

DIVISION OF COMPUTER SCIENCE

Use of Multimedia in a Public Information System

**Jill Hewitt
John Sapsford-Francis
Philip Halford**

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1. Introduction

The work described in this paper is being carried out as part of an EC funded pan-European project under the TIDE initiative - MODEMA (Modelling for the Disabled in a working Environment - a Multiperspective Approach). The MODEMA group is building a multimedia knowledge based browsing system to support queries relating to the integration of people with disabilities into paid employment. Three main types of user of the system are envisaged: employers, advisers to the disabled and people with disabilities.

The knowledge held in the system covers a broad spectrum of expertise and could neither be obtained from a single expert nor be modelled using a single technique. It mainly concerns complex interrelations between work environments, disability profiles, task requirements and available compensatory equipment. The use of a multimedia system has been the only feasible way to allow access and interaction to the combination of text, hypertext, stills and video clips made necessary by this diversity of knowledge types.

A fundamental premise in the design of the system was that it should not provide any negative information, that is it should never discourage an employer from considering a disabled person for a job (e.g. by indicating that a task was 'impossible' for a person with a particular disability) rather it should offer alternative means of reaching a goal. The provision of case study material augmented by video clips and still images was considered important to reinforce the view that alternative solutions were in fact practicable. Case studies also provide an insight into the use of compensatory equipment and the adaptations that could be made to the workplace and working practices in order to accommodate a 'differently able' person.

2. Development platform and the design approach

In view of the novel nature of the system we were developing, and the need to refine our knowledge of user requirements as the project progressed, it was considered imperative that we follow an iterative prototyping approach, allowing potential end users to view working prototypes from a very early stage in the project. However, the goal of user-centred design (see Norman and Draper 1986) is not without its problems in a project of this nature, since the users are scattered over five countries and test results must be co-ordinated and fed back to the system developers -this necessitated a fairly well-structured iterative approach, with three phases of trials and evaluation, the results of one evaluation phase leading to a refined prototype for the next phase.

In addition to the creation of the system structure, the knowledge to be embodied in the system must be collected, modelled and refined; this process took place in parallel with the system development thus allowing us to provide a progressively more informative system with each prototype as well as a more usable interface. Photographs were incorporated in the knowledge base right from the start, but because of the time needed to gather and process video clips, it was only the final version in which video was widely presented.

An early decision was that the system would be implemented for a PC platform running under Windows - this was because the PC is widely used across Europe, and many of our target user organisations were already used to the PC environment.

A prototyping tool was required that would support the rapid development of early prototypes, but which was flexible enough to allow the inclusion of external code (to drive interface devices) and which could support an underlying data model. Knowledge Pro for Windows (Knowledge Garden) was chosen from among the many prototyping tools that are available, as it met these criteria. It has an object-oriented interpreted high level language which provides support for the development of all MS Windows features. The resultant application is event-driven and can be designed to comply with existing Windows guidelines and standards (Halford, Hewitt, & Weaver 1992). Multimedia is supported in the form of comprehensive links to the appropriate Windows extensions. This facilitates such activities as playing of videos and controlling external hardware, for example a CD-ROM drive, video machine or camera. Video is currently captured and stored using the Actionmedia DVI video card. It is envisaged that the final version will store the video and photographs on CD ROM, and that a smaller demonstration version will utilise the new software for video playback provided by Microsoft Video for Windows.

3. Knowledge extraction and modelling

It was apparent early in the project that the knowledge required for the system was widely dispersed and was not vested in the heads of just a few experts. Where experts existed, they tended to be 'narrow domain' experts, typically in one disability area, so that a large number of people in all participating countries would have to be approached to provide the full and rich picture which was required for the system. In view of the limited time scale of the project (18 months) and the fact that not all people carrying out interviews would be experienced 'knowledge extractors', it was important to use a knowledge extraction technique suitable for the task in hand and to develop methods which would:

- be portable across international boundaries
- allow knowledge extraction by practitioners with varying degrees of expertise
- be usable in a wide variety of settings
- be capable of testing existing hypotheses about the knowledge base
- capture knowledge in a form readily convertible for input to the computer system

It was considered that an ideal way of modelling working environments would be to capitalise on work already carried out in developing a generic office reference model (Hewitt et al., 1990, and Watkinson et al, 1991) by investigating ways of extending this model to cover the use of compensatory equipment by disabled people and to deal with other working environments. The original model presented a multi-perspective model of an office based on four views:

- i) the goal view - overall organisational goals
- ii) the task view - tasks carried out by people in the organisation in order to achieve their goals
- iii) the dialogue view - communications between people in the organisation in order to carry out their tasks
- iv) the functional view - existing technology and services which supports user activity

This model was adapted to include a 'compensation' view to isolate the equipment and services utilised by people with disabilities to support their tasks - the revised version is given in Figure 1.

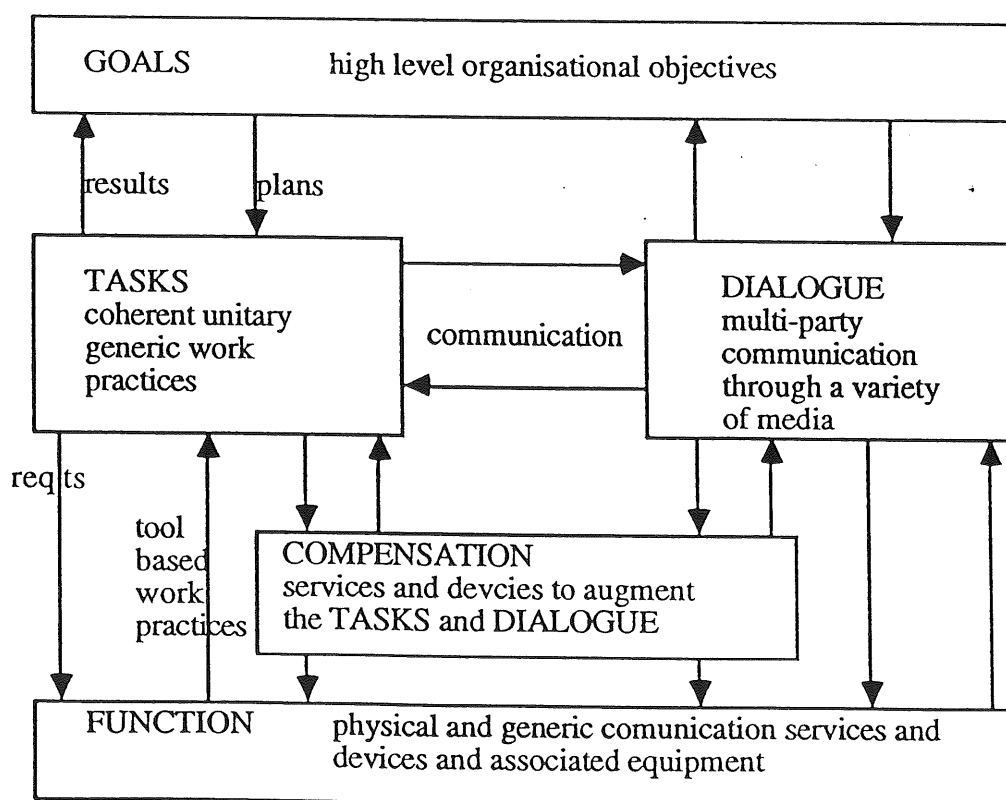


Figure 1: The revised reference model

Involvement of compensatory equipment may:

- replace a standard function
- augment a standard function
- allow achievement of the goal through a different set of tasks

The compensation function is not necessarily related to equipment, as for example when a human reader is employed to assist a blind person, or when someone uses the special telephone exchange to contact a deaf person.

In order to cover a wide range of scenarios in all the participating countries, a task checklist approach - TOX (Hewitt and Sapsford-Francis, 1992,) was developed, this gave a broad but shallow coverage of many work places and allowed us to refine our task models of the working environment. This was augmented with more detailed case study information gained by interview and questionnaire and by video material relating to selected case studies.

4. The underlying data model

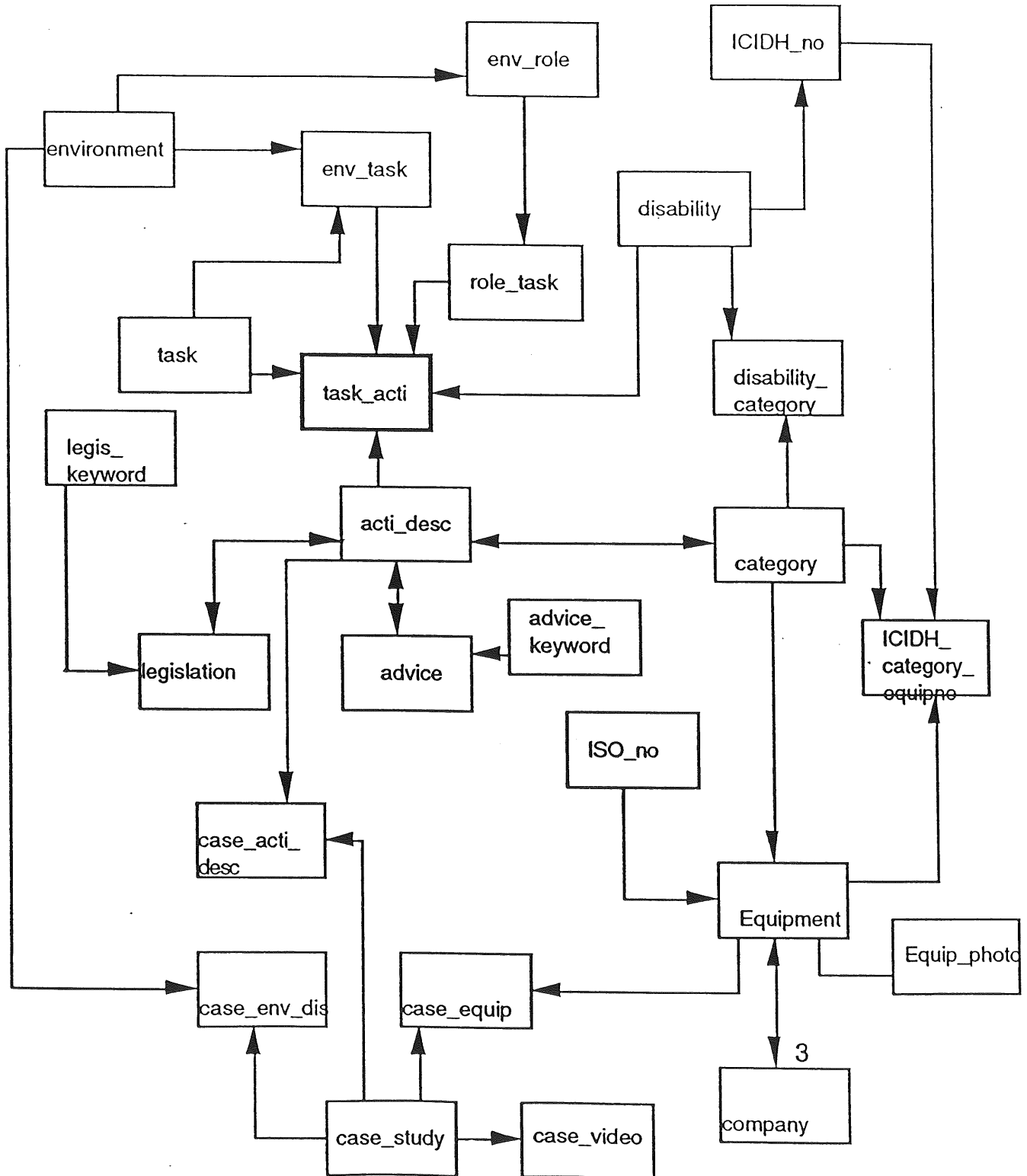


Figure 2: Entity Model

The creation of a good underlying data model is the key to providing a system that can expand and adapt over time without losing its integrity, and an object-oriented design is generally considered to be

amenable to adaptation and change (e.g. Booch, 1991). In the case of a multimedia system it is necessary to ensure that adequate labels and indexes are provided for the 'media' - in our case photographs and video clips, and that the data entry system is designed to simplify their inclusion as part of the data model. A further consideration is the organisation of hypertext links - where they are to be made available to the user and what structure is needed to support their incorporation.

The entity model in Figure 2. shows the relationships between the types of data held in the prototype system.

The main data stores in the system are the equipment, legislation and advice databases and the case studies. The "task-acti" entity is central to the design of the system, since this embodies expert knowledge relating environment, task and disability to relevant equipment, advice and legislation for carrying out an activity. The knowledge is presented in the format of free text containing hypertext links to connect to the data stores. These are managed through a separate entity (not shown) which connects the hypertext keyword to the appropriate database entry.

An extract from an entry for the activity "Reading" is shown on the screen in Figure 3. The hypertext links are underlined.

Environment Selected: Office
Disability: Severe Visual Impairment
Task: Arrange Meetings
Selected Activity: Reading

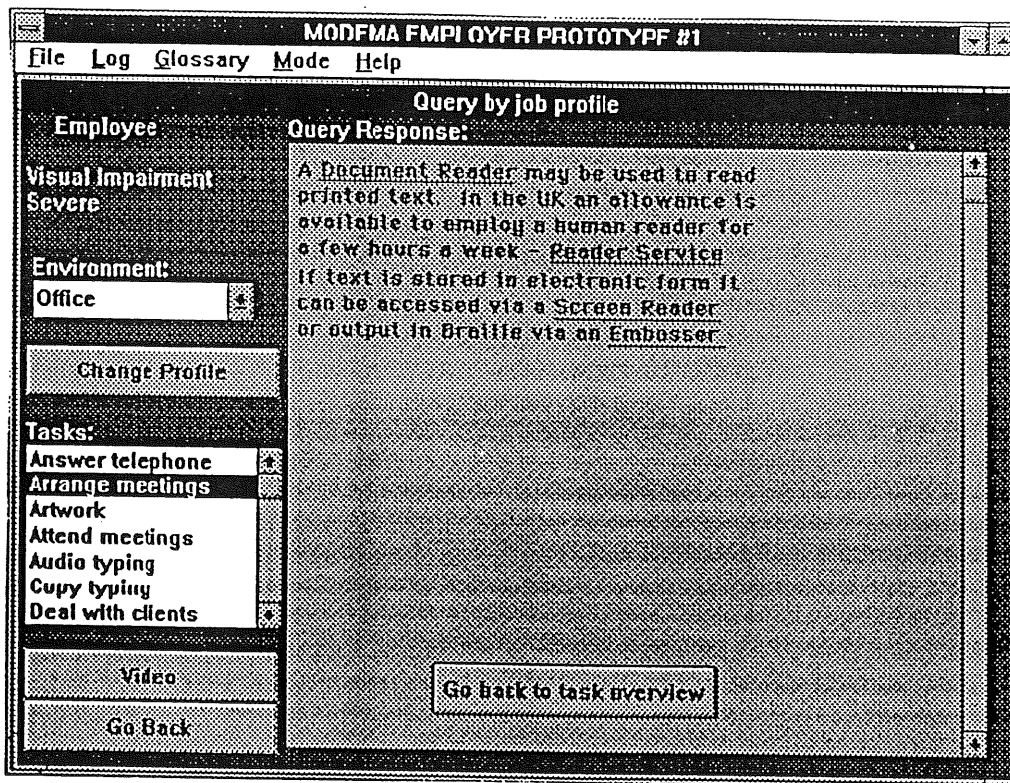


Figure 3: The Job Profile Screen

In this extract, the links to *Document Reader*, *Screen Reader* and *Embosser* would lead to entries in the equipment database, whereas the link to *Reader Service* would show an entry in the advice database in the grants section.

5. User models and the design of the interface

Because of the relatively short project time scale, it was necessary to fully interleave the system development with the knowledge extraction and modelling. If the knowledge models had been well-established before system design was begun, they could have contributed to the conceptual design of the interface (this problem was surmounted by the generation of scenarios of use - see the section below on conceptual design), but in this case every attempt has been made to integrate the two processes, so that for example, the evaluation programme for the system was also being used to augment the knowledge extraction.

The principal design objectives of the system were to meet different but overlapping requirements of the three target user groups only one of which - the advisors currently use existing computer based systems. Initial investigations into the requirements of the advisor's group found that current applications in the field were complex to use and accessing the data from such systems required a degree of expertise that invalidated many applications suitability; especially for the new users. An additional requirement was to create a system that would work with the users rather than a system that was used as a last resort.

The standard approach to database access i.e. through restrictive criteria to the data elements was to be represented in a form that would abstract from the complexity of the data and allow queries that are consistent with the user's task.

5.1 Conceptual design

Conceptual design capitalises on the user's familiarity with concepts, structures and sequences of operations by including them in the design of the interface. Good conceptual design is therefore an important factor in creating a usable computer system.

Scenarios of use, based upon preliminary discussions with potential users, were generated for the three user groups (advisors, employers and potential employees). Various conceptual designs were proposed and early prototypes were constructed and evaluated to establish the "look and feel" of the user interface. We have focused most of the development effort on one prototype designed to support decision making by the advisor user type.

In eliciting user requirements it became clear that prospective users associated traditional database query systems with frustrating interactions. We experimented with the inclusion of graphical features with the intention of increasing user motivation and attention span.

Evaluation of these design features indicated that they were successful in:

- giving visual cues to the size, operation and physical characteristics of compensatory equipment.
- acting as a catalyst for new solutions in the dialogue between users.
- increasing interest levels in users.

Short video clips provided a particularly rich compact information source, conveying knowledge that would be hard to present textually.

There are several noteworthy conceptual design features in the system:

- The provision of access routes to the complex information within the knowledge based system via work environment, role, task and disability profiles. This aspect of the conceptual design helps to structure the user's decision making about how to use the system.
- Basing most of the system use around the "Profile Screen"(not sure of name???). This screen provides a familiar starting place. It also allows default decision making about work environment, role, task and disability profiles.
- The use of the card metaphor in the compensatory equipment, advisory and legislation databases. This metaphor, which may be familiar to users of applications such as Hypercard, supports orientation and navigation for browsing. The card concept also provides a sense of closure: as one card is replaced by another users feel that a particular sub-unit of the interaction is over and need not be retained in short term memory.

6. Evaluation

A variety of evaluation methods have been used to evaluate the system in this country, these include:

- Scenario driven use of the system with verbal protocol capture.
- Structured interviews to capture user attitudes to the system.
- Attitude questionnaire
- "Hallway and storefront" evaluation.

To allow evaluation in the other participating countries, where evaluators may not be particularly expert the evaluation approach was simplified to scenario driven use of the system with limited verbal protocol capture followed by a standard structured interviews to capture user attitudes to the system (Sapsford-Francis & Hewitt 1992).

The evaluation requires three iterations. Two have been completed, the final iteration requires a different approach: the installation and evaluation of the prototype at 5 test sites in each participating country. Ultimately the test of the system is this: Do the professional advisors use the system effectively when carrying out day to day work? Overall the evaluation results for the first iteration were very positive. There were some concerns on the part of the users about the usefulness of the on-line help, the appropriateness of system feedback and the systems flexibility. Generally users were pleased with the "look and feel" of the system. The results of the second evaluation were also positive. The system re-design following the first evaluation iteration had evidently substantially reduced the problems mentioned above. User's criticisms instead centred around the usefulness and accuracy of the information that the system provided. These criticisms, although valid, did not particularly concern us because the development at this stage was focused on the providing useful and usable access to the information in the system rather than on the quality of that information. Subsequent knowledge elicitation and knowledge representation has addressed the issue of the quality and usefulness of the information supplied by the system.

In parallel with the development of the main prototype, work has been progressing on establishing the interface requirements for users with disabilities. A version designed for blind users which uses synthetic speech output is currently under development. Various discussions have been held with the designers of switch systems which would allow motor handicapped users to access the MODEMA system. Some of these units are under test to establish the optimum solution for the user's requirements.

7. Planned developments

A further development planned for this system is the provision of an annotation facility. Many users have expressed a desire to be able to comment on the information in the system, and perhaps to add new information. We plan to provide a free annotation facility which can be called up by the users to allow them to input comments at any point in the interaction. These annotations will be stored and subsequently analysed via transformation tools which will relate specific annotations with respective knowledge representation formalisms which are used in the expert system part of MODEMA. Various individuals or groups will have update privileges for the system and will decide which of the annotations should be included as permanent data and subsequently re-distributed to other users.

8. Conclusions

The application demonstrates a real need for the use of multi-media in the presentation of complex information rich scenarios, such as the use of rehabilitation technology in a working environment. The value of video clips and stills in presenting case study material is particularly beneficial.

The early prototyping approach is of particular importance in designing applications where there is no previous system and no consensus on user requirements.

We have developed new approaches to deal with the particular problems of this project namely

- the distribution of the development team across several countries
- the necessity of carrying out task analysis, knowledge extraction and usability evaluation in different countries by non-expert practitioners
- the need to carry out knowledge extraction, evaluation and development in parallel.

The interface style that we have developed is potentially usable in other multi-media applications, for example: we are currently considering its use in a system to support design conceptualisation meetings in product engineering.

9. References

- Booch, G. Object-Oriented Design with applications. 1991. Benjamin Cummings Publishing Company
- Halford, P.G.R., Hewitt, J.A. & Weaver, S.J. "Ergonomic design solutions and model interrelationships in a knowledge based browsing system for diverse user groups across international boundaries", 13th International Cybernetics Conference, Namur, Belgium, 1992
- Hewitt, J.A. & Sapsford-Francis, J. "A knowledge extraction approach for capturing dispersed knowledge and its application to the modelling of working environments for people with disabilities", 13th International Cybernetics Conference, Namur, Belgium, 1992
- Hewitt, J., Hobson, J. & Sapsford-Francis, J. 1990 An application of task analysis to the development of a generic office reference model. Interact '90, Cambridge England.
- Norman, D.A. & Draper, S.W. 1986. User Centered System Design. Lawrence Erlbaum Associates
- Sapsford-Francis, J. & Hewitt J. "Validating Knowledge models across multinational boundaries", 13th International Cybernetics Conference, Namur, Belgium, 1992
- Watkinson, N., Furner, S. & Dickerson, K. 1991. A usage reference model for office systems. Br Telecon Vol 9 No. 1