types of application. They will learn about communication, describing problems and application sharing. This knowledge will then be applied to a concrete problem with the application described above.

2.2 Aims

- The aim of the unit is to allow students to gain an appreciate of the tools and infrastructure required for teleservice.

2.3 Objectives

At the end of the course students will be able to

- Use application sharing to monitor and control remote systems.
- Perform simple maintenance functions on remote hardware.
- Make modifications to software in remote systems.
- Use collaborative tools to consult with experts in the solution to problems.

2.4 Pre-requisite Knowledge

The students will need to be familiar with embedded systems and an associated development environment. The use of high-level languages particularly 'C' in control applications will be useful.

2.5 Time

The estimated time to complete this unit is 6 hours.

2.6 Evaluation Aims

Evaluation of the lessons will be centered on the effectiveness of the tools used for teleservice. These will be extracted by questionnaires and comments from students, teachers and remote experts. The learning outcomes will be considered achieved if the students are able to complete the tasks associated with the unit.

2.7 Material

The teaching material can be found in the following sections.

3 Teaching Material

3.1 Overview

This unit is concerned with the servicing of microprocessor based equipment. In this scenario a microprocessor based system is controlling an industrial processes. The process is concerned with temperature control and monitoring. The computer samples the temperature of a system at regular intervals. A required temperature entered by the user is used to develop control signals for a heater and fan. The heater and fan are used to maintain the temperature at the required value. This application is typical of embedded controllers in industrial process control and the complexity of modern systems mean that servicing by onsite personnel is often restricted to the main software configurable options and simple hardware faults. To facilitate the application the module uses a 680X0 based microprocessor based system with a demonstration application board. These systems are available from **flite** electronics (http://www.flite.co.uk).

3.2 Sessions

Session 1	Introduction - Access and Monitoring
Session 2	Maintenance Functions
Session 3	Making Modifications to Remote Systems
Session 4	Consulting Remote Operators

4 Session 1 - Introduction

4.1 Objectives

At the end of the session you will be able to

- Describe the structure of the temperature control application.
- Access remote systems using desktop sharing
- Monitor the operation of remote hardware.

4.2 Tasks

To complete this session you need to complete the tasks listed below

Task 1	Overview of Temperature Control
Task 2	Accessing Remote Systems
Task 3	Monitoring Remote Hardware

Once complete you can proceed to Session 2

4.3 Task 1 - Overview of Temperature Control

In this task you will explore the system hardware used for the temperature control and gain an appreciation of the application being used for the example of tele-service. The task considers the hardware of the system and the details of the temperature control interface to the micro-controller.

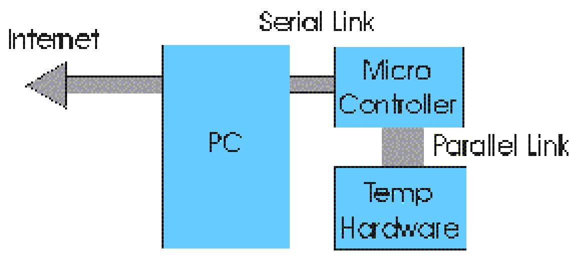
4.3.1 Overview of Hardware

The block diagram below shows the configuration of the hardware system used in the temperature control system.

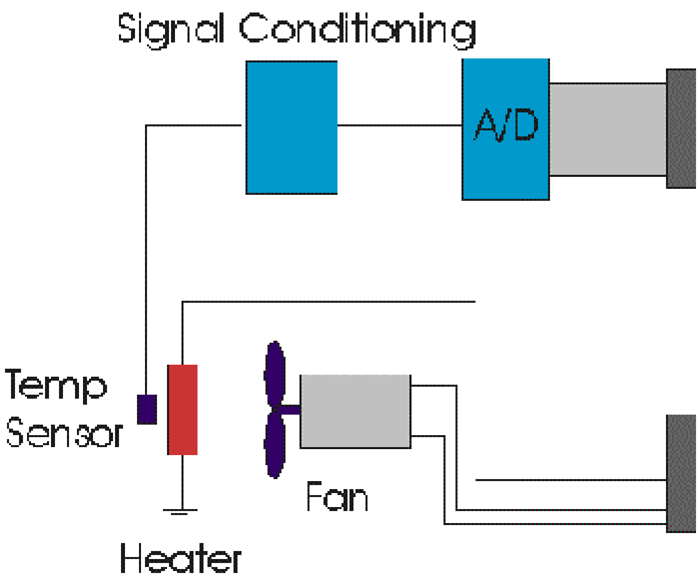
A Personal Computer with Internet connection is linked to a micro-controller via a RS232 serial data link. This link allows users to monitor the operation of the micro-controller and also make changes to the program etc.

The micro-controller used for this project is a 68020 based system from flite electronics.

Connected to the micro-controller is a parallel interface linked to the hardware of the temperature control system. The parallel interface allows the micro-controller to monitor the temperature and control a heating element and cooling fan.



The following diagram shows the arrangement of the temperature controller hardware. The temperature sensor is internally compensated and produces an output of 20 mV per C. This is then sampled by the analogue to digital converter with a resolution of 10mV per step. Thus the resulting digital output presented to the microcontroller is 2 times the measured temperature. This gives a measurement accuracy of 0.5oC.The heater and fan are connected to the second parallel port. The interface electronics between the port and heater are not shown in the diagram. To turn the motor a logic 1 is required on bit 7 and a logic 0 on bit 6 of the port. To re-verse the motor the bits are swapped. The heater is connected to bit 5. A logic 1 on bit 5 turns the heater on a logic 0 turns the heater off.



4.3.2 Self Test Questions

1) If the temperature of the heater is 20^{o}C use the information above to calculate the voltage presented to the analogue to digital converter.

2) If the voltage at the input to the analogue to digital converter is 0.5V calculate the value digital output produced by the A/D converter.

3) With a temperature of 15^{o}C, find the value presented to the micro-controller at the output of the A/D converter.

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4.4 Task 2 - Accessing Remote Systems

4.4.1 Getting Authorisation

This part of the session involves the real connection to a remote system . Before you can access the remote system you need to obtain a username and password from the system administrator. Please complete the form below and press the send button. A username and password will be returned to you by email.

Surname	
First Name	
Institution Name	
Email address	

[Übermitteln] [Zurücksetzen]

4.4.2 Logging On

Having received authorisation follow the the steps below

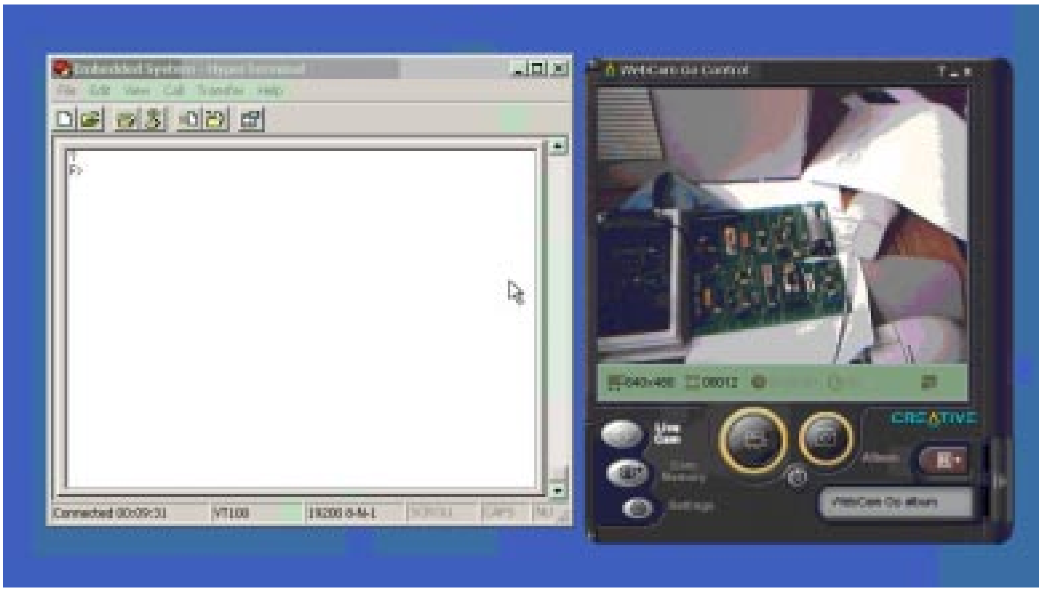
- launch NetMeeting and connect to the radio server (radio.stockport.ac.uk).
  (Ensure that you select secure call otherwise the request to connect will be rejected.)
- Enter the username and password at the prompt to connect to the server.
- When presented with the desktop of the remote machine log on using the username and password
- A camera and terminal window will open automatically.

Proceed to task 3

4.5 Task 3

4.5.1 Monitoring the temperature

The desktop of the remote machine has two windows a terminal window connected to the remote micro-controller and a web-camera showing the actual hardware. The view should be similar to that below.



4.5.2 Starting the monitor software

- Select the terminal window and press enter a few times. You should see the prompt F>
  (If you have problems at this point contact the tutor by email)
- At the prompt type GO 400600
- The software should now start.

4.5.3 Monitoring the Temperature

- Initially enter the set point at 20^{o}C.
- Observe the output on the terminal screen as the software uses the heater and fan to maintain the temperature.
- In the web-camera view you may see the fan turning and the heater LED light showing the heater is active

4.5.4 Logging Off

- Log of the PC in the usual way by pressing the start button
- Close the Net-Meeting session

Congratulations you have completed the first session

5 Session 2 - Maintenance Functions

5.1 Objectives

At the end of the session you will be able to

- Download software to remote hardware
- Use software to test the remote hardware
- Use video-observations to test remote hardware

5.2 Tasks

To complete this session you need to complete the tasks listed below

Task 1	Download Software to remote hardware
Task 2	Use software to test remote hardware
Task 3	Use video-observations to test remote hardware

Once complete you can proceed to Session 3

5.3 Task 1

5.3.1 Download Software to Remote Hardware

In this task you will connect to the remote system and download a test program that can be used to test the temperature control hardware. The test program, exercises all parts of the system, by turning on the heater and waiting until the temperature has reached 40^{o}C. The fan is then turned on and the temperature cooled down to 20^{o}C.

5.3.2 Connect to Remote System

In this part of the task we will use the same system to connect to the remote system as that used in Session1. You may need to go back and check on the procedure to make the connection.

Once you are connected login using the username and password provided by the system administrator.

5.3.3 Download Software

- Select the terminal window and press enter until the F> prompt appears.
- At the prompt type LT<CR>
- Select the transfer menu and send text file.
- Send the text file hrdwrtst.txt located in the directory c:\radio\software
- It may appear that nothing is happening but it takes about 2 minutes for the software to download!!

When you see the message DOWNLOAD complete you can move on to the next task

5.4 Task 2

5.4.1 Use software to test remote hardware

The program you downloaded in task 1 is designed to test the hardware of the temperature control system. The software should first turn on the heater and heat the system to 40^{o}C and then turn the fan on and cool the system down to 20^{o}C.

5.4.2 Starting the software

- To start the software make sure that the terminal window is showing the F> prompt.
- Type GO 400600 at the prompt
- The program should start

5.4.3 Testing the hardware

- Observe the output on the terminal window to see if the temperature rises and falls as expected in the program.
- This should take approximately 5 minutes.

5.4.4 Some things to think about

- What would have happened if the test had failed at the heating stage?
- How could you ensure that you keep control of the hardware?
- Write down the sequence in which the hardware should have been tested and email it to the tutor.

When you have sent the email and received a reply move on to task 3

5.5 Task 3

5.5.1 Use Video Observations to Test Hardware

This task is very similar to that of Task 2. Except that in addition to running the test program and observing the results at the output, you will also use a remote video camera to observe the operation of the hardware.

- Make sure that the video camera output is visible on the desktop.
  This program should automatically start when you log if not then start it from the link on the desktop.
- Run the test program as in the previous task
- Observe the output of the video camera. You should see a number of LEDs lighting
- One LED near the fan indicates that the Heater is on.
- The blades of the fan are painted to make observations easier.

5.5.2 Questions

- If the hardware was inoperable. You would need to communicate with an operator to find the faults. Which types of tools do you thinkn you would need to use?

6 Session 3 - Modify remote systems

6.1 Objectives

At the end of the session you will be able to

- Upload software to remote systems
- Install software on remote systems
- Test software on remote systems

6.2 Tasks

To complete this session you need to complete the tasks listed below

Task 1	Upload Software to remote systems
Task 2	Install software on remote hardware
Task 3	Test Software on remote hardware

Once complete you can proceed to Session 4

6.3 Task 1

6.3.1 Upload Software to Remote Systems

The object of this session is to upload a new version of the temperature monitoring software to the remote hardware. To do this you first need to transfer the software to the remote PC and then install the software. This task is concerned with transferring the new version of the software to the remote PC.

6.3.2 Getting the new Version

In the old version of the software you will have noticed that the system does not echo characters typed at the keyboard. This is a fault in version 2 of the software and the new version (3) corrects this and other minor faults. Since this is a major fault it is necessary to upgrade the software of the remote system.

You need to obtain the latest version of the temperature control software by right mouse clicking on the link below and selecting save target as from the pop up menu.

- temperature control software version 3 : tmpctrl3

Save this file somewhere on your hard disk drive.

6.3.3 Uploading the new version to the remote system

- As before connect to the remote system and login using the username and password supplied.
- On your own PC switch to Net-Meeting and select the send file button.
- Add the file tmpctrl3.txt to the files to be transmitted and send the file.
- On the remote system you will see the file being received. Close the box when this is complete
- On the desktop of the remote system is a link to the files received folder. Open this folder.
- Move the tmpctrl3.txt file to the directory c:\radio\software

6.3.4 If you made it this far well done

Now move on to <u>task 2</u>

6.4 Task 2

6.4.1 Install Software on remote systems

Installing the new software is the same procedure as used in the previous sessions.

- Select the terminal window and press enter until the F> prompt appears.
- At the prompt type LT<CR>
- Select the transfer menu and send text file.
- Send the text file tmpcrtl3.txt located in the directory c:\radio\software

When you see the message DOWNLOAD complete you can move on to the next task

6.5 Task 3

6.5.1 Test Software on Remote Systems

To test the new version of the software you need to run the program and observe the results. This is the same procedure as the previous sessions.

- To start the software make sure that the terminal window is showing the F> prompt.
- Type GO 400600 at the prompt
- The program should start
- Enter the set point values as before and monitor the system operation
- Change the temperature to different values to ensure that the software operates correctly.

This session is now complete.

7 Session 4 - Use Remote Operators

7.1 Objectives

At the end of the session you will be able to

- Use communication tools to consult with remote operators.
- Find faults in remote systems

7.2 Tasks

To complete this session you need to complete the tasks listed below

Task 1	Arrange online meeting with remote operators
Task 2	Communicate online
Task 3	Find faults in remote systems

Once you have completed this session please complete the evaluation questionnaire

7.3 Task 1

7.3.1 Use Net-Meeting to communicate with remote operators

The object of this task is to use Net-Meeting to communicate with real people rather than interact with a remote system. In session 2 you looked at the possibility that the hardware was not operational. In this context you need to have an operator in the vicinity of the hardware to check items and correct physical faults in the system.

7.3.2 Making Contact

Use the form below to set up a meeting time with the remote operator. They are usually available the same day.

Name

Email

Date of Meeting

Time of Meeting (Specify Time Zone)

Übermitteln Zurücksetzen

7.3.3 If you made it this far well done

Now move on to task 2

7.4 Task 2

7.4.1 Communicate with remote operators

In this ask you will use Net-Meeting to communicate with process operators close to the hardware of the temperature control system.

- Launch Net-Meeting on your PC.
- Select the address book button and search the directory www.brevie.uni-bremen.de
- The operator you are searching for is called radio operator
- Select the operator and hit the call button.
- If the operator is present they will answer you call.

7.4.2 Using Net-Meeting

Experiment with the communication tools be sure to use

- chat
- voice

When you feel confident using the tools go on to <u>task 3</u>

7.5 Task 3

7.5.1 Finding Faults in remote systems

There are three basic faults on the temperature control system it is your job to find the faults with the help of the remote operator. The operator will give you some help but they have very limited technical knowledge.

Good Luck

All Tasks Complete - Well Done

Please help us by completing the evaluation questionnaire

8 Summary

This document describes a teaching module on an introduction to teleservice. The document looks at the aims of the RADIO project and further develops these into a practical application of teleservice.

The implementation is based on a typical mechatronic control scenario of temperature control and monitoring. Internet based tools are used by the students to monitor and control the system, perform routine maintenance, upgrade software and collaborate with remote experts in fault finding.

The course helps students to explore the types of tools required in teleservice and the evaluation of the teaching will help to further explore the types of collaboration tool required to solve technical problems remotely.

Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

Contract No.: D/99/2/07331/PI/II.1.1.a/FPI

TEACHING UNIT 'USE OF TELESERVICE IN EMBEDDED SYSTEMS'

Ian Hadfield

Work Package:	**W40 Teaching Unit "Teleservice" – Module 2**
Deliverable:	**D42 Documentation of held course**
Date of Delivery:	07 August 2001
Deliverable Type:	Restricted

Abstract:	This document describes the teaching experiences of teleservice courses in embedded microcontroller systems.

Keyword List:	Learning Environment, Learning Scenarios, Teaching Units

Contents

1 Introduction

1.1 Scope

The purpose of this deliverable is to present the findings from tele-service courses delivered during the RADIO project. The deliverable also reports on the selection of tools used for the courses. This deliverable concentrates on the results of the evaluation of the tele-service course in the use of embedded systems described in deliverable D21. The deliverable also describes the software produced by students for use in the project.

1.2 Structure

The document is structured into three main sections.

Section 2 describes the evaluation of tools to be used in the tele-service course and the final selection of the tools used for the course delivery.

Section 3 gives a brief description of the course to place the evaluation into context.

Section 4 presents the results of the work done during the delivery of the tele-service course. It presents the software produced by the students, the application of faults in the final section of the tele-service course and a review of the course and its effectiveness.

Section 5 presents a summary of the conclusions and main findings of the work.

2 Evaluation of Resources

2.1 Tele-Service requirements

Tele-service operation has a number of facets. In simple scenarios, hardware equipment is connected to tele-communication devices and is interrogated remotely to determine parameter control, and hardware state.

In more advanced systems, the tele-communication devices are TCP/IP based networks and the hardware provides a web-based interface that can be interrogated by any standard web browser (Hewlett Packard Printers for example). In both these scenarios, the remote user has access only to certain parameters within the hardware and not full control of the system.

It is also apparent from the study presented in deliverable D21, that much of this technology remains used by industry. For example most photocopier systems provide remote diagnosis facilities and require only connection to the telephone system, for implementation. However when questioned service engineers in this industry indicated that this feature was mostly unused. Some of this was due to infrastructure requirements and it may be that the rapid increase in mobile communications means that these infrastructure requirements will be overtaken by built-in telephony capability.

In considering the development of a course in tele-service it was necessary to consider the types of application and the types of tools required by industry. The field of Mechatronics is concerned with the automation of manufacturing systems and is an area of growth within the manufacturing industry. For a number of years there has been a trend for manufacturing companies to require technicians with electrical and mechanical skills.

This requirement has developed in the last five years to include skills more specific to the automation of manufacturing; These include the use of Programmable Logic Controllers (PLCs), electronic sensors and electrical and pneumatic actuators. In Germany a new vocation of Mechatronic technician has been developed and in the United Kingdom new curricula at National and Higher National level have been developed in Mechatronics and Plant and Process Maintenance.

A picture of a training system designed to fulfil the requirements of this type of vocation is shown in **Figure 1**.

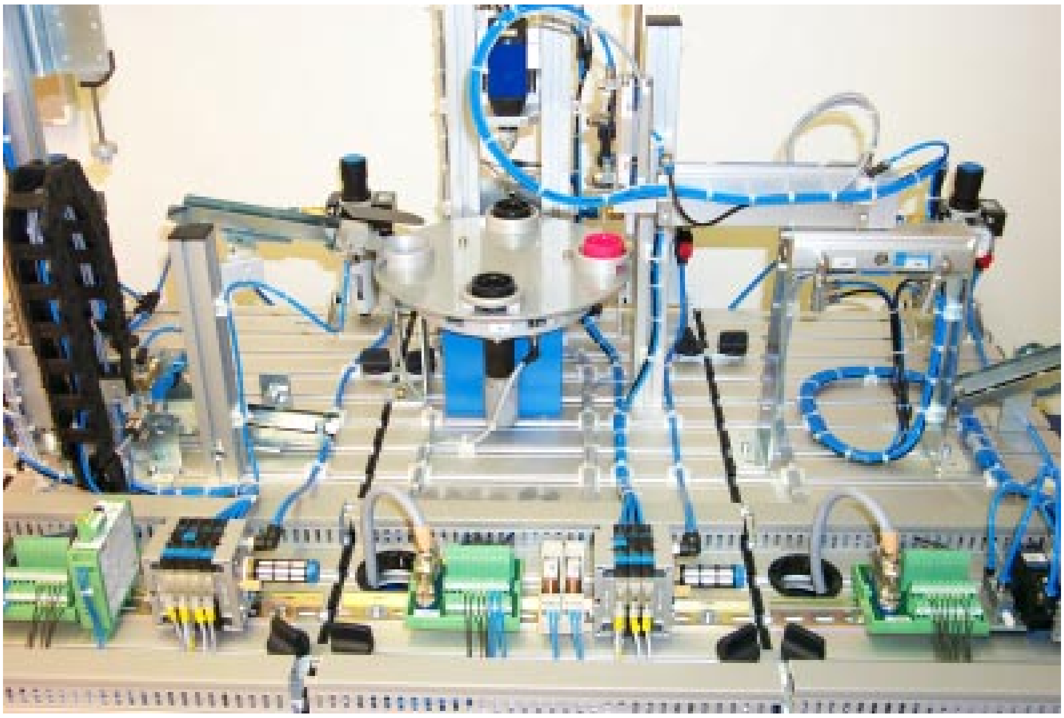


Figure 1 Modular Production System from FESTO Didiactic

In this type of system controlled by a PLC or embedded controller, remote diagnosis using the methods described above only cover the software aspects of the system. It is also more than likely that the types of fault that will occur this system are sensor or actuator orientated.

Within any manufacturing environment, it is recognised that whilst a degree of automation is required, it is also necessary for machine operators to be available close to the machines. The main function of these process operators is to ensure the smooth running of the machinery and to clear feed and simple faults. In some companies (eg Philips Semiconductors; Hazel Grove Stockport) operators are trained to fix commonly occurring faults on machines without the need to request assistance from the technician support staff.

In addition to the use of PLCs in automation technology is the use of embedded controllers. Similar in format to PLCs, these controllers are often used in more dedicate environments or where more complex forms of control are required. An example of a training system for this type of system is shown in **Figure 2.**

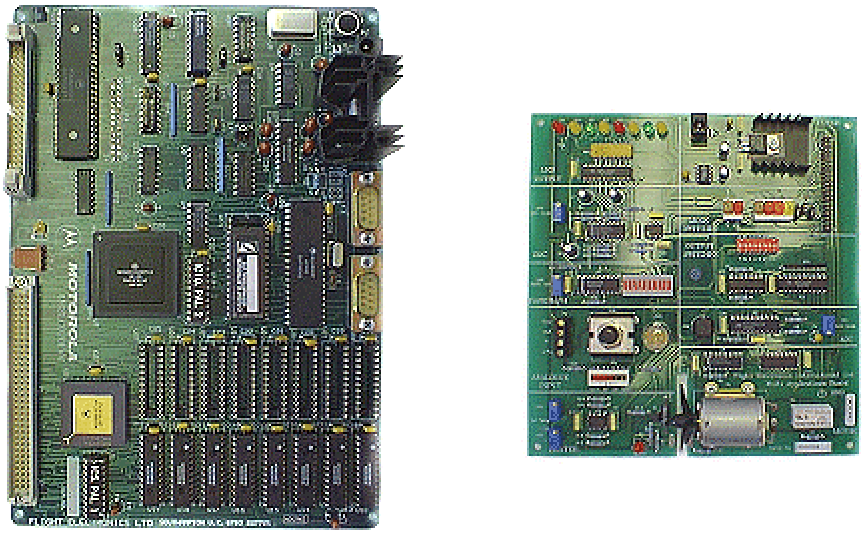


Figure 2 68020 based embedded controller training system

The embedded controller training system allows students to perform experiments in analogue measurement, switch sensing, control of temperature and control of motor speed using pulse width modulation.

Unlike PLC based system, software for embedded controllers is more likely to be written in a high level language like C. This offers greater advantages for remote control and software maintenance systems and consequently the embedded system has been selected as the hardware model for the tele-service applications.

The scenario used for the tele-service course in embedded systems is concerned with the temperature sensing and control using heating and cooling elements. This scenario is described in section 3. The full details of the course are described in deliverable D41.

2.2 Communication and Collaboration Tools

In the development of a training course in tele-service it was decided to extend the use of operators and combine the use of remote experts and remote monitoring of system variables. To achieve this combination a range of communication and collaboration tools are required.

At the time of development of the course the types of tools required for tele-service in this mode were not clear. However it was considered that the types of actions required by the experts and operators are as follows.

- Communicate using voice.
- Communicate using text chat
- Communicate by drawing diagrams
- Take remote control of software systems
- Make upgrades to software systems remotely
- Use video to observe hardware operation.

Deliverable D23 presents a review of tools available for use in tele-service and tele-learning systems. Within this study are identified a number of tools that provide synchronous communication.

Synchronous Voice and Chat

Name	***Platform***	***URL***
Internet Phone	Unix, Windows95/NT	http://www.vocaltec.com
Netmeeting	Windows95/NT	http://www.microsoft.com
NetscapeCooltalk	Unix, Windows95/NT	http://www.netscape.com/
RealAudio	Unix, Windows95/NT	http://www.realaudio.com

Synchronous Video

Name	***Platform***	***URL***
Audiovision	Unix, Windows95/NT	http://www.smithmicro.com/
Avistar Conference	Unix	http://www.avistar.com/avistar/
CineVideo/Direct	Windows95/NT	http://www.cinecom.com/
Communique!	Unix, Windows95/NT	http://www.insoft.com/
CuSeeMe	Unix, Windows95/NT	http://www.cu-seeme.com

HoneyCom	Windows95/NT	http://www.honeysw.com
ICUII	Windows95/NT	http://www.icuii.com/
InPerson	Windows95/NT	http://www.sgi.com/
SeeQuest	Windows95/NT	http://www.sharkmm.com/
TeamVision	Unix, Windows95/NT	http://www.iclnpbg.co.uk/

In addition to these tools the requirements listed above also require that the remote expert be able to take control of the system. A number of tools are also available for this.

Name	***Platform***	***URL***
Remote Admin	Windows95/NT	http://www.famatech.com/
PC Anywhere	Windows95/NT	http://www.symantec.com/

These tools were tested across local area networks at Stockport College and it was found that Remote Admin 2.0 provided good performance levels with fast screen updates and easy to use interfaces. PC-Anywhere also provided good performance levels and more advanced features with a price tag of $180.00.

During the course of the project the partners tested some of the communication systems. In particular the product Net-Meeting from Microsoft was evaluated. The initial purpose of these trials was to test the possibilities of on-line meetings rather than full face to face.

During these trials it was found that NetMeeting provided many of the features required for the project and also that in version 3.0 NetMeeting also provided facilities for remote desktop control. The performance of this product compares favourably with the Remote Admin product from Famatech. The cost implications of using NetMeeting and also its free availability across potential users of the tele-service course meant that it was selected for use in the project.

NetMeeting provides two modes of operation. It can be used as a communication tool providing the following facilities

- Point to point video and audio
- Text chat
- Shared whiteboard
- File Transfer
- Application sharing

In remote desktop mode users can take control of a remote desktop as though they are sat at the remote computer. This mode uses video grabbing technology and captures the instructions to video cards, passing them to the remote clients. This is the same technology as used by the Remote Admin package and as such NetMeeting provides comparable data rates and video updates.

Since it is the aim of the project to provide access to this type of course in vocational schools where resource implications mean that costs are required to be kept to a minimum. Also the inclusion of NetMeeting as standard in current versions of the Microsoft Windows operating system means that accessibility to the course is greater.

2.3 Internet Capabilities

Although the Internet has had significant influence on this project, it has to be recognised that the capabilities of the Internet will have an impact on the success on both the implementation of tele-service applications and tele-learning.

To assess the impact of the Internet capability on this particular application, remote desktop sharing using NetMeeting was tried with four different connection types. In each case a remote computer connected to the Internet at Stockport College was controlled from a remote machine using different types of Internet connection.

In the first instance, connections were made using local area networks with a desktop connection speed of 100Mbs. Under these circumstances desktop sharing performed extremely well and in most cases, the operation had similar performance to local control of the machine.

The Second test involved high speed Internet connections between Germany and the U.K. Both the University of Bremen and Stockport College have access to high speed internet connections (>2Mbs) and on good days the performance was similar to that of a LAN. On poor days, the performance was reduced, but not significantly.

The Third test involved the use of Cable modems access to the Internet operating at 512Kbs. Under these circumstances the performance of the link was reduced significantly. However, operation of the remote machine was still practical provided that mouse control was more exact.

In the fourth test a dial-up connection operating at a nominal 56Kbs was used. In this test the user was able to connect to the machine and control the operation of the remote machine. However, the screen refresh rate of about 5 frames per second, meant that there was a significant delay between mouse movement and mouse operation. This meant that mouse control whilst still possible was more difficult and required greater concentration by the operator.

The results of these trials indicate that general dial-up Internet access does not provide a suitable medium for this type of application. However, the use of dedicated ISDN or ASDL or Cable modem technology provides sufficient bandwidth for this type of application to be used with some degree of success.

3 Tele-Service Course

This section provides a brief overview of the tele-service course using embedded micro controllers. The course has been developed for web-based delivery to allow as wide a participation as possible. The delivery of the course in this medium means that the learning material can be distributed to students on-line rather than in paper form.

Although the teaching material is presented in web-form (http://radio.stockport.ac.uk/radio), no attempt has been made to exploit the use of multi-media technologies or other forms of rich web based media. This is to concentrate the effort of the learner on the remote access experience and the interaction with the remote tools.

3.1 Unit Description

The teaching unit allows students to explore the use of communication tools used in teleservice applications. The unit is based around the use of microprocessor based systems in embedded applications. The unit has a very practical focus and is intended to help students get a hands on feel to teleservice using communication tools. The aims and objectives of the unit are detailed below.

The unit is based around a microprocessor controlled temperature control application. The application is typical of those found in manufacturing industries and is concerned with maintaining the temperature of a process at a set point, whilst displaying in real time the actual and set point temperatures. Students studying the unit will be expected to maintain the system, by changing the temperature set point, monitoring the operation of the system and upgrading the software of the system.

The initial part of the course will look at the use of communication tools such as net-meeting. They will learn about communication, describing problems and application sharing. This knowledge will then be applied to a concrete problem with the application described above.

3.2 Aims

The aim of the unit is to allow students to gain an appreciate of the tools and infrastructure required for teleservice.

3.3 Objectives

At the end of the course students will be able to

- Use application sharing to monitor and control remote systems.
- Perform simple maintenance functions on remote hardware.
- Make modifications to software in remote systems.

Use collaborative tools to consult with experts in the solution to problems.

3.4 Pre-requisite Knowledge

The students will need to be familiar with embedded systems and an associated development environment. The use of high-level languages particularly 'C' in control applications will be useful.

3.5 Time

The estimated time to complete this unit is 6 hours.

3.6 Evaluation Aims

Evaluation of the lessons will be centered on the effectiveness of the tools used for teleservice. These will be extracted by questionnaires and comments from students, teachers and remote experts. The learning outcomes will be considered achieved if the students are able to complete the tasks associated with the unit.

4 Results and Evaluation

This section describes the results found during the delivery of the tele-service unit. The section looks at the results of software produced by students studying the tele-service module and the experiences of students and teachers in the final fault finding section of the unit. In the final part of the evaluation the tools used by the participants are considered and evaluated.

4.1 Software Production

In order for the tele-service course to be successful, control software is required for the embedded system. Two programmes were required for the course a simple version and a more complex version. This part of the project was given to students studying on Higher National Courses in Electrical Engineering at Stockport College.

4.1.1 Control Software Version 1

Version 1 of the control software has a very basic user interface. The microcontroller system is connected to a PC via an RS232 based serial interface. When connected to a terminal emulation on the PC the microcontroller is able to transmit and receive characters along this link.

Using the serial link the control software is able to present the user with a simple menu to enter a set temperature or control the temperature. By sending characters to the serial port the software is able to display on the terminal the set point and current temperature.

The microcontroller is interfaced to the application hardware through a 60230 parallel interface and timer (PI/T). This device is configured by the software so that one of the parallel ports is connected to the digital to analogue converter thus reading the temperature. The other port is connected to the fan and heater hardware allowing control of the temperature.

The software uses a simple algorithm to control the temperature. If the temperature is below the set point then the heater is turned on; if the temperature is above the set point the heater is turned off and the fan turned on.

The simple nature of the interface means that if the software is stopped the heater or fan may be left in the on position, potentially causing damage to the control circuitry.

Appendix 6.1 shows an example of the software produced by students for this version of the control program.

4.1.2 Control Software Version 2

Unlike the previous version this version of the software presents a much more control like interface. The version uses ASCII control characters to control the terminal emulation allowing more information to be presented to the user and also dividing the display and control tasks.

Although the software still uses polling to test for user input, it does ensure that the temperature is controlled continuously even when input is sought from the user.

Another feature of this version of the software is that the user interface also indicates to the user the state of the fan and or heater. This allows the user to compare the output from video cameras pointing at the hardware with the actions of the software. It also provides feedback as to the state of the application bard hardware.

Appendix 6.2 shows an example of the software produced for this version of the application.

4.1.3 Hardware Test Software

Students were also asked to develop a hardware test program that would exercise the application board. Following some discussion the software shown in Appendix 6.3 was produced.

This software exercises the hardware by initiaally heating the heater to 40^{o}C and then cooling the temperature to 20 ^{o}C. This was deemed by the students to be a suitable test to exercise the hardware however when asked to assess the impact of certain faults the hardware test software was revised.

The main findings in this area concern the effect on the hardware if parts of the system fail. In a temperature control system, this could have serious consequences on the remote hardware and the site in general.

Although these tests took place in the development phases of the project it was felt important that the lessons learned be experienced by all students studying the module. Consequently the original test program is included in the course and students are asked to reflect on potential problems that may occur.

The impact of remote testing on safet is further explored in the fault finding section.

4.2 Fault Finding

At the end of the unit students are asked to find faults remotely in the embedded system. This section of the unit is most demanding for the students and serves to illustrate a number of problems with tele-service. The first of these problems is safety and the second is communicating with remote operators who may not have the same depth of knowledge.

In this section of the course, three faults were applied to the application boards.

- The first fault was the removal of the power supply to the application board.
- The second fault was the decoupling of the micro-controller from the application board.
- The third fault was the simulated failure of the fan.

The three faults were applied simultaneously to the system and the students were expected to work in a methodical manner to find the solutions.

Generally the students found all the faults, taking approximately 45 minutes to complete the task. Although the first two faults would normally be found by visual inspection, these two faults were the most difficult to find.

Students explained that the main reason for this is the poor quality of the video available over the Internet using NetMeeting. The camera used in the project has only a limited resolution and is fixed focus.

Experiments with more sophisticated cameras incorporating zoom and pan functions have since been tried in other projects (DERIVE) with greater success. However visual fault finding of this type remains a challenging area.

Although students had available a range of tools for fault finding, by far the most important were considered to be audio communication and video. When taking on the role of remote expert the students used audio communication to instruct the operator to take certain actions and provide feedback. This was seen to be a crucial part of the experience.

4.3 Course Evaluation

The main focus of the evaluation took two forms an online questionnaire completed by students at the end of the course and observation of students during the course and in the fault-finding sessions.

The questionnaire sought to allow students to comment on their general impression of the course and what they saw as the most important lessons learned from the experience.

Unfortunately, the time scales of the course completion and the academic year mean that the course has been completed by only a small sample of students. This means that quantative data is not available, however even with a small sample a number of general comments and experiences can be recorded.

The general feedback on the course was good. With students finding the course challenging and different to the normal activities within their training.

The most important element of the experience was expressed as the need to think more critically about the failure modes of this type of control software particularly in regards to safety. This is a large area of study and is more properly related to mission critical systems. However it is worth noting that when considering the implementation of remote diagnostic and maintenance systems, more detail in design and testing is required than is normally the case.

Some students experienced technical difficulties with the course and this meant that they had a poor experience. These difficulties were traced to poor network connections causing the link to the remote system to be lost suddenly. This experience shows some of the inherent problems of using the Internet for this type of activity and at the present time it is safer to use dedicated links where bandwidth and connectivity can be assured.

Observations of student's online showed that the communication tool most frequently was audio conferencing. Students felt that this part of the NetMeeting tool was vital to the success of the fault-finding exercise. Video was also seen as an important part of the processes and being able to see the operation of the various components in the system was desired by most of the students.

Further detailed evaluation of this course is required. To facilitate this the teaching unit is to be incorporated into one of the standard units at Stockport College. The unit Microprocessor Based Systems is studied by students on Higher National Certificates in Electrical Engineering at the college and their experiences through the academic year 2001/2002 will be recorded.

4.4 Evaluation Questionnaire

'Remote Action in Distributed Learning Environments' (RADIO)

Evaluation

Please help us to evaluate the effectiveness of this course by completing the following questionnaire

Name	
Institution	
Email address	

What speed of Internet connection are you using?	
For how long have you used computers?	
How often have you used NetMeeting before?	
What other remote access software have you used?	

What are your general impressions of the course?	

What are your views on this type of remote operation?	

Do you think this type of remote diagnosis can be used in you area of work?

What is the most important thing you have learned from this course

What is your impression of the material used in the course?

Übermitteln Zurücksetzen

5 Summary and Conclusions

This document seeks to present the experiences of the delivery of a course in tele-service to students using embedded micro-controller based systems. Student's have been given access to a system at a remote location and been able to monitor, maintain, upgrade and fault find using this system.

The experiences have shown that the Internet can be used for this type of operation, however, consideration needs to be taken of the available bandwidth of the connection and the type of application being considered. Also the connectivity of the Internet at certain times can cause difficulties in operation and this may not be acceptable in a real Industrial process. At the present time the use of dedicated lines for this type of activity reduces the risks but also present problems of infrastructure and cost. This is born out by those industries currently using this type of technology where the remote maintenance features are rarely used.

The experiences have shown that safety is an important feature of remote service. This is particularly true when operators or other agents are not present at the remote site and control of the remote system is lost. Greater risk assessment of software is required in this type of system to consider the effects of hardware and software failure in different modes. Although this is not a new area of study it becomes more pertinent in control systems monitored and acted upon remotely.

It is clear from the observation of students that audio and video communication are a major tool in the area of fault-finding. This finding is not surprising since the majority of faults in systems are found by visual inspection and students are attempting to use the same techniques in remote situations. However, it is also a finding that there is a need for the remote expert to have confidence in the feedback from the remote system. The impression is that this is not provided when a software interface is placed between the remote expert and hardware.

Further evaluation work is required using this tele-service unit and the content of the unit means that it is suitable from inclusion in the mainstream provision at one of the vocational schools (Stockport College). This is an added benefit of the course and means that the unit can lead to formal accreditation through its study.

6 Appendicies

6.1 Temperature Control Software Version 1

```
//
// Control and Monitoring program for temperature control v1
//
// RADIO project 2001
//

#include <stdio.h>
#include <stdlib.h>
#include <realio.h>

#define HEATON    32
#define FANON     64
#define OFF 0

int  getTemp();
int  enterSetPoint();
void initialise();
int menu(int setTemp);
void control(int setTemp);


int main(){
      int setTemp=20;

      initialise();

      for(;;){
            printf("%c[2J%c[H",27,27);
            switch(menu(setTemp)){
                  case 1 :setTemp = enterSetPoint();
                          break;

                  case 2 :printf("\n\n\r");
                          do{
                              control(setTemp);
                              delay(1000);
                          } while (!kbhit());
                          break;

                  case 3 :return 0;
            }
      }
}


int getTemp(){

      byte test;
      test = pit[dra] / 2;
      return test;
}
```

```
int enterSetPoint(){

      int temp;

      printf("\n\rEnter new set point :");
      scanf("%i",&temp);
      return temp;
}


void initialise(){
      ioinit(0x00,0xFF,0x800000,0xA00000);
}


int menu(int setTemp){

      int choice;

      printf("\n\n\rTemperature Controller (V1)\n\r");
      printf("~~~~~~~~~~~~~~~~~~~~~~~~~~~\n\r");
      printf("\n\r");
      printf("[1] change set temperature : %i\n\r",setTemp);
      printf("[2] control\n\r");
      printf("[3] quit\n\r");
      printf("\n\r");
      printf("Enter Choice :");
      scanf("%i",&choice);

      return choice;
}


void control(int setTemp){

      int temp;

      temp = getTemp();
      if (temp < setTemp)
            pit[drb]=HEATON;
      else if (temp > setTemp)
            pit[drb]=FANON;
      else
            pit[drb]=OFF;

      printf("Set Temperature %i   Current Temperature :%i  \r",
      setTemp, temp);
}
```

6.2 Temperature Control Software Version 2

```
//
// Control and Monitoring program for temperature control V2
//
// RADIO Project 2001
//

#include <stdio.h>
#include <stdlib.h>
#include <realio.h>


#define HEATON    32
#define FANON     64
#define OFF 0


int  getTemp();
int  enterSetPoint();
void initialise();
void display(int setTemp, int getTemp, int status);
int  control(int setTemp);
void clrscr();
void home();


int main(){

      int  setTemp;
      int  choice;
      int  status;

      initialise();
      clrscr();
      setTemp = enterSetPoint();

      for(;;){

            status = control(setTemp);
            display(setTemp, getTemp(), status);
            delay(1000);

            if (kbhit()){
                  scanf("%i",&choice);
                  printf("%i\n\r",choice);

                  switch(choice){
                        case 1 : setTemp = enterSetPoint();
                               break;
                        case 0 : return 0;
                  }
            }

      }
}
```

```
void clrscr(){
      printf("%c[2J",27);
      home();
}

void home(){
      printf("%c[H",27);
}


int getTemp(){
      byte test;

      test = pit[dra] / 2;
      return test;
}


int enterSetPoint(){

      int temp;

      printf("\n\rEnter new set point :");
      scanf("%i",&temp);
      return temp;
}


void initialise(){
      ioinit(0x00,0xFF,0x800000,0xA00000);
}


int control(int setTemp){

      int temp;
      int status;

      temp = getTemp();

      if (temp < setTemp){
            pit[drb]=HEATON;
            status =HEATON;
      }
      else if (temp > setTemp){
            pit[drb]=FANON;
            status =FANON;
      }
      else {
            pit[drb]=OFF;
            status =OFF;
      }
      return status;
}
```

```
void display(int setTemp, int getTemp, int status){

      home();
      printf("\n\r");
      printf("   Temperature Controller version 2\n\r");
      printf(" ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ \n\r");
      printf("|                                      |\n\r");
      printf("| Temperature Set Point : %2i
|\n\r",setTemp);
      printf("| Temperature Current   : %2i
|\n\r",getTemp);
      printf("|                                      |\n\r");
      if (status == HEATON)
      printf("| Status : Fan off  Heater on          |\n\r");
      if (status == FANON)
      printf("| Status : Fan on   Heater off         |\n\r");
      if (status == OFF)
      printf("| Status : Fan off  Heater off         |\n\r");
      printf("|                                      |\n\r");
      printf(" ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ \n\r");
      printf("| [0] - Exit  [1] - Change Temp        |\n\r");
      printf("|                                      |\n\r");
      printf(" ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ \n\r");
}
```

6.3 Hardware Test Software

```
//
// Hardware Test Software to exercise the application boards
//
// RADIO Project 2001
//

#include <stdio.h>
#include <stdlib.h>
#include <realio.h>


#define HEATON    32
#define FANON     64
#define OFF 0


int  getTemp();
void initialise();
void clrscr();


int main(){

      int temp;

            initialise();

      clrscr();
      printf("Hardware Test Program\n\r");
      printf("~~~~~~~~~~~~~~~~~~~~~\n\r");
      printf("Turning on Heater\n\r");
      printf("Raising Temperature to 40C\n\r");
      printf("\n\r");

      pit[drb] = HEATON;

      do {
            temp = getTemp();
            printf("Actual Temperature : %i\r",temp);
      } while (temp <= 40);

      pit[drb] = OFF;
```

```
	printf("\n\r");
	printf("\n\r");
	printf("Cooling to 20C\n\r");
	printf("\n\r");

	pit[drb]= FANON;

	do {
		temp = getTemp();
		printf("Actual Temperature : %i\r",temp);
	} while (temp >= 20);

	pit[drb] = OFF;

	printf("\n\r");
	printf("\n\r");
	printf("Tests Complete\n\r");

}


void clrscr(){
	printf("%c[2J%c[H",27,27);
}


int getTemp(){
	byte test;
	byte test2;

	do {
	  test = pit[dra] / 2;
	  test2= pit[dra] / 2;
	} while (test!=test2);

	return test;
}


void initialise(){
	ioinit(0x00,0xFF,0x800000,0xA00000);
}
```

Universität Bremen

Research Centre Work - Environment -Technology (artec)

Leonardo da Vinci Programme

Remote Action in Distributed Learning Environments (RADIO)

Contract No.: D/99/2/07331/PI/II.1.1.a/FPI

EVALUATION AND DISSEMINATION

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Ian Hadfield, George A. Papadopoulos

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Deliverable: **D50-D51**

Date of Delivery: 31 July 2001

Deliverable Type: Restricted

Abstract: This document includes evaluation and dissemination material

Keyword List: Evaluation, dissemination

1. Evaluation

1.1 Overview

In RADIO the evaluation procedure based on work we have done in the research project called Hypermedia supported Simulation in vocational education, sponsored by the German Ministry of Education (HYSIM)[1].

To support the evaluation process, two project meetings where organised. Beside this activities the consortium used a groupware system (BSCW, Basic Support for Co-operative Work) as a communication means to exchange documents and to discuss the results of training courses. In detail the evaluation of the teaching concept took place in several phases:

In the *pre-evaluation phase* the university partners did basic research in the field of teleservice work organisation, techniques, tools and methods. We also investigated vocational training concepts for the teleservice field. (Deliverables 21-23). These studies base on literature research, participation at relevant conferences and workshops, as well as the exchange of detailed information with teleservice providers and customers. Every study includes an evaluation part at the end.

For the *process analysis-phase* (evaluation of training courses), we have done the following steps:

- Documentation of the development of teaching and training units by teachers and trainers (Deliverables 31, 41)
- Documentation of held courses, summarisation and estimation of results. (Deliverables 32, 42).

In the *post analysis-phase,* we employed observations and questionnaires to get information about the quality of the new learning concept and of the used learning material.

1.2 Results

In the work packages 30 and 40 (deliverable 32 and 42) the experiences and evaluation of teaching courses are described. In both courses student's have been given access to a system at a remote location and been able to monitor, maintain, upgrade and fault find using this system.

The experiences have shown that the Internet can be used for this type of operation, however, consideration needs to be taken of the available bandwidth of the connection and the type of application being considered. Also the connectivity of the Internet at certain times can cause difficulties in operation and this may not be acceptable in a real Industrial process. At the present time the use of dedicated

[1] HYSIM (1997): Hypermediagestützte Simulationssysteme für berufliche Schulen (HYSIM). Final report. Bremen, Senator für Bildung, Wissenschaft, Kunst und Sport

lines for this type of activity reduces the risks but also present problems of infrastructure and cost. This is born out by those industries currently using this type of technology where the remote maintenance features are rarely used.

The experiences have shown that safety is an important feature of remote action in distributed work and learning environments. This is particularly true when operators or other agents are not present at the remote site and control of the remote system is lost. Greater risk assessment of software is required in this type of system to consider the effects of hardware and software failure in different modes. Although this is not a new area of study it becomes more pertinent in control systems monitored and acted upon remotely.

It is clear from the observation of students that audio and video communication are a major tool in the area of fault-finding. This finding is not surprising since the majority of faults in systems are found by visual inspection and students are attempting to use the same techniques in remote situations. However, it is also a finding that there is a need for the remote expert to have confidence in the feedback from the remote system. The impression is that this is not provided when a software interface is placed between the remote expert and hardware.

It is important to mention that involvement in training for teleservice which is based on novel technologies is a learning experience for all concerned ("tutors" as well as "learners"). Both the teacher and each student are challenged by new roles, functions, and tasks they need to perform. The dominant change is from teaching and presentation of knowledge to more student active learning. For the instructor it is characteristic to change from "a sage on the stage" to " a guide on the side". The learners will also experience a different role from that of a traditional student. The role changes from passive receptacles to constructors of their own knowledge. Students become complex problem-solvers rather than just memorises of facts.

1.3 Conclusions

The novel technologies and especially the WWW, the Virtual Reality and the Asynchronous Multimedia Conferencing, as an aid in teleservice training are a current research issue. Like any other technologies, they have advantages and disadvantages. Implementations that capitalise on the strengths and added value of the technology and that circumvent or adjust for its limitations can be expected to be successful in terms of learning outcomes.

The teaching projects in RADIO showed, that unsupervised and autonomous learning played a key role in training for teleservice. The open learning situation enabled training to be interesting and variable. The central focus was on the acquisition of functional and extra-functional skills, such acquisition being significantly supported in such open forms of learning through the use of *real* telecommunications and teleservice systems. Improving the visual clarity of complex interrelationships by using real systems was a predominant element of the learning process. The new media had a consistently motivating impact on the students.

The action-centred lessons exhibited a definite improvement in student activities and the independent approach taken by students. These forms of learning, new to the students, enabled playful and risk-free experimentation.

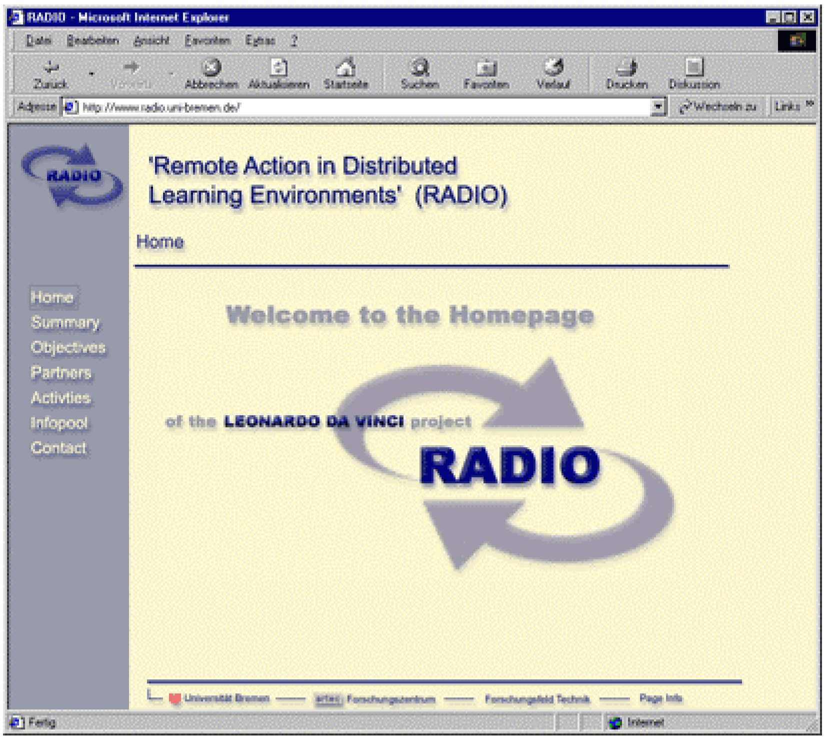
Figur 1: Radio – BSCW

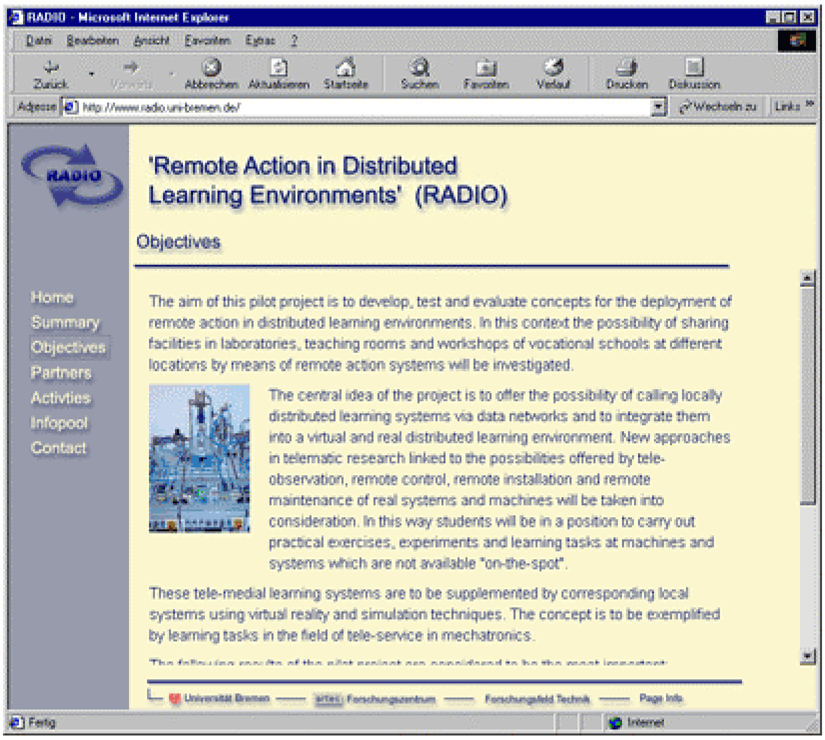
2. Dissemination activities

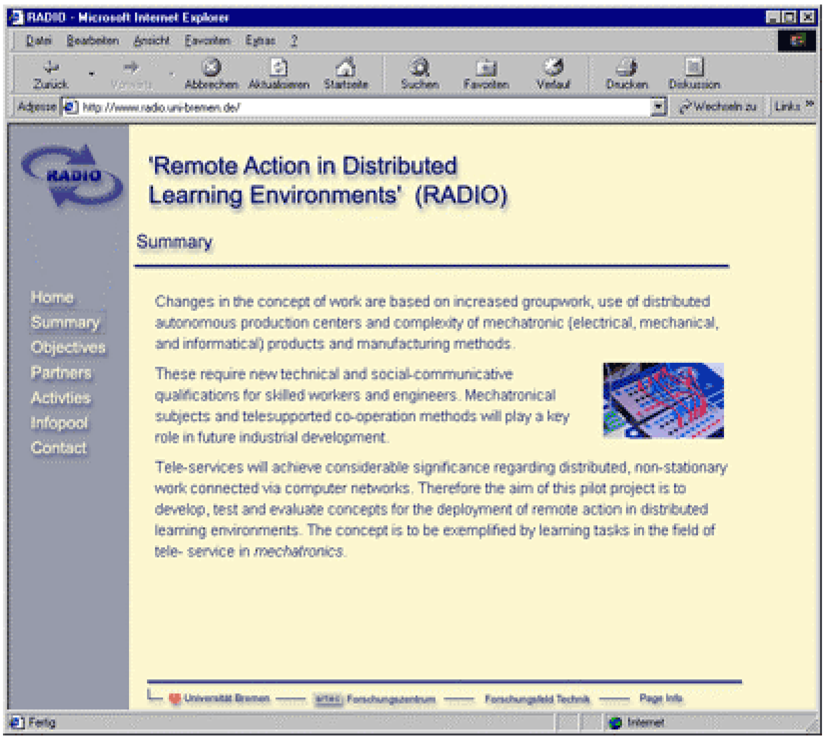
2.1 Project presentation

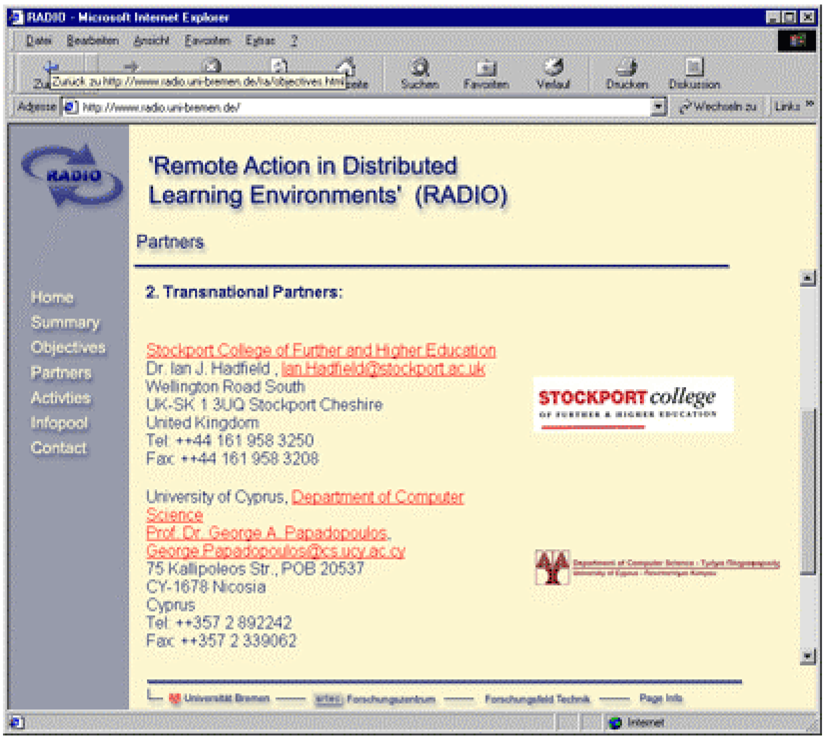
2.1.1 RADIO Homepage

(http://www.radio.uni-bremen.de)




RADIO - Microsoft Internet Explorer
'Remote Action in Distributed Learning Environments' (RADIO)
Objectives
Home
Summary
Objectives
Partners
Activties
Infopool
Contact
The aim of this pilot project is to develop, test and evaluate concepts for the deployment of remote action in distributed learning environments. In this context the possibility of sharing facilities in laboratories, teaching rooms and workshops of vocational schools at different locations by means of remote action systems will be investigated.
The central idea of the project is to offer the possibility of calling locally distributed learning systems via data networks and to integrate them into a virtual and real distributed learning environment. New approaches in telematic research linked to the possibilities offered by tele-observation, remote control, remote installation and remote maintenance of real systems and machines will be taken into consideration. In this way students will be in a position to carry out practical exercises, experiments and learning tasks at machines and systems which are not available "on-the-spot".
These tele-medial learning systems are to be supplemented by corresponding local systems using virtual reality and simulation techniques. The concept is to be exemplified by learning tasks in the field of tele-service in mechatronics.


RADIO - Microsoft Internet Explorer
'Remote Action in Distributed Learning Environments' (RADIO)
Summary
Home
Summary
Objectives
Partners
Activties
Infopool
Contact
Changes in the concept of work are based on increased groupwork, use of distributed autonomous production centers and complexity of mechatronic (electrical, mechanical, and informatical) products and manufacturing methods.
These require new technical and social-communicative qualifications for skilled workers and engineers. Mechatronical subjects and telesupported co-operation methods will play a key role in future industrial development.
Tele-services will achieve considerable significance regarding distributed, non-stationary work connected via computer networks. Therefore the aim of this pilot project is to develop, test and evaluate concepts for the deployment of remote action in distributed learning environments. The concept is to be exemplified by learning tasks in the field of tele- service in mechatronics.


RADIO - Microsoft Internet Explorer
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Activities
Infopool
Contact
2. Transnational Partners:
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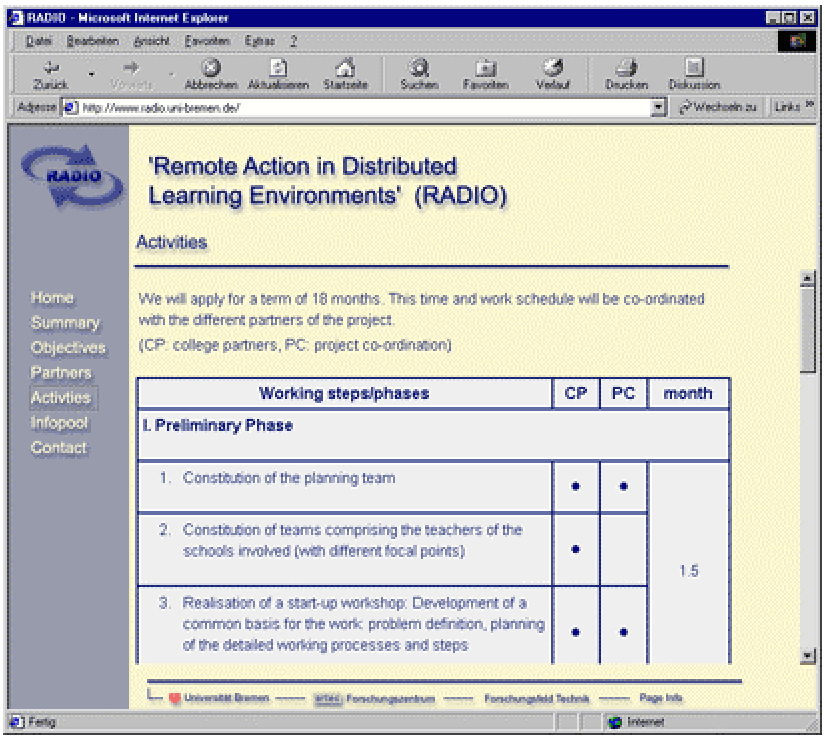
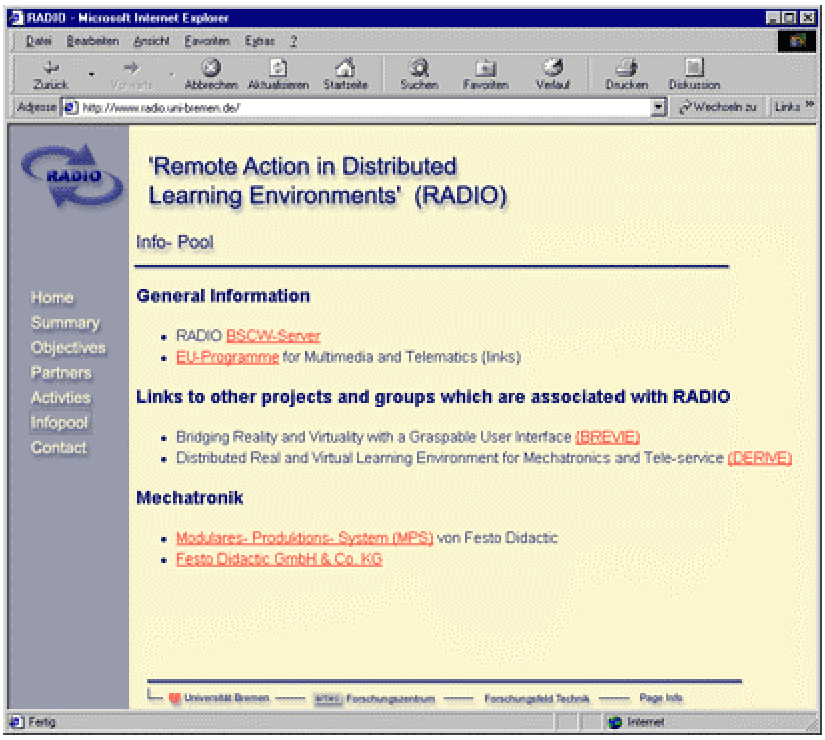
Fax: ++357 2 339062


RADIO - Microsoft Internet Explorer
'Remote Action in Distributed Learning Environments' (RADIO)
Activities
Home
Summary
Objectives
Partners
Activities
Infopool
Contact
We will apply for a term of 18 months. This time and work schedule will be co-ordinated with the different partners of the project.
(CP: college partners, PC: project co-ordination)
Working steps/phases
CP
PC
month
I. Preliminary Phase
1. Constitution of the planning team
2. Constitution of teams comprising the teachers of the schools involved (with different focal points)
3. Realisation of a start-up workshop: Development of a common basis for the work: problem definition, planning of the detailed working processes and steps
1.5


RADIO - Microsoft Internet Explorer
http://www.radio.uni-bremen.de/
'Remote Action in Distributed Learning Environments' (RADIO)
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General Information
RADIO BSCW-Server
EU-Programme for Multimedia and Telematics (links)
Links to other projects and groups which are associated with RADIO
Bridging Reality and Virtuality with a Graspable User Interface (BREVIE)
Distributed Real and Virtual Learning Environment for Mechatronics and Tele-service (DERIVE)
Mechatronik
Modulares- Produktions- System (MPS) von Festo Didactic
Festo Didactic GmbH & Co. KG

2.1.2 RADIO- Flyer

Information

Changes in the concept of work are based on increased groupwork, use of distributed autonomous production centers and complexity of mechatronic (electrical, mechanical, and informatical) products and manufacturing methods. These require new qualifications for skilled workers and engineers. Mechatronical subjects and tele-supported co-operation methods will play a key role in future industrial development. Tele-services will achieve considerable significance regarding distributed, non-stationary work connected via computer networks.

Objectives

The aim of the RADIO project is to develop, to test and to evaluate concepts for the deployment of remote action in distributed learning environments. The possibility of sharing facilities in laboratories, teaching rooms and workshops of vocational schools at

Objectives

different locations by means of remote action systems will be investigated. The central idea of the project is to offer the possibility of calling locally distributed learning systems via data networks and to integrate them into a virtual and a real distributed learning environment. New approaches in telematic research linked to the possibilities offered by tele-observation, remote control, remote installation and remote maintenance of real systems and machines will be taken into consideration. In this way students will be in a position to carry out practical exercises, experiments and learning tasks at machines and systems which are not available "on-the-spot". These tele-medial learning systems are to be supplemented by corresponding local systems using virtual reality and simulation techniques. The concept is to be exemplified by learning tasks in the field of tele-service in mechatronics.

Highlights

1. Support of co-operation between regionally and nationally distributed learning sites.

2. Improvement of teaching and learning offers by common utilisation of distributed and scarce resources.

3. Enrichment of lessons by new telemedial learning subjects and methods.

4. New forms of telemedia based learning in technical training will meet with future requirements in industry.

2.1 Dissemination Activities of project partners

Bremen Teleservice-Course for University Teacher-Students

A course titled "Training for Teleservice in Mechatronics" was held by D. Müller during the winter semester 2000/2001 at the University of Bremen with students majoring in "Vocational Teacher of Electrical or Mechanical Engineering". The course was intended to get a first insight in teleservice tools and methods. A result of this course was a teaching unit entitled 'Teleservice and Tele-cooperation', which was planned and carried out in a Bremen technical college by students in conjunction with the RADIO project (see Deliverable 22).

Seminar for Students at the University of Cyprus: Emerging Technologies for Tele-Training Systems

A seminar titled "Emerging Technologies for Tele-Training Systems" was held by George Papadopoulos" as part of the course EPL422: Multimedia Systems, 4th year, BSc programme in Computer Science. In this seminar the emerging and novel technologies for tele-training systems were described and analysed. Main subjects of the course: Web-based programming, web-based environments, Java programming, collaborative information systems with respect to training including groupware and CSCW systems. In this course also the potentials of using such environments for mechatronics applications were discussed.

Summer school for Korean Teachers (Cooperation artec - Korean University of Technology and Education)

A one-week course "New Subjects, new Media and new Ways of Co-operation in vocational Training and Education" (25 hours) was held by W. Bruns and D. Müller at the Korean University of Technology and Education, Human Resources Development Institute (HRDI) Cheonan, Aug. 28. – Sept 1. 2000, as a further education for teachers in Electronics and Mechanics at the levels of High-School, Vocational School, Polytechnic School and Chambers of Commerce. This was a good chance to present the ideas of RADIO and get some feedback. The course showed a vivid interest of the Korean teachers for this new application field. Supported by BSCW, a network of mechatronic experts was formed, and a perspective of a continuing institution of further education and consulting was opened. In September 2001 there will be further cooperation activities between artec and Korea and the research results of RADIO will be presented.

Contacts with companies, training institutions and colleges

The ideas and results of RADIO were also disseminated by artec through the participation at relevant conferences and workshops, as well as the exchange of detailed information with teleservice providers and customers. This includes the following activities:

- 31.01.2000 Visit to *AlgoVision* Systems GmbH, Bremen (Internet: www.algovision.de). Main focus: Presentation of the ‘NewMedia280 system’ for data, image and voice transmission.
- Participation on the final workshop of the *TeLec* (multimedia teleservice) project
- 13.03.200 Visit to the Bremen branch of Siemens AG
- 27.03.2000 Visit to *LSW* Maschinenfabrik GmbH, Bremen (user of products made by AlgoVision GmbH)
- 15.05 2000 Visit to Delmenhorst Technical College (visit to a solar energy laboratory with measurement data capturing and process simulation, use of products made by Siemens AG)
- 10. / 11. 07.2000 Continuing training event at *Technotransfer* GmbH in Erfurt
- 12. / 13.10.2000 Participation at the VDI event entitled ‘Wireless-controlled communication’, in Düsseldorf.

Other dissemination activities

In terms of dissemination, the project has been advertised to companies in the local area of Stockport through newsletters and information leaflets. A paper (prepared by Ian Hadfield of Stockport College) will be presented at the Further Education Research Network in October of this year.

The Technische Bildungszentrum Mitte (TBZ) in Bremen disseminated the project results on a local scale. The following activities have been done

- Representation of the activities of the project in college conferences (Ausbildungsbeirat, Gesamtkonferenz, Abteilungskonferenz).
- Meetings with members of local firms and industry.
- Incorporation of local technical colleges into RADIO activities by using of RADIO learning concepts and material.
- Intensive know-how transfer between RADIO and the project ‘Telemedia based training environments in mechatronics (TELLME)’ (funded by the German ministry of education)
- As a member of a curriculum-commission, which is fixing the contents of the curriculum for the new IT-professions, the experiences and results of the project RADIO are processed for this curriculum.
- Publishing links to the TBZ-Server.