Chapter 6 Listening to CVE Designers

H1	***Need for design guidelines for CVEs*** Interviews, questionnaire, and design problem analyses.

6 Listening to CVE Designers

This chapter presents the results of five interviews with CVE designers, a questionnaire survey among the COVEN designers' about the usefulness of the COVEN design documentation. Common themes are outlined and compared to an interpretation of the type of design problems found during the COVEN usability studies.

6.1 Introduction

This chapter presents the early empirical work of the author on CVE design practise, in order to assess hypothesis 1. Current CVE design practise has been clarified through interviews with CVE designers, a short questionnaire on the applicability of the design guidelines as presented in the COVEN usability reports, and an analysis of the type of design problems found through the COVEN usability evaluations. These are by no means exhaustive in their description of the designers' tasks, but rather consider in pertinent detail each of the issues that seemed to shape the CVE designers' activities. This approach has been adopted in order to clearly identify the state-of-the-art design practise that governs how CVEs look and feel, at the time this thesis was produced. Furthermore, the analyses are aimed at uncovering what type of design guidance CVE designers seem to need and would like to use. The aim of this chapter is to make explicit the consequences of current design practise on the one hand and the type of design support that would be considered useful by the designers on the other hand, to describe the type of usability design guidance needed for CVEs and discuss the requirements of usability design guidelines for CVEs.

The next section presents the interviews (section 6.2), followed by a section that presents the results from a feedback questionnaire about the usability evaluation reports that were written for COVEN (section 6.3), and a section that presents the types of usability design problems that were found during the COVEN project. Finally, conclusions are drawn with regards to usability design guidelines for CVEs (section 6.5).

6.2 Interview with CVE Designers

In order to find out how to provide CVE design guidance the author together with Sandos, a placement Bachelor student from the School of Sociology at the University of Nottingham, asked five CVE designers to tell us about their particular design problems and practices in an interview of an hour each. Sandos followed a training in conducting interviews and took an active role in asking the questions, and the author guided the follow-up questions when necessary.

A basic form of analytical induction was used to draw conclusions from the interviews. We looked at themes that recurred in all five interviews (see Appendix E for the questions used during the interviews).

6.2.1 Methodology

In order to derive interview questions, first a designer was observed at work on a particular design. Interview questions were developed based on these observations and on background knowledge of CVE design issues. The interview questions were tested in two iterations of pilot studies on CVE designers. Based on the results of

these pilots the interview questions were refined and restructured. The interviews were guided by the following structure:

- Definition of task and role in design process.
- Design choices made for CVEs.
- Approaching an Assignment.
- Making (part of) a CVE.
- Sources of inspiration.

The five individual CVE designers all had a background in computer science, all were involved in building CVE demonstrators, using the C programming language, the AC3D graphics editor, and MASSIVE-2. Their experience ranged from work on one project for half a year, to work on eight+ projects for the past six years, building parts of futuristic stand-alone Internet based CVE software.

All but the pilot interviews took place in the workplace of the CVE designers, with the designers sitting at their computer. This allowed them to illustrate issues by showing examples of their work on the screen.

6.2.2 Results

The results from the interviews (an extensive amount of qualitative information about CVE design practises) are presented below. The relatively small number of interviewees (five) has to be noted when generalising from the results. Below we outline themes, which were found to be common to the design practise for CVEs.

- People working in CVE design do not really see themselves as designers because the whole process is broad and they have a specific role and specialism to bring to the process; unfortunately this means that CVE design is not a conscious process.
- There is a problem with defining collaborative behaviour in CVEs. Does it refer to communication or the ability to act on objects with the environment along with other participants?
- Hyperbole is rife: the designers' imagination, mission and purpose is not actually reflected in the results of their work. This leads to frustration but also an ideological rather than tangible perception of the value of the work.
- There is confusion between the natural world and natural laws and the familiar world created by social conventions and expectations.
- There seems to be a lack of clear realistic design direction amongst designers. Designing starts with the trivial and microscopic, building into the wider environment.
- Individualistic work cultures are common working practices. But, tough designers work by themselves, relying largely in their own ideas and seeking help only in practical cases, the ways they work and their approaches are strikingly similar, despite the different focus each designer has due to their own specialisms.
- Virtual worlds parallel real worlds; they are defined in this way so that will be intuitive to use. This brings with it a continuous trade-off between the amount of visual detail used and the effect this has on run-time performance.
- Dissatisfaction with the visual impact means that the interviewees feel that they lack the artistic capabilities to design the contents of the world.

- Testing is informal, often conducted by the designers themselves, or with a few colleagues. Typically no representative end-users are used.

The interviewees seem to interpret ‘design’ in two different ways; but often the same word is used to talk about two significantly different tasks:

A) Design in terms of implementation (assuming a designer with a computer science background).
B) Design in terms of appearance (assuming a designer with an artistic background).

Many CVE designers are performing both design tasks simultaneously, and the interviewees make clear that a lot of the frustration in their work originates from the fact that they feel they are not sufficiently qualified to do either kind of design. Both design tasks need to take into account how to make things usable for (multiple, collaborative) users. Each design task (A + B) belongs to a different discipline, with different associated skills.

The interviewees also seem to interpret ‘guidelines’ in two different ways, and again the same word is used to talk about two significantly different kinds of information:

A) Guidelines on how to implement objects and worlds in software.
B) Guidelines on how to design usable objects and worlds visually.

A strong need is expressed for guidelines of type A although, this may be situation dependent and only apply to these particular interviewees, and a strong preference is expressed for a certain artistic kind of guidelines of type B. But, they believe they would not use guidelines for design if they felt this stifled their creativity. They would rather see design tools created that allow artistic designers to design code to build CVE objects and worlds, or design tools with built in usability guidelines that would allow both types of designers to build artistic useable CVE objects and worlds.

During the course of the interviews the respondents were reluctant to define themselves as CVE designers. This analytical category had been created by us, to describe someone who is involved in creating CVEs. However the respondents were not keen on what seemed, based on the existing CVE literature, to be a fair descriptive term. The view varied according to the interests of the respondent. It generally seemed to be anything that they were not involved in. For instance, respondent 2 (R2) considered a CVE designer in these terms:

> *R2: "[T]here's a CVE designer in terms of the system and there's the designer in terms of the person who puts something together."*

Respondent 4 (R4), respondent 5 (R5), and respondent 6 (R6), were of a similar opinion: a CVE designer is someone who creates the content of a world. In contrast respondent 3 (R3), did think that CVE designer was a reasonable category to be put in, but s/he also said that s/he felt s/he had not done any actual CVE design yet (although in fact s/he had been working in the general CVE development area for almost a year).

In their own eyes, the respondents' contribution to the development of CVE is not seen as design, which they see as a separate process, distinguished from their own work. This leads them to identify more with their own research area than with the overall process to which their work is ultimately contributing. This can mean that they do not fully appreciate the extent to which their work contributes to and shapes the design of CVEs. By identifying other processes as CVE design, the responsibility for its development can be easily shifted. However, it has to be noted that the interviewees are all university researchers who work to demonstrate basic technological improvements and not commercial end products, so that this attitude may be a bias of our sample. Be that as it may, judging by the concern expressed by the interviewees about their artistic capabilities, even these CVE designers are aware of the fact that a good idea presented badly does not do the idea justice.

CVE designers use a number of terms that are recognisable to usability researchers. Terms like interaction, collaboration, sociability and functionality are words familiar in their work. However the way these words are used are very different from computer science, the background of the interviewees.

For instance, one of the important concepts for CVEs is that of interaction. When a sociologist discusses interaction, they look at the normative and cultural relationships that people have to create links between themselves and society. For usability researchers, interaction has a more technical meaning, it refers to the way that humans react to computers; how people use interfaces in achieving their job. For the interviewed CVE designers, the term interaction seems to refer to the mechanical

process of communication. The focus on interaction is technical, the emphasis is on making it work, or happen. Interaction is dissolved into a number of computer operations, obscuring the role of the users in these processes. This kind of reductionism - where words are turned into mechanical references - does create a potential 'language-gap' when CVE designers come to work in an interdisciplinary team with members from usability research, the social sciences, and the art community. The ideas, values, and use of language differ widely between the different disciplines; more so than each team member may be aware.

The end-user is not typically considered when designing:

> *R3: "[Y]ou have ideas and you want to test them out and so you write an application and then it is deciding which is the best way of transforming your ideas into something more tangible in terms of the application."*

> *R4: "[T]he approach has always been how can we improve it technically and not how can we improve it for users. The assumption is that technical improvements cause user improvements."*

Areas of sociology and cognitive psychology have been picked up and used by CVE designers. CVE designers are using ideas from the social sciences. However, they do not always feel that this information is very accessible.

> *R6: "[S]tuff like aesthetics and world building, if there is a literature it is outside the scope of things that I monitor. The sort of books that come out*

> *about VR I find to be extremely unsatisfactory containing 450% [sic] of gratuitous waffle with 0% insight. Presumably there are resources that exist within the areas of art, aesthetics, architecture and so on that one might attempt to translate into this arena. I have never yet seen it done well."*

All interviewees basically used a universally iterative prototyping working style:

> *R6: "I always like to have something that works no matter how trivial and incrementally extended. I would probably create a rough outer shape for it which would probably be a cuboid and assuming that it is going to have enough functionality in it to require its own programming behaviours, then code the skeleton class for it, instantiate it in the world, check that it is subject to the behaviours that I am encoding, then it is such a vague problem it is difficult to say more. I add some more features one at a time until I get the desired functionality."*

The interviewees used an informal usability test to evaluate their work. They try things out themselves, which could be seen as a kind of informal 'Cognitive Walkthrough', or they discuss it with a few colleagues; arguably a kind of informal 'Heuristic Evaluation'. Through this process they aim to understand the social dynamics of CVE interaction. This has a few consequences for the effectiveness of the iterative design process. Currently the design is being modelled on other professionals of the same discipline, as this is where they are being tested. This can result in a closed professional culture; drawing together professionals of the same discipline. This means that it is very difficult for outsiders to gain a detailed

understanding. This issue is of particular importance to the design of CVEs, as they are ultimately interfaces to social environments. The way CVEs are made today, influences our expectations and thoughts about the CVE technology of the future.

The interviewees seemed to have problems defining the design issues to support collaborative behaviour for CVEs. For some it referred to communication issues between participants, for some it referred to the ability for multiple users to interact on the same object without creating confusion. None of the interviewees had a clear definition of what makes a CVE collaborative:

R4: "[K]ind of manipulative collaborative malleable I suppose."

Any set of design guidelines need to take into account that CVE designers have to consider various issues on different levels and aspects. There are also discrepancies in the different things that designers bring to their work according to their own interests and expertise. Any CVE design guidelines could be split into the different issues and provide a basic breakdown of the things that CVE designers need to consider.

The designers interviewed have no clear strategies for designing CVEs. They have no clear understanding on the usability topics to address in order to design for the support of collaboration in CVEs. None of the interviewees work according to the so-called standard design method of requirements specification, conceptual specification, building prototype, testing, and rebuilding. Their primary concern seems to be to demonstrate functionality, and a second concern seems to be to generate publishable papers from these demonstrations (a function of their position within a university).

6.3 Feedback Questionnaire on Usability Evaluation Reports

A separate questionnaire was used to address the designer's community in COVEN. They were asked to give feedback about their reception of one of the Usability Evaluation deliverables (Del 3.3). This deliverable identified many usability problems found during an Inspection of the COVEN platform, in great detail. Twelve designers answered the questionnaire. Six designers confessed not having read the document, because they felt it had no direct bearing on their task. Three designers, who were directly involved in creating the design under evaluation, had read 80% of the document or more. However, the usability problems that were found during the Inspection, did have a direct bearing on the overall task of building a CVE. The three respondents found Deliverable 3.3 reasonably useful, but would have liked the advice on solutions to the usability design problems that were found, to be more specific. The respondents expressed the need for a type of step-by-step, procedural description of the relevant design principles. Indeed, the fixes made to the interface by the designers, after reading the information in Del 3.3, removed the identified problems while at the same time introducing new problems of a similar type as the ones removed (Del 3.5c). It seems therefore that there is a need to educate the designers themselves more about the underlying usability design principles, such as visibility and feedback.

6.4 Analysis of Design Problems

To specify the type of usability problems found the author of this thesis presents a number of quotes from Deliverable 3.3 (COVEN, 1997); and Combined Inspection Report 1 (COVEN, 1997) below. The type of usability problems found were:

1. System problems including lack of functionality, performance and display quality.
2. Interface problems that concern the actions of navigating, and picking of objects.
3. Application specific problems concerning the actual actions and meaning of objects within the environment.

These problems are listed below (in the tables (6.1-6.6) the manifestations of the problem are referenced with a code which refers to each respective problem as described in the inspection report (Del.3.3)).

System Problems

"System problems are not often apparent immediately but can result in less than optimum strategies having to be taken in interface and environment design. For example, perhaps the most serious problem encountered was navigating through the doors in the environment. Though ostensibly an application problem, since the door is simply an object with a behaviour, the problems were exacerbated by three factors. Firstly the fact the door opening causes the scene on the other side to be loaded, which results in a short stall as the relevant information is loaded. Secondly the script to control the door runs on a central server, so the remote clients have to send a signal, which delays the opening of the door. And thirdly, synchronisation problems between the client view, and the collision detection (which also runs on a central server) meant that although the participant might

see an open door, they could not enter because they had not got the correct response from the collision system." (See table 6.1)

Problem	Description	Manifestations of Problem
Application Start Up	The application start up procedure is fairly complex and time consuming. The "slide show" that accompanies the start up is unnecessary. Occasionally a participant will start near the floor rather than at normal height.	B.CG.1,B.CG.2, C.CG.1, C.H2.4
Scene load stalls	General problem of the rendering slowing/stopping when new scene components are loaded, either by changing zone, or objects being loaded for the first time.	B.CG.14, B.H1.3, C.H1.6
Centralised Script Evaluation	This leads to a few side effects, such as events appearing to be out of sync in different modalities and slow response to actions such as selection.	C.H2.5 (clock) doors - C.H3.9,
Centralised Collision Detection	An instance of the above which occurs fairly often and can lead to confusing effects upon collision when navigating.	doors - C.H3.9
Generalised Undo	No general way to undo actions such as selections or navigation if they were accidental. If these have semantic effect, such as playing the CD, this is a distinct disadvantage.	B.H3.9, C.H9.1
Object Locking	No concept of ownership or indications of action	B.H3.8
Selection Highlighting	All objects are selectable, which might lead one to believe they had some function, but can also just look slightly odd, when, for instance, the whole room has been selected.	B.CG.40, B.H1.1, B.H4.1, B.CG.13
Independent Selection	Selections are exclusive.	B.CG.40
Audio Conferencing	Apparent disassociation between VE events and positions and audio channel.	B.H10.3, B.H10.2
Unique Collision Detection Reporting	Each object only reports collisions with one other object, which has a number of side-effect, especially in the use of the bandy box.	B.CG.32
Multimedia scripting	Difficult to schedule of 2d multimedia presentations, in particular there would appear to be some deficiencies in the control of timed events.	C.CG.28, C.H3.5, C.H3.10
Feedback	Inconsistent feedback on object interaction. .	Many instances

Table 6.1: System Problem Classification

Interaction Problems

"Since both the initial demonstrators are for use on desktop systems, it is not surprising that there are some interaction control problems since this is a known problem area. Essentially problems arise because an input device with

few degrees of freedom is used to perform six degree of freedom tasks. These can involve problems with interface modalities, such as there being several control modes depending on which mouse and modifier buttons are depressed or the actual mapping of user motions into three dimensional transformation. These are aspects of the interface that are plainly not obvious to a naïve user. Interaction control problems thus tend to be pervasive across applications since they are constrained by the capabilities of the underlying VR toolkit." (See table 6.2)

Problem	**Description**	**Manifestations of Problem**
Interface "level"	There can be a confusion about the manner in which an action is performed, at a 2D interface, by a mouse action, by a action within the VE or by using the keyboard. All modes are used at the moment,	B.H4.6, implicit in the carrying out of other actions
Modal Control	Mouse control is inherently 2D, so many modes are used. There is a implicit mode in the area on the screen in which a manipulation is made.	B.CG.6, B.CG.7 B.CG.9 B.CG.28, B.H6.2, C.CG.3, C.CG.4, C.CG.5, C.CG.6, C.H1.5, C.H7.1
Un-separable Control Dimensions	When moving forwards at speed, the view turns unless the mouse is dragged directly upwards which is difficult to perform	B.CG.10, B.H3.7
Manipulation Relationship	The cursor does not have to be over the object when moving it, which can lead to confusion.	B.CG.49
Navigation/Manipulation Disjoint	Objects can not be held when navigating since both are activated by the mouse. This make it difficult to move objects long distances, or between rooms.	B.H3.2
Granularity of Manipulation	Precise object manipulation is hard because of the nature of the dragging motions involved.	B.CG.53, B.H3.10, B.H3.6, C.H2.3, C.H7.3
Object Manipulation	Moving objects over long distances takes a lot of mode swapping and dragging options.	B.CG.27, B.CG.36, B.H3.6
Manipulation Constraints	Because the direction of object manipulation depends on the area of the screen the drag occurs in, it can be confusing when a constraint is also applied since it is difficult to tell whether the objects is moving or not. Some extra feedback is necessary.	B.CG.50, B.H1.6, B.CG.28, B.H3.6
Automatic/Object Centred Navigation	In certain cases objects are being inspected or destinations for navigation are known, automatic or objects centred techniques would seem to be appropriate.	B.H7.2, C.CG.61, C.H3.9, C.H7.5
Navigation Velocity	Navigation occurs at a fixed speed, and this can appear slow.	C.H7.4, C.H7.1, C.H7.7

Navigation Constraints	Application of navigation constraints (flying on the level verses free direction) seems arbitrary and is not a user controllable option.	C.CG.7, C.CG.59
Re-orientation/Re-location Methods	There are no general tools to align oneself to the world, or return to a sensible position. Co-ordinates can be typed in directly, this relies on the user knowing suitable co-ordinates	B.H9.1, C.CG.7, C.H3.1, C.H3.3
Selection at a Distance	May not be a desirable facility although it means that certain tasks may be performed more quickly. It might lead to more mistakes since not just objects within range are candidates for selection. It has ramifications for group awareness.	B.CG.35, B.H3.3
Selection/Manipulation Choice	Not always obvious whether an object has a behaviour on being selected, on being manipulated, or can actually be picked up. This is not consistent, and also prevents some objects being moved, since the perform their action first.	B.CG.12, C.CG.19
Continuous Navigation Control	The behaviour of the navigation when the frame rate is low can be confusing. The motion can appear jerky anyway, but when the scene freezes unpredictable results can occur.	C.CG.57, C.H7.6
Multiple Interaction Metaphors	There are three ways of moving, by mouse navigation, form input in the body control, and occasionally in-scene controls. In addition in the citizen application is it possible for another person to move you by operating the carpet.	C.CG.51, C.CG.54, C.CG.53, C.H4.7, C.H4.8, C.H8.7
Direction of Travel	Since navigation is in the direction of look, moving around an object is hard since the user must look away from their focus of interest.	B.H3.1, C.CG.7
Appropriate Viewpoints	In some situations it is not obvious where the best viewpoint to perform an action is. Especially when manipulations have to be made.	B.CG.51. B.CG.52, C.H3.3, C.CG.14

Table 6.2: Interaction Problem Classification.

Application Problem Classification

"Although the efficiency with which a particular task is presented depends upon the interaction metaphors, there are more general problems with the participant's understanding the purpose of the application components. In the context of VR research this has often been referred to as a problem with the affordances of the objects in the environment. There is a balance to be struck between making the objects realistic in appearance so that they may be recognised, and making functionality apparent to the user. A great number of

particular problems were noted in the inspections." (See table 6.3, 6.4, 6.5, and 6.6)

Generic Coven Services		
Problem	**Description**	**Manifestations**
Communication - Message Control	Need to know or find out the name of an object or person before sending a message. There is no error feedback when an incorrect name is entered.	B.CG.34, B.H5.4, B.H6.5, B.H6.6, C.H2.2, B.H9.3, C.CG.64, C.CG.65, C.CG.71
Communication - Message Display	Messages get truncated after two lines. There is no hard limit on the length of a message when entering it nor a signal that the end of the line is approaching. This is exacerbated by words disappearing when the name of the sender is pre-pended to the text.	B.H3.4, B.H4.2, B.H5.2
Communication - BlueBoard Display	Once an object has been copied to the blueboard it can be manipulated and moved away. This potentially leads to several copies of the same object existing in the world which might cause confusion.	B.H2.5, B.H4.4, B.CG.13, C.
Communication - Audio	Many problems exist with the audio since it is not fully integrated with the VE system. There is no feedback about the quality of your own audio when received by others. The RAT controls also seemed slightly un-intuitive.	B.CG.16, B.CG.17, B.CG.18
Communication - HoloView Display	The fact that the HoloView display is flat doesn't immediately suggest that 3D objects can be displayed. The size of objects once presented can be surprising.	B.CG.24, B.CG.31
Communication - HoloView Control	The remote control for the HoloView is fairly abstract and its purpose is not at all obvious. It is only useful for an immersed participant behind a desk since a desktop participant can select and manipulate the object from any distance.	B.CG.35, B.CG.36, B.H3.4
Communication - Holoview Commands	Text input is hidden, in that it is never apparent when a text message is required or even that it can be done	B.CG.19
Object Manipulation - Selection Consistency	All objects are selectable, they can change colour to indicate action, but this must be consistent. Most objects (those without any role in the application) should not be selectable.	B.CG.48, B.H4.1, C.H4.4
Object Manipulation - Picking Consistency	Many objects can be picked in the environment, but this does not always indicate that this has any use or meaning given the semantics of the application.	B.H5.3
Mutual Awareness - Actions	There is little feedback as to what the other people are doing in the environment. In particular when a person speaks or moves an object there is no indication from their avatar that they are doing anything.	B.H10.4, B.H10.5, B.H10.3, B.H10.2
Mutual Awareness - Avatar	A full body is presented, but it doesn't move very much which might confuse people (they might think their body is "broken"). In addition it would be very beneficial to be able to set ones body colour once inside the application.	B.CG.37, B.CG.62
Mutual Awareness - Positions	In general with the desktop display it can be difficult to remember the positions of others since there is a lack of peripheral vision. Since peoples' voices are of a constant	B.H10.1, B.H10.2, C.CG.63, C.H1.1,

	volume no matter how far away or which room they are in it can be confusing when trying to remember that they are remotely situated.	C.H10.1
Group Navigation - Group Formation	The mechanisms for group formation seem to be too mechanical and unwieldy. More transparent support is needed for joining and leaving groups. The role of group leader would seem to complicate the interface issues since they have sole control of the Notebook.	C.H1.3, C.H6.4
Global Map-	Although the Rhodes Zone itself can be considered a global map since it can be experienced at several scales, there is no overview to provide a context at smaller scales.	C.H6.6

Table 6.3: Application problems; generic COVEN services.

Application Common		
Problem	**Description**	**Manifestations of Problem**
Orientation/ Relocation Tools	There is a need for better re-orientation tools since it is easy to get lost in the environment. To some extent this can be done in the body dialogue but it is not at all obvious what the required values should be.	B.H9.1
Object Collision	Object intersection is preventable, and makes sense for most objects.	B.H2.2, B.H5.1
Room Functions	It is not obvious once in the applications what or who might be found behind the doors. Some sort of labelling would seem appropriate.	B.CG.8, C.H8.3
Affordance Issues	The realistic style of the rooms and furniture doesn't hold throughout application. For example the HUD controls and teleporter seem to break the metaphor for the design of the rest of the environment.	B.CG.11, B.H4.5, B.H8.1, C.CG.1, C.CG.12
Door Opening	Not immediately obvious how you open doors. The choices would appear to be: automatic opening on approach, open on select, open on select and drag, open on rotation of handle. It needs to be obvious and consistent. Also the door can slam in your face and sometimes you get through the door only to be "pulled" back.	B.CG.12, B.CG.13, B.CG.38, B.H7.3, C.CG.8, C.CG.9, C.CG.10, C.CG.11
Object Consistency	Related to affordances, but in particular the maintenance of object class distinctions, door sounds are consistently applied.	C.CG.35, C.H3.9, C.H4.1, C.H4.6, C.H4.7, C.H4.9

Table 6.4: Application problems; application common.

Business Application		
Problem	**Description**	**Manifestations of Problem**
Application Context	The business application starts up initially in the room with the business game. If they are undertaking a conferencing task it might more sense to start in the other room. A 3rd "neutral" room (such as the VTA in the Citizen application) might be appropriate.	B.CG.3
Business Game Rules	There is no information in the business game room about the objectives or rules of the game.	B.CG.4, B.CG.5, B.H2.6, B.H4.5

Desk Choice	In the conferencing room there are several desks and no hint whose is whose or even if this is important.	B.CG.20
Bandy Box Control	The bandy box controls are complex and its capabilities are not obvious. There is little feedback when facing the box on whether an error has occurred or the object was successfully sent. It would seem to be impossible to reset the Bandy Box to show no object. Reliance on text controls means that it is impossible to use with immersive display.	B.CG.21, B.CG.22, B.CG.23, B.CG.25, B.CG.26, B.CG.30, B.CG.40, B.H1.2, B.H1.4, B.H2.1, B.H2.3, B.H3.5, B.H4.5, B.H6.1, B.H6.3, B.H6.4, B.H7.1, B.H7.4, B.H9.4
Slide Control	The sequence of actions to operate the slides is not obvious. Focus must be indicated by selection which is not obvious. Also not obvious which objects are actually slides and which are plain objects.	B.CG.41, B.CG.42, B.CG.43, B.CG.44, B.CG.45, B.H1.5, B.H9.1
Slider Bars	The handles on the slider bars are difficult to see. There is no feedback when limits of slider bar movement are reached.	B.CG.46, B.CG.47, B.CG.50, B.CG.53, B.H9.5

Tab 6.5: Application problems; Business application.

Citizen Application		
Problem	**Description**	**Manifestations of Problem**
Remote Control	The functionality of the remote control is a little obscure. It seems to duplicate some functionality available elsewhere. The control clutters the display somewhat, especially when a notebook is added.	C.CG.2, C.H2.1, C.H4.1, C.H4.3, C.H4.7, C.H5.1, C.H6.1, C.H7.2, C.H8.2, C.H8.6
CD Selection	The CD titles are hard to read. The layout would seem to limit the number of slide shows that can be supported.	C.CG.15, C.CG.16, C.CG.17, C.CG.19, C.CG.20, C.H1.7, C.H7.8, C.H8.4
CD Player	The controls on the CD player are hard to see and activate. Not obvious that selecting the CD automatically plays it rather than a button control on the player.	C.CG.14, C.CG.23, C.CG.24, C.CG.26, C.CG.27, C.CG.29, C.CG.30, C.H1.8, C.H1.9, C.H2.6, C.H4.8, C.CG.22
Slide Show	A video tape would seem more appropriate if pictures are going to be displayed. There does not appear to be a way to pause or wind back the presentation once it has started.	C.CG.21, C.CG.18, C.CG.25,

	There are also problems with synchronisation between video and audio.	C.CG.26, C.CG.27, C.H1.9, C.H3.10
Teleport Buttons	The controls for the teleporter are not obvious since they are unlabelled. Indeed one has to open the teleporter first before these controls become apparent.	C.CG.33, C.CG.43, C.CG.44, C.CG.45, C.CG.46, C.CG.47, C.CG.48, C.H6.3, C.H8.2
Teleport Machine	No hint of the teleporter's function or mode of operation. It is not obvious that the participants must stand inside the teleporter. Indeed this is hard to gauge on the desktop system. Error conditions aren't handled yet.	C.CG.31, C.CG.32, C.CG.34, C.CG.42, C.CG.49, C.CG.50, C.CG.67, C.H1.2, C.H1.4, C.H1.10, C.H4.9, C.H9.3, C.H9.4
Notebook	The functionality of the Notebook is not obvious. It has several buttons and a window that seem to be inoperative. The user will probably not expect the Notebook to attach to the visor upon select. If one then tries to move the Notebook in order to reduce screen clutter it is dropped. Some functionality is duplicated with remote control.	C.CG.36, C.CG.37, C.CG.38, C.CG.39, C.CG.40, C.CG.41, C.CG.66, C.CG.70, C.H3.6, C.H4.2 C.H4.3, C.H4.5, C.H4.6, C.H5.2, C.H5.4, C.H5.5, C.H5.1, C.H8.1, C.H8.5, C.H8.6, C.H9.2
Carpet Controls	The carpet controls have two main drawbacks. The participants can be moved independent of their own controls, and they might suddenly find them selves in mid air when they are afraid of heights.	C.CG.52, C.CG.53, C.CG.55, C.CG.56, C.CG.58, C.CG.67, C.CG.68, C.H1.1, C.H6.5
Site Icons	It is not obvious that the site icons have to be clicked upon to enter. This is a third transformation type control (c.f. walking through doors or teleporting). The use might expect more information before teleporting.	C.CG.60
Hotel Icons	The hotel icons are presented without a reference scale in order to compare or look up information.	C.CG.69, C.H6.2

Table 6.6: Application problems; Citizen application.

The usability design advice derived from the Inspection (Del 3.3) ends with a detailed list of suggestions for design alternatives that should be more efficient was created

(see Table 6.7). Whilst some of these suggestions are taken directly from the inspection data, most were generated by subsequent discussions between the Inspectors and the designers.

Generic Coven Services Suggestions	
Problem	**Suggestion**
Communication - Message Control	Ideally a more visual metaphor for selecting services via a menu. Alternatively a two stage approach to entering a message, where the first stage is specifying the name, which is checked and then the message itself can be entered
Communication - Message Display	Some facility to send longer messages would be useful, combined with better reading facilities and an ability to read previous messages. This might best be combined with the suggestion for a combined Notebook (see suggestion in Citizen Application table).
Communication - BlueBoard Display	Simplest way to improve would be if the blueboard objects' copies could be rotated only. Maybe the copies could be drawn slightly transparent to indicate they are not "real" objects.
Communication - Audio	A technological challenge, but experience suggests it might be vital to know who is speaking which would require some sort of animation of their avatar.
Communication - HoloView Display	The holoview might be better represented as some sort of "container" into which the object is copied rather than a straight copy of the actual object. This makes it more apparent that the object is "projected". Something simple like a museum display case might be appropriate
Communication - HoloView Control	The holoview position controller is fairly redundant. The control is only useful for an immersed participant, and then it would be useful for ALL objects not just the holoview.

Table 6.7: Detailed list of suggestions for design alternatives for COVEN (Del.3.3).

6.5 Conclusions

Hypothesis 1 seems to have been positively confirmed. Designing for CVEs proves to be a multi-faceted task that is not fully understood, without readily available guidelines. Improving current understanding and knowledge about usability design for CVEs should involve a number of strands. A better understanding of what constitutes collaboration in CVEs is needed. A better understanding of the level of detail, and degree of realism necessary to support users in their task is needed. A better way of presenting the usability design principles is needed. A general direction for such design support could be in the shape of lightweight automated hints in world

construction tools. The author of this thesis has made an attempt to create a method with which an incrementally refined design specification can be build, based on cognitive psychology, team-work, and a systematic interaction analysis technique (this method is presented in Appendix F).