Chapter 4 The COVEN Project

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This chapter consists of a description of the general aims of the COVEN project, the usability aims, the constraints on the usability experiments were to take place, and the author's role in the project.

4.1 Introduction

The COVEN Project took place from January 1995 until December 1999, and aimed to demonstrate the feasibility and utility of scaleable CVE worlds through prototype applications in the general area of virtual travel. Researchers from 12 institutions in Europe collaborated to build the COVEN Platform, in three general cycles of software engineering. The complete process of requirements engineering, development and testing was collaborative within and between institutions; in which all partners joined their respective expertise, in keeping with the view that development is a delicate social process, involving exchange of requirements information between individuals working in teams within an organizational context (Viller, Bowers, Rodden, 1999; Devine and Banahan, 1999).

The COVEN project partners were Thomson-CSF (France), Division Ltd. (United Kingdom), Lancaster University (United Kingdom), University of Nottingham (United Kingdom), IIS Ltd. (Greece), KPN Research (The Netherlands), SICS (Sweden), Swiss Federal Institute of Technology (Switzerland, Arax Ltd (United Kingdom), University College London (United Kingdom), TNO-FEL (The Netherlands), University of Geneva (Switzerland) (see figure 4.1 for the geographical distribution of the partners). COVEN was a unique project which brought together European researchers with a wide range of expertise in telecommunications

infrastructures, CSCW and groupware, distributed virtual environments, computer graphics, VR animation, and human factors (see figure 4.2a and 4.2b for the COVEN brochure).

Figure 4.1: The geographical locations of the partners involved in the COVEN project.

The technical basis of the COVEN platform was formed by CVE applications developed in two of the partner institutions: an existing world-leading commercial VR platform called “dVS” from Division Limited, and the cutting-edge VR research platform called “DIVE” from the Swedish Institute of Computer Science. Both are mature toolkits, with the former being focused towards robust collaborative engineering type applications, and the latter as a more general tool for the exploration of future CSCW applications. The networked usability evaluations were based on methodologies developed by researchers in two partner institutions: presence research by University College of London, and CVE network and human behavioural research by the Communications Research Group of the University of Nottingham.

4.2 General Aims of the COVEN Project

The COVEN activities incorporated the creation of advanced design features such as:

- Support for multi-participant interactivity within a shared 3D virtual environment;
- Real time visualisation of complex dynamic 3D objects with variable-resolution - graphics; and a scalable distribution scheme over Wide Area Networks (WANs);
- Virtual humans, autonomous agents and virtual crowds;
- More natural interaction forms including speech and multi-modal interaction.

The COVEN approach involved building two CVE application scenarios with which to test the advanced features of the COVEN platform. The first was a business-oriented 'Conferencing Tool' targeted at professional users, while the second was a citizen-oriented 'Travel Agent and Rehearsal Tool' targeted at the home user. Extensive network trials of the platform, involving national hosts of the UK, The Netherlands, Sweden, Greece, and Switzerland, using ISDN, ATM and the Internet. Data collection during the trials took place on two levels: bandwidth usage measurements and human factors measurements. The first level was to establish predictions of future network requirements of CVE facilities; the second was to establish human factors issues for the successful use of CVE technologies similar to those demonstrated by the COVEN platform. Contributions were made to standards development in the research and development area of distributed interactive simulations (DIS), high-level architectures (HLA), VR modelling language (VRML),

and synthetic and natural hybrid image coding (MPEG4-SNHC), all from the perspective of CVE applications. Dissemination of results took place through international conferences, open workshops and public demonstrations including EU organised dissemination events.

The software was built in many small incremental steps, with fortnightly, networked trials, which were used to collect system, network, and usage data. The repetitive design of the network trials allowed us to adopt a longitudinal approach, collecting large amounts of qualitative and quantitative data from our usability evaluations.

4.3 Usability Aims of the Project

Usability evaluation activities specifically took place at specified times, throughout the application-building phase, and during the final validation phase. Our usability evaluation supported the development of the applications in an iterative fashion, through the execution of three 'design / test and evaluate / re-design' cycles. The usability evaluation also supported formal user validation activities towards the end of the project life-cycle, in order to demonstrate the added value of the completed system, and to assess its acceptance by the intended users and performing cost / benefit analyses through comparisons with alternative existing systems (Tromp, Steed, Wilson, in press).

The evaluation of the COVEN Platform was influenced by three considerations: usability engineering, scientific inquiry, and development of a methodology for CVE-specific usability studies. Firstly, regarding usability engineering, the COVEN project was developing demonstrator applications intended to create an impression of the

added-value of the CVE concept from the end-user and the customer point of view; this required an evaluation of the overall usability of the CVE applications, together with elements of a cost / benefit analysis, placing our evaluation activities in the general framework of usability engineering methods (Melchior, Bösser, Meder, Koch, and Schnitzler, 1995).

Secondly, the CVE technology on which these demonstrators were built is in its early stages, and in particular the human factors impact of its specific features are still poorly explored (Mavor and Durlach, 1995). Investigating the human behavioural aspects which affect performance and satisfaction in CVEs was precisely one of the objectives of COVEN; requiring focused exploratory studies of specific phenomena, which placed our evaluation activities in the general framework of scientific inquiry (Groot, 1969). The COVEN evaluations were set up to as focused studies, aimed to provide insight into the specific and unique features of CVEs, especially with regards to concepts such as presence, co-presence, and awareness of one's virtual self and other participants.

Thirdly, there were methodological issues that needed to be addressed. Due to the three dimensional, distributed, and prototype nature of CVEs a number of factors which constrain the option available for our experimental designs had to be identified. These constraints further characterise the specificity with which one has to choose CVE usability methods. To be precise, CVEs attempt to create a 3 dimensional place for people to interact, so there is more than one level at which usability testing could take place. The COVEN usability research did not simply cover human behaviour and performance with the application, but also human behaviour and performance inside

the CVE. Thus, in general, observations and experiments were to be performed both from outside the CVE and from inside the CVE. This required a reassessment of the applicability of standard HCI evaluation techniques and methods, to CVEs.

Another methodological issue was that a CVE allows multiple geographically distributed users to interact simultaneously within the CVE in real-time, regardless of the physical location of these users. One of the implications of the distributed character of the CVE application and its users is that network traffic generated by the users influences the performance of the application. Another implication is that it becomes more complicated to conduct proper controlled experiments due to the geographically distributed subjects. The prototype nature of the applications becomes another methodological issue in that it is often not feasible, within the resources available, to create different conditions for experiments, thus constraining the process of pure scientific inquiry. There may remain defects in the functioning of the application, which means that there are fewer opportunities for end-user experiments.

The main challenge for the COVEN usability researchers lay in defining the usability evaluation framework in such a way as to have these three concerns and their related sets of evaluation techniques cohabit and feed each other in a relevant, fruitful and well-controlled manner.

To address the lack of VE specific usability tools, COVEN carried out investigative empirical work, contributing to CVE design understanding. Our point of origin was that we needed to address the usability problems introduced by CVE technology by investigating the human behavioural aspects that affect performance and satisfaction

in CVEs. Our general usability approach, which we applied during the three evaluation iterations of the COVEN Platform, was based on three hypotheses:

- There are existing HCI design and evaluation methods for 2D applications that possibly could be translated to 3D/CVE applications and tested.
- There are CVE specific concepts describing human behavioural needs that are still in evolution which need to be explored and tested.
- There are CVE specific constraints on methodological aspects of evaluations that need to be addressed and solved.

A rich source of information became available by exploring network activity and human behaviour with and within CVEs. As such, it became an important component in the empirical cycle of scientific inquiry (Groot, 1969), which was employed during the three phases of the evaluation-development cycles of the project. COVEN provided some solid building blocks to the scientific community for future empirical research of CVEs, and contributed to the formulation of guidelines for CVE design (see Chapter 9, 10 and Appendix F).

4.4 Constraints of the COVEN Project

The usability activities in COVEN were in keeping with the general pattern of user-centred system development. This well-documented approach (Norman and Draper, 1986; Nielsen, 1993) relies on usability engineering activities at all stages of the development process:

- Project planning phase: user needs elicitation and task analysis.

- Application building phase: iterative design
- Demonstration/validation phase: user validation.

In addition to the exploratory nature of CVE technology, emphasised in the previous section, a number of factors are identified, which further characterised the specificity of the COVEN usability evaluation activities.

4.4.1 Independent variables difficult to manipulate

One of the consequences of evaluating prototypes is that it is often not feasible with the time and resources available to create two (or more) different situations for an experiment, this means that the independent variables cannot always be manipulated. For instance, a researcher may have found that having a personal shadow in a CVE may assist orientation and wayfinding. In order to find out what kind of shadow is most effective the researcher needs at least two versions of the CVE, each one with a different kind of shadows, and preferably one CVE without any shadows at all, for the control group. These three versions of the CVE constitute the manipulation of the variable 'shadow'. The group that does best on the orientation and way finding points to the CVE with the best shadow. Obviously this is an informative, but labour intensive way of gathering knowledge, which may not always be possible. However, this is a labour intensive method of gathering, so that an experimental design may not always be possible within the limits of the resources of the project.

The usability experiments during the COVEN project suffered from this limitation to a certain degree. Although it was possible to introduce new interface design solutions

between the cycles of evaluation and re-development, and subsequently to compare performance between the old version and the new, it was not possible to create one or more interface design solutions and to make empirical comparisons between them. However, we did try to make comparisons based on the independent variable 'experience' by running the same experimental tasks with novice and experienced users respectively. This allowed us to make some careful generalisations about the 'ease of use', and 'intuitiveness' of the application interface (further described in Chapter 8, section 8.3.6).

4.4.2 Interface to the CVE application is given

The applications that were used during the COVEN project (dVS and DIVE) are mature toolkits that brought with them ready-made interface designs. These interface designs were set, and could not be changed radically within the scope of the project. However, neither dVS nor DIVE had ever been subjected to thorough usability testing, indeed many of the interface problems encountered during experimentation were interface control problems. Since measuring usability of the CVE for collaboration was the first priority, interface shortcomings were carefully documented, and every attempt was made to remove known bugs and other usability problems before starting the experiments. In some cases users were specifically trained before the start of an experiment.

4.4.3 Subjects can not be properly controlled

During the early networked distributed experiments which took place with the COVEN prototypes, the data collection was regularly hampered by major bugs at one or more sites involved in the experiments. To avoid major delays in the experiments

we made use of the telephone, Ychat (a multi-user chat facility running on UNIX), and intense supervision of the subjects during the experimental tasks. Nonetheless, many data-sets were invalidated because of:

- Experimenter involvement at one or more sites,
- Break-down of communication between one or more sites due to crashing software,
- Break-down of communication between one or more sites due to undetected desperation of experimental subjects with seemingly unresponsive software and/or other users within the environment.

We tried to avoid these problems by carefully testing the audio configurations and audio connections before experiments and monitor any subject attitudes after the experiments with questionnaires and interviews. One final confounding aspect for the data collection was caused by subjects either intentionally or accidentally moving one of the many windows with which the applications were controlled over the graphical CVE window, or the system clock window, so that the information needed for the observational analysis made from the video-recordings of the experiments was obscured. Although the subjects were instructed to avoid obscuring the major windows, the occurrence of this problem could not always be avoided successfully.

4.5 Author's Role in the COVEN Project

The author's role in the project consisted of:

- Providing methodological know-how on performing distributed CVE usability experiments.
- Encouraging all partners involved in the usability activities of the project to hire local usability experts and design their own experiments within the project framework.
- Planning and driving collaboration between project partners involved in design and evaluation activities.
- Actively collaborating with the other researchers affected by primary activities such as:
    - Finding solutions for usability design issues.
    - Developing a methodological framework for usability testing.
    - Designing, planning and running experiments.
    - Writing monthly reports for the project management.
    - Writing deliverables for the European Commission.
    - Writing up and disseminating project results.
    - Collaborating with COVEN designers on open design issues.
    - Guiding students on placements within the project on design, scientific writing, and experiment design.
    - Organising, chairing, hosting, and attending usability meetings within the project.
    - Designing usability experiments.
    - Defining and adapting usability methods suitable for CVEs.
    - Co-authoring project deliverables on usability.
    - Co-authoring and authoring project deliverables on usability design.

- Presenting usability plans and results to project partners during project meetings.
- Attending project management meetings, representing CRG/University of Nottingham.
- Running and assisting in network trials and usability experiments.
- Writing conference and journal publications based on project findings.
- Instigating and co-organizing of first international VE Usability Workshop.
- Attending and presenting at meetings and conferences as a project representative.

More precisely, the author, together with local colleagues, brought to the project the methodological know-how (Tromp, 1995) and practical experience about performing networked, distributed CVE experiments (Greenhalgh, Bullock, Tromp, Benford, 1997, Tromp and Snowdon, 1997), which was incorporated into the COVEN project usability framework.

The author conducted interviews with CVE designers to establish the types of design guidelines needed and expected, created an hierarchical task analysis of collaboration to guide experiment design and analysis, a spatial and temporal interaction measurement method, co-authored adaptations of the traditional HCI Inspection method for CVEs and finalised the COVEN Inspection method. The author provided a chapter on usability design for CVEs and wrote a follow-up deliverable on

systematic usability design for CVEs. Furthermore, she authored and co-authored research papers written on the first (Steed and Tromp, 1998), second (Tromp and Fraser, 1998; Tromp et al., 1998c) and final usability phases (Tromp, Steed and Wilson, in press) of the project and on the project in general (Normand and Tromp, 1996; Tromp, 1998).

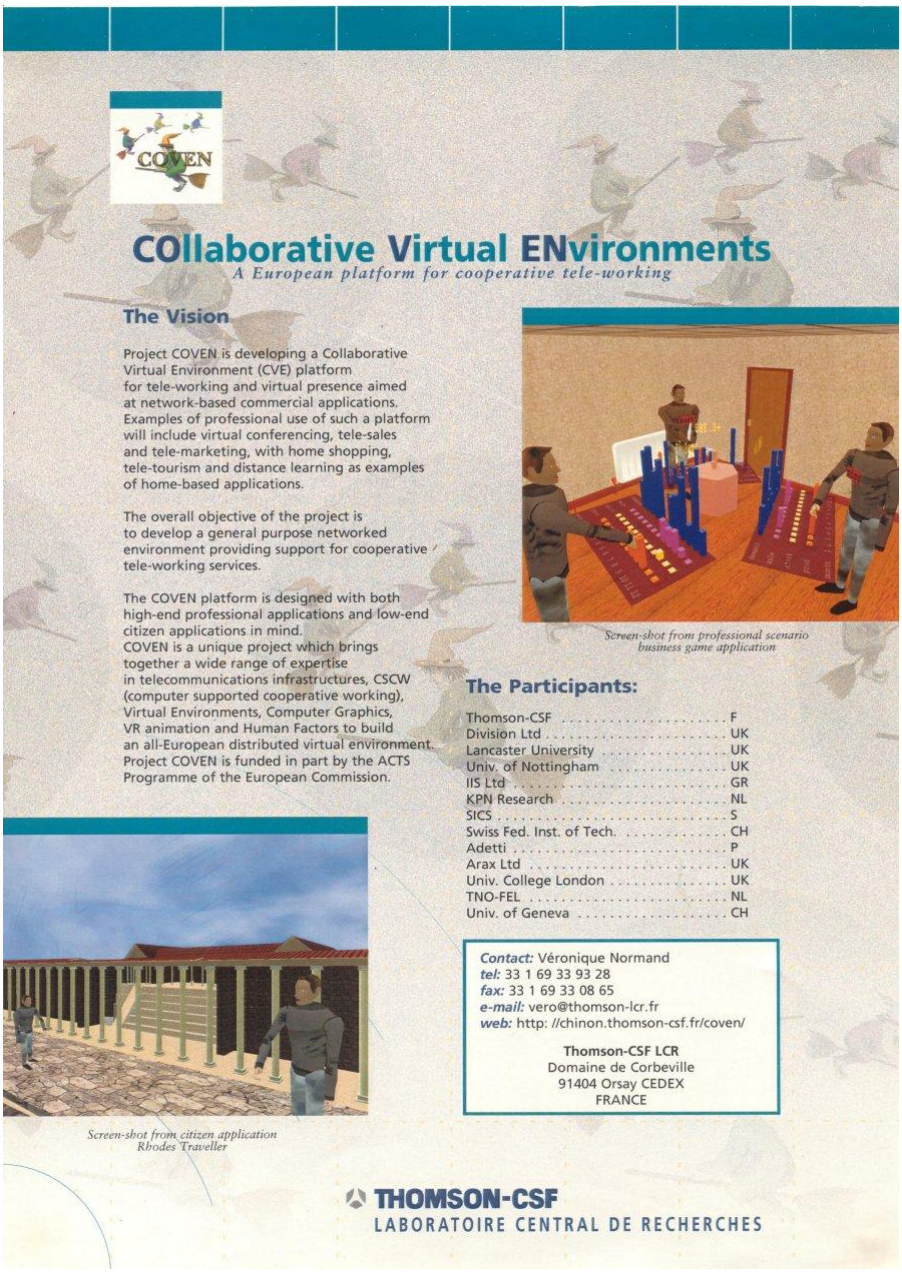
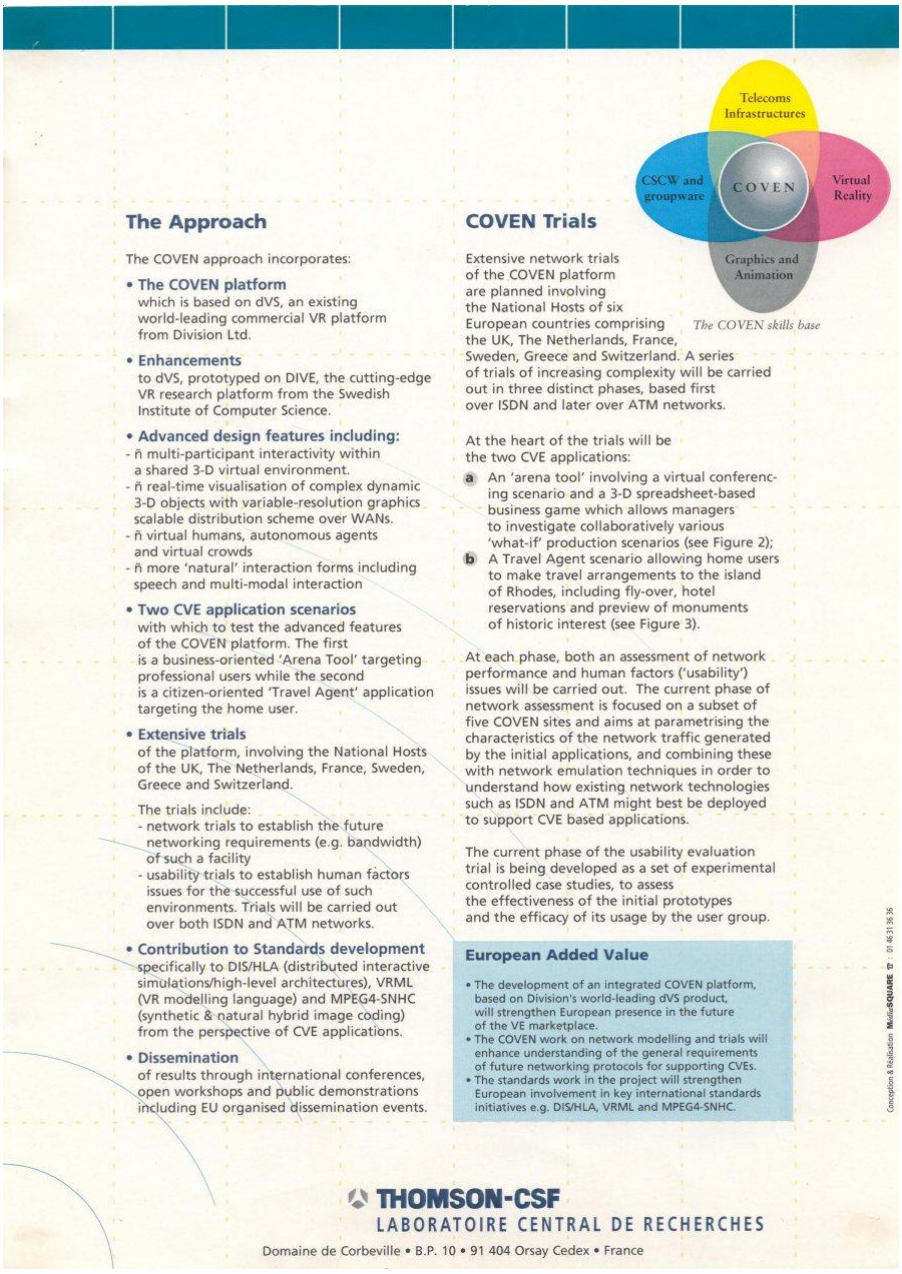


Figure 4.2a: Side one of COVEN brochure.

Additionally, the author instigated and co-organized a lunch-time discussion group during CVE98 (Tromp et al., 1998a), and a workshop on VE usability (Tromp et al., 1998b). The papers and deliverables authored and co-authored by the author of this thesis are reviewed in Chapter 9. Finally, the author was specifically invited to represent the COVEN project at USINACTS97 were and SID-CHAIN97.



The Approach

The COVEN approach incorporates:

- **The COVEN platform** which is based on dVS, an existing world-leading commercial VR platform from Division Ltd.
- **Enhancements** to dVS, prototyped on DIVE, the cutting-edge VR research platform from the Swedish Institute of Computer Science.
- **Advanced design features including:**
  - ñ multi-participant interactivity within a shared 3-D virtual environment.
  - ñ real-time visualisation of complex dynamic 3-D objects with variable-resolution graphics scalable distribution scheme over WANs.
  - ñ virtual humans, autonomous agents and virtual crowds
  - ñ more 'natural' interaction forms including speech and multi-modal interaction
- **Two CVE application scenarios** with which to test the advanced features of the COVEN platform. The first is a business-oriented 'Arena Tool' targeting professional users while the second is a citizen-oriented 'Travel Agent' application targeting the home user.
- **Extensive trials** of the platform, involving the National Hosts of the UK, The Netherlands, France, Sweden, Greece and Switzerland.

  The trials include:
  - network trials to establish the future networking requirements (e.g. bandwidth) of such a facility
  - usability trials to establish human factors issues for the successful use of such environments. Trials will be carried out over both ISDN and ATM networks.
- **Contribution to Standards development** specifically to DIS/HLA (distributed interactive simulations/high-level architectures), VRML (VR modelling language) and MPEG4-SNHC (synthetic & natural hybrid image coding) from the perspective of CVE applications.
- **Dissemination** of results through international conferences, open workshops and public demonstrations including EU organised dissemination events.

The COVEN skills base

COVEN Trials

Extensive network trials of the COVEN platform are planned involving the National Hosts of six European countries comprising the UK, The Netherlands, France, Sweden, Greece and Switzerland. A series of trials of increasing complexity will be carried out in three distinct phases, based first over ISDN and later over ATM networks.

At the heart of the trials will be the two CVE applications:

a. An 'arena tool' involving a virtual conferencing scenario and a 3-D spreadsheet-based business game which allows managers to investigate collaboratively various 'what-if' production scenarios (see Figure 2);
b. A Travel Agent scenario allowing home users to make travel arrangements to the island of Rhodes, including fly-over, hotel reservations and preview of monuments of historic interest (see Figure 3).

At each phase, both an assessment of network performance and human factors ('usability') issues will be carried out. The current phase of network assessment is focused on a subset of five COVEN sites and aims at parametrising the characteristics of the network traffic generated by the initial applications, and combining these with network emulation techniques in order to understand how existing network technologies such as ISDN and ATM might best be deployed to support CVE based applications.

The current phase of the usability evaluation trial is being developed as a set of experimental controlled case studies, to assess the effectiveness of the initial prototypes and the efficacy of its usage by the user group.

European Added Value

- The development of an integrated COVEN platform, based on Division's world-leading dVS product, will strengthen European presence in the future of the VE marketplace.
- The COVEN work on network modelling and trials will enhance understanding of the general requirements of future networking protocols for supporting CVEs.
- The standards work in the project will strengthen European involvement in key international standards initiatives e.g. DIS/HLA, VRML and MPEG4-SNHC.

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Figure 4.2b: Side two of COVEN brochure.