e S C A P E

Common Methodology

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Table of Contents

Section 1: Disciplinary Perspectives

Section 2. Common Experiences

Introduction and Overview

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One of the central motivating aims of the eSCAPE project has been concerned with developing the future paradigms essential for the use of Virtual Environments as a means of providing inhabited information spaces. eSCAPE has attempted to support the integration of inhabited information spaces by the development and appreciation of a common methodology, incorporating ideas and techniques from computer sciences, social sciences and interactive media arts.

In this deliverable we will focus on experiences of bringing these previously disparate traditions together in order to tackle the problems associated with the construction of new forms of interactive environment. The convergence of these disciplines that has taken place during the three years of the eSCAPE project has a seen a growing understanding of the nature of each discipline and the different contributions each brings to the development of virtual environments in general and electronic landscapes in particular.

Within eSCAPE we have tended to consider the combination of different disciplines as a practical and pragmatic matter. Consequently, we have tended to combine these disciplines in practice rather than consider links at a more abstract or theoretical level. The move towards a common method described in this deliverable reflects the practical orientation of the project's approach. Thus, rather than present an overarching theoretical framework we focus on the techniques and experiences gained from combining these disciplines in practice.

The focus on practical experience is reflected in the general structure of this deliverable. The deliverable has two main components. Section One focuses on conveying the eSCAPE project from three main *disciplinary perspectives*, computing, social science and interactive media art. In separate chapters we present descriptions of the core research of the project from artistic, social science and computational perspectives. These perspective chapters reflect the diversity of experiences involved in the project and provide an overview from their starting disciplines of utility to those about to undertake an endeavour of this form. The presentation of these different perspectives is complemented in Section Two by a series of illustrative *common experiences* describing different collaborative activities undertaken in the project. These descriptions focus on the different ways in which we have combined different traditions and disciplines in order to meet the objective of developing an electronic landscape.

The involvement of interactive multimedia arts within eSCAPE has been motivated by the need to develop e-scapes which are aesthetically interesting, engaging and challenging, invite interactivity and are pleasurable to inhabit. The challenge for the social sciences has been to motivate and inform technical development through field studies and to assist in the development of evaluation strategies. For the computer sciences the interest has been to develop novel interaction techniques and displays that are appropriate to e-scapes and the connectivity they provide and to provide techniques for the long-term management of e-scapes, their initial set-up, maintenance and technical-infrastructural support. The overall challenge for the project has been to integrate and adapt these different research and design methodologies, approaches and concerns into a common methodology.

Interdisciplinary Communication

Development of all applications - and electronic landscapes are no exception to this - by necessity involves a greater reliance on meeting particular user needs. Applications are often developed in the context of a laboratory or software house and designers and developers often have only a partial knowledge of the setting and circumstances of use. This can produce a mismatch between the design and development process and important features of the setting in which the application comes to be used. This may prove to be a central problem in the design of applications such as e-scapes, which need to provide support adequate to the socially situated features of user activities.

A variety of methods and approaches have emerged to support design activity through the capture of various user experiences and needs and the development of requirements. Although, historically, these have mostly been from within a single disciplinary perspective the approach of the eSCAPE project has been to attempt to take very different disciplinary approaches and perspectives on the design process and use them to inform the design process. This constitutes a movement towards developing a ‘common methodology’, not in the sense that eSCAPE postulates a single or even combined approach, and certainly not that any single disciplinary approach predominates, but in the sense of a common appreciation of the strengths each perspective brings to design.

It is vital to understand from the outset of any discussion of individual disciplinary approaches or the development of a ‘common methodology’ that there is unlikely to be any ‘silver bullet’ to resolve the problems of systems design. In the context of developing a common methodology the task is essentially a matter of establishing effective interdisciplinary communication. The approaches of the different disciplines are informed by different foundational principles, different sets of assumptions, and different conceptual frameworks, which may shape the kind of questions asked or the method is seen as capable of answering. In the context of eSCAPE, the movement towards developing a common methodology must serve the *practical* purposes of system design. It is this that makes eSCAPE an interdisciplinary endeavour. This means that a method must also be able to identify, describe and analyse relevant aspects of the setting, the e-scape and its activities so that design is adequately informed. It is also important to stress that many of the methods used to inform design are themselves being worked out and that what is important is developing a better sense, through an effective dialogue between the different approaches of social science, art and computer science, of just what a method can and cannot deliver.

To convey the fluid nature of this field we present two different sets of understandings within this deliverable:

- **Disciplinary perspectives** are presented in Section One of the deliverable. These provide insights into the eSCAPE project from the perspective of different disciplines. These aim to inform those about to undertake interdisciplinary endeavours of the form of eSCAPE about the differences in disciplinary views.
- **Common experiences** are presented in Section Two of the deliverable. These present different sets of everyday practical experiences where different disciplines have worked together to develop particular electronic landscapes.

In the following sections we briefly review each of these in turn before they are presented in the main body of this deliverable.

Disciplinary Perspectives

In *'**Artistic Perspectives on eSCAPE'*** the rationale for artistic involvement within the eSCAPE project and the contribution to the development of a common methodology is described. The aim has been to realise a systematic and meaningful role for artistic input in the design process. The construction, habitation, comprehension and socialisation of virtual space require artistic input to provide a creative approach which learns from artistic perspectives and presents the possibility of viable augmentation and enrichment of experience.

Artistic interest and involvement is based on the assumption that information is the fundamental material of media art and that the information societies are themselves shaped by technological standards. While artistic involvement in design is commonly equated in terms of making an artefact more 'attractive' design and functionality are necessarily deeply intermingled if the final product is to be user-friendly, sensible and attractive. In eSCAPE the media artists were dealing with technological tools that have had a powerful shaping effect on contemporary media art and that necessitated collaboration with technical and scientific specialists. This required that the artists' own technical understanding had to be sufficient for them to grasp the conceptual implications of the technology being used. The artistic involvement included acting as translators and mediators sustaining the collaborative work through a synthetic vision of the work in progress whilst keeping sight of the final aesthetic goal.

Artistic involvement' in eSCAPE has proved itself a valuable resource in developing a common methodology in a number of respects. It interpreted and transformed the project's objective of 3D information visualisation into three-dimensional meaningful spaces with the intention of being valuable to their audience/users. By abstracting the characteristics of the various approaches, the two essential kinds of electronic spaces could be defined, and abstraction of the art works provided a set of ‘organisational principles’ or structure. Throughout the project, artists developed and presented new ways of thinking about the design process acting as both a design catalyst and a comment on evolving solutions. Artists, social and computer scientists and designers explored and distilled ideas, generating new awareness and energy for innovation.

The chapter on ***Social Science Perspectives on eSCAPE*** provides some reflection on the varied ethnographic studies, conducted by the project, in order to progress towards a methodological framework for the study, design and development of electronic landscapes. Ethnographic or observational studies have gained some prominence in recent years throughout the design process with their claim to allow a more effective bridge between the system’s design and development process and the setting in which it is located and utilised. As Hammersley writes; “The purpose of ethnographic analysis is to produce sensitising concepts and models that allow people to see events in new ways. The value of these models is to be judged by others in terms of how useful they find them..” (Hammersley 1992: 15) What we need to appreciate in approaching the design of VR systems is the social organisation of the setting as seen and understood by parties to that work. Furthermore, we need to develop an appreciation of particular aspects of social organisation that are of relevance to the design task. The design task in the eSCAPE project has been one of developing virtual environments or spaces. Consequently, the focus on social organisation is directed towards developing an appreciation of the social construction of space and place. Of particular importance is the attention paid to the embodied work by which spatially situated action in the various e-scapes is accomplished and a number of themes relevant to the design of electronic landscapes have emerged. The move towards a common methodology is then grounded in empirical and theoretical work in the social sciences. This grounding emphasises the importance attached to basing the development of e-scapes on what is known about human activity in real social spaces in order that we might relate this to the design of virtual environments.

Given that it is important to make virtual environments publicly intelligible and that VR environments need to be learnable, the ethnographic approaches deployed in eSCAPE have furnished the design process with some sensitivity to the importance of background expectancies and schemes of interpretation in making sense of spaces and places and the role they play in accomplishing coordinated activity within virtual environments. Our studies have emphasised the use of material arrangements within VR worlds and the provision for monitoring and coordination of user interactions within the VR world. The essence of these observational studies has been to regard participants in VR worlds as engaged in a day-to-day business, exploiting local knowledge, mobilising everyday skills and competences, managing turn-taking, displaying attentiveness and orienting to presence, in the attempt to make the VR world recognisable and reliable. The design principle to emerge from this is then that interaction within the VR world trades upon mundane skills and competences The ethnographic studies demonstrate that virtual reality is observably 'worked up' as an orderly arena for action through the ordinary interactional competencies of participants. The utility of virtual space and user embodiments is then not produced by the technology alone but has to be worked on, maintained and repaired in the light of ongoing activity in both real and virtual worlds

The ethnographic emphasis on the 'social construction' of place and space through background expectancies, the methodical use of the material arrangements and monitoring and coordinating methods provides the common methodology with a framework for investigation into alternate settings. This framework provides a focus for the design of virtual environments by grounding research and design in practical socially organised situations of use. However, there is no *intrinsic* design significance to the results of an ethnographic study, for such significance must be *relative* to the nature of the design exercise itself. In the move towards a common methodology it has to be accepted that the kinds of changes to design which will result from our approach are intended to be incrementa*l* rather than transformative, and that it remains the case that it is for *designers* to draw design conclusions from the results of ethnography.

Finally, the ***Computer Science Perspectives on eSCAPE*** chapter introduces the motivation underpinning the turn to the social and artistic within eSCAPE. The chapter introduces the development of spatial models as a means of supporting cooperative work and the way in which spatial considerations have arisen within the CSCW community. The chapter presents a consideration of the importance of understanding space that mirrors the discussion of space from a social science perspective. However, rather than consider the social and constructed nature of the space the computational perspective considers the means by which different computational representations can be used to model spatial structures.

The chapter presents a discussion of the different forms these spatial models can present and outlines the basic challenges facing the development of virtual environments that underpin the computer science involvement in the eSCAPE project. The chapter briefly reviews these challenges in terms of the ways in which they have been addressed within the eSCAPE project and how these have been addressed in partnership with other deliverables.

The chapter also stresses the diversity of computer science issues involved in the development of electronic landscapes and to illustrate this provides an individual tour of the eSCAPE project from the perspective of one of the computer science researchers. This section of the chapter describes how the research activities and agenda of the AIG group and Virtual Environments has been advanced by involvement with other disciplines within eSCAPE.

The chapter concludes with a brief presentation of a semantic model of space. This model is undertaken from the perspective of computer science and is provided in order to illustrate the lack of subtlety of these models and the need to complement what is essentially a structural model of the space with a greater understanding of how this space is used and experienced.

Common Experiences

The presentation of the perspectives within the first section of this deliverable are complemented by the presentation of a set of common experiences that illustrate how an electronic landscape designed to meet a particular purpose is developed in practice. This section uses the development of an abstract electronic landscape to meet the needs of a library community that wish to search for on-line information to illustrate the key stages of the development process.

The chapters in this section are basically structured around a simple four stage methodological account of how eSCAPE has developed links between interactive multimedia art and the construction of real world virtual environment applications. The core of the approach outlined in this section focuses on the generation and use of novel "blue sky" concepts. Essentially four important activities are outlined and described.

The generation of "Blue Sky " concepts through the development of novel interactive art.

The grounding of "Blue Sky " concepts by positioning new concepts against detailed studies of settings.

The configuration of "Blue Sky " concepts through the iterative and user centred development of real world applications.

The calibration of *"Blue Sky " configuration* by undertaking situated evaluation of these concepts in practice.

These four key activities can be considered in terms of the principal stages envisaged in the development of cooperative electronic landscapes. The aim of this section is to illustrate these key activities in practice and to present this as a potentially useful methodological approach for future development.

Chapter 1 Artistic Perspectives on eSCAPE

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Art implies values more various than those determined by practical necessity.[1]

In this chapter the rationale for artistic involvement within the eSCAPE project will be explicated. In the first part some general considerations relevant to the evaluation of artistic productions for system design will be outlined. The main focus is on the social dimension of artistic production, seeing the aesthetic as rooted in society and culture. The second part will reflect on and evaluate some learning experiences from the project. The emphasis here is on turning these learning experiences (both positive and negative), that have emerged through the artistic involvement in the project, into the project's values.

Art as a model for society

The *socio-cultural constructivist* approach of the multi-media researcher Siegfried J. Schmidt presents a moderate and environment-referential theory of art. In the specific context of media art, Schmidt explores the aesthetic condition of our reality(ies) which is – according to him -marked both by its constructive character and through its presentation by fictional means. At the same time such reality is plural, full of conflicts and fluidly defined. In opposition to some general understandings, 'construction' here does not simply mean an intentional position, but instead defines an empirically highly conditioned process, in which realities are developed as *reality-concepts* that derive their force from their interactive and communicative proving and viability.[2]

In the context of media art Constructivism is an especially interesting theory, because it refers to the mathematical, cybernetic and neuro-biological, i.e. scientific world-models, which have always played a decisive role for the production of media art. Not only are computers and media technologies built upon cybernetic models, they are, at the same time, able to simulate evolutionary programs, which are important for the 'Artificial Life' and 'Artificial Intelligence' Research. The intersection of scientific and artistic projects such as the interactive installations by Christa Sommerer & Laurent Mignonneau, Torsten Belschner &

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[1] Sir Herbert Read (1934): Art and Industry – The Principles of Industrial Design; Faber & Faber, London.

[2] Siegfried J. Schmidt (1993): Wissenschaft als ästhetisches Konstrukt? [Science as an Aesthetic Construct?], Fischer TB, Frankfurt a.M.

Bernd Lintermann or by Karl Sims represents a challenge to the differentiation of the media art system.[3]

Within the constructivist discourse, Schmidt presents a position, which integrates environmental issues and socialisation mechanisms. By doing this he distances himself from a strongly deterministic-evolutionary position which is based on neuro-biology. Additionally, more than once he criticises media theorists like Friedrich Kittler or Norbert Bolz whom he is accusing of reducing the human consciousness to an ‘appendix of mediated-technical dispositive’ and to acknowledge media a sovereignty that does not allow for a self-referentiality of the human-being. In respect to an observation of the art system, Schmidt defines a *multiple-level- and multiple-component-model* of systems, consisting of the following components: actors, media offers, institutions/organisations, communication, interaction and symbolical orders in the sense of *culture*. Under the term 'culture’, Schmidt summarises the programme for the socially obliging, semantic universal interpretation of the reality-concept of a society. The constructivist understanding of reality is based on reflections on ‘differentiation’ and ‘difference’, which allows us to perceive the environment. Based on our (socialised) knowledge, we construct a difference between objects (containers for meaning) and environment and consequently construct a reality.

Now, what makes the reality-concept a general symbolic order, is the permanent reflection about it in the form of communication. Through the act of communication socially reliable orders of differentiation and naming are established. These differentiations and namings construct a network of further differentiations and namings, which – according to Schmidt – are affectively and normatively defined. He calls these networks reality-concepts in the sense of concepts *for* reality and not in the sense of concepts *of* reality. Whether this reality actually exists, as a physical environment, is irrelevant since meaningful environments are constructed and established by individuals through difference-models. Reality-concepts are in need of a permanent topicalisation, observance and legitimisation through individuals. The necessary socially obliging semantic is *culture*.

What makes Schmidt interesting, both in the context of discussions of ‘Art and Technology’ as well as for the eSCAPE project, is how he emphasises the differentiation between culture and art. For him, art, rites or institutions do not define culture, as the conservative definition of culture implies. Rather, only in applying the programme ’culture’ appropriately, something can emerge, which can be called art (rites and institutions). The cultural programme defines what art is, and only through it and only once it is over, is it confirmed by each art piece in its importance. Culture (as a learning programme) solves a two-fold social task: the reproduction of the society and the control of the individuals’ possibilities to act over symbolic power. By this, art as a construct is only possible within or

[3] The interactive installations of Sommerer/Mignonneau as well as of Belschner/Lintermann have been described in the eSCAPE deliverables 1.1 as well as 2.1.

based upon a cultural programme. Schmidt stands for a very broad cultural term, which allows art to become art.

For the constructivist cultural programme the media plays a fundamental role. A mutual complementary relationship exists within the overall-media-system and as new media develops the complexity of the overall-media-system increases. This complexity results in a plurality of sense-constructions that simultaneously make successful communication difficult. Individuals are communicating by reproducing and representing *media constructions*. For Schmidt this means the cooperative realisation of a social action; the communicative reproduction of the expectations' structures on which it is based; and the coordination of sense assignment by the actors ("Only through communication the speakers learn (and experience), what they meant, by saying, what they said. For this reason cognition needs communication, in order to know what it does – and vice versa.").

Schmidt describes the different *functions* of media within modern society as follows:

- Media plays an important role for the individual as well as the social *construction of realities*
- Media have become a powerful *instrument of socialisation*
- Media influences the *relation between memorising and forgetting* (history and presence or identity and difference)
- Media changes the *production types of communication*
- Media produces increasingly different *realities*
- Media changes the understanding of *public and politics*
- The *observation of societies* is changing.
- *Digitalisation* plays especially for the media technologies a crucial role, since it permanently writes the conventional concepts of author and recipient, of information and communication, of interaction etc. anew.

Schmidt understands art as a media-offer that is considered as art. He sees the art-term established via socially developed attitudes, prototypical expectations and communicatively relevant evaluation categories. Consequently art exists because of the difference between symbol system and social system. As symbol system, art exists as a "communicatively or discursively ordered quantity of media construct. Art as ordering categories means that relations defining kinds, authors, schools, epochs and so on, as well as intertextual relations, are possible."

As social system art exists as the above mentioned multiple-level- or multiple-component-system consisting of actors, media-offers, institutions/organisations, communication and interaction (production, mediation, reception/usage and processing system-specific media-offers) as well as symbolical orders.

Art conditioned by media technology establishes a clear cut in the development of the social system art, insofar as media art replaces traditional art pieces via interactions of programmes and users and because a stable trigger mechanism for the process of meaning construction does not exist anymore. The traditional dichotomies of reality and virtuality, truth and fiction, authenticity and simulation necessarily change their semantics under the pressure of the technical possibilities to produce images without model.

However, this situation is not entirely new. As mentioned above, every new media has amongst other things also influenced the re-definition of the art-term. For Schmidt, a difference-management must exist, in order to differentiate between art and non-art. All categories of media art (as for example interactivity or hypertextuality) are only possible via communication about them.

Bringing together science as an aesthetic construct and art as a social system via culture as programme and art as a media offer, results for Schmidt in questioning the changing art-term by means of media technologies. He answers this question by showing the extent to which social systems are constructed through self-organisation and difference-management, and how a collective understanding of reality emerges. In Schmidt's theory the social is additionally carried by cognitive research, which means that assigning meaning to art(pieces) is by no means to be found in themselves, but can only emerge out of the discourse around them. Within media art this discourse still has to be differentiated. Within the eSCAPE project media art has been used exactly within these boundaries.

Establishing structures for collaborations

When in 1986 Umberto Eco described the methods of the artists, he wrote that they are often not aware of the fact that they know the procedures when applying them.[4] Today one can only partially agree - only if the artist is working within the traditional arts this is correct, but not in regard to media art. In media art the exact opposite is accurate: only with a precise knowledge of the underlying structures artistic work is possible and only a close relation to research allows the necessary basis for this conceptual thinking. One hardly finds examples where digital technologies are so perfectly mastered that they are automatically applied – the artists and developers have to learn permanently new software and hardware configurations. A qualitatively highly valued artistic end product can be primarily ascribed to the artistic vision and will behind it.

The world of media art exists as a phenomenon of the information society as well as one of the art world. A close relation generally exists between a newly developed medium and an artistic application and generally the system-specific outbidding is the 'task' of the arts. For example, Rudolf Arnheim describes the beginning of the cinema as a time in which the narrative structures succeeded while the actual quality of the medium was reserved for experimental

[4] Umberto Eco (1986): Nachschrift zum 'Namen der Rose' [Postscript to 'The Name of the Rose], dtv, Munich.

applications.[5] The importance of Maya Dern for the early film art is equivalent to the importance of Nam June Paik for video art. How many of the specific software applications actually raised current art projects to advanced media productions is hardly ever discussed. One focus we are dealing with here at ZKM concerns questions such as: what are the developers of the software-empires not able to achieve and which art-strategies or intrinsic worlds can be set against the globally standardising tendencies?

Looking at interactive media art involves a number of assumptions and questions concerning constructing 'realities' or 'worlds' and autonomous sub-systems. In this context the question involves which kind of world will be constructed and which ideas lay behind it. Artistic production can only be 'work in progress' as each programme leads to new possibilities of expression and consequently to new applications and further modifications. Media art is always a mirror of the state of the current technical development and cannot be judged independently from the technical infrastructure on which it is based.

Within eSCAPE the artistic developments are based on the following assumptions:

- *Information is understood as the material of media art* and is meant as contextual interrelation that does not necessarily lead to further chains of results, but to a quality of events. The basis for working with information is the binary code which leads to a new grammar of perception: text, images and sounds are presented on a digital level and – for the time being - are formally equal.
- *Technological standardisations determine the information societies.* The development of graphical interfaces and platform independent programming standards made the boom of the World Wide Web possible. This aspect forces us to see the achievements of the associated 'technoculture' critically. One way out of this is the phenomenon of imagination which is seen as a social-political factor as well as a meaning-creating moment of individual resolve. At the same time the appropriate demarcation of the areas of culture and art is essential.

The participation of an institution like the ZKM in the IT-programme was a novelty, and new kinds of interdisciplinary encounter between artists and technology developers were tested for the first time. Within the art world, however, this kind of interdisciplinary encounter is not new at all. Already in 1968 at the ICA in London an international exhibition took place under the heading 'Cybernetics Serendipity' "exploring and demonstrating some of the relationships between technology and creativity. The idea behind this venture … is to show some of the creative forms engendered by technology. The aim is to

[5] see Rudolf Arnheim (1988): Film als Kunst [Film as Art], Fischer TB, Frankfurt a.M.

present an area of activity which manifests artists' involvement with science, and the scientists' involvement with the arts; also, to show the links between the random systems with the making and the use of cybernetic devices."[6] Mainly in the form of festivals this undertaking has been manifested over the years. The trends of media art in all its various forms of expressions are 'set' by two international festivals: ISEA and Ars Electronica. The decision of the jury of the Ars Electronica 1999 for the winner in the net.category confirms the importance of collaborative structures like those which the eSCAPE project established by creating developing teams consisting of computer scientists, researchers, ethnographers, artists and engineers, while at the same time it is symptomatic for the 'cultural' discourse of media art, and for this reason the public statement will be cited here exemplary. The Prix Ars Electronica is the most renowned media art price. The competition categories include: interactive art, computer animation, visual effects, digital music, freestyle computing and .net. In all categories the awarded prices are the Golden Nica, Distinctions and Honorary Mentions. In the net.category the Golden Nica 1999 was awarded to Linus Torvalds for the operation system Linux. The jury published a statement which will be quoted here in order to illustrate the transformation of art, culture and innovation.

In 1991 the Finnish student Linus Torvalds began working on an operation system for his PC. Since the existing operation system did not fulfil his ideas he imagined something equivalent to the Unix operation system running on mainframes. After several months of work, he offered his first kernel under the name Linux as freeware via the Internet. Right from the beginning Linux was an open-source project. By publishing his operation system on the Internet, Torvalds soon found several competent programmers collaborating with him on the project. At the same time, other programmers developed tools and programmes that supported Linux. Within a couple of years Linux became worldwide, the widest used Unix- clone running on PCs. All this would not have been possible without the existence of the Internet, and specifically not without the Usenet. Most of the programmers only knew each other via email and news-group discussions. Today Linux is the most frequently used server-operating system in the Internet. Additionally, leading companies like IBM, Oracle, HP and SAP announced their support for Linux.

The jury of the net.category awarded Linus Torvalds the Golden Nica as a representative of all those people who have been working on this project throughout the last years. The fact that Linux is one of the first products derived from the Internet that had an enormous impact on the 'real' world was one of the most important reasons for the jury. Additionally, the jury wanted to make a statement with this Golden Nica: this prize is not meant for the most beautiful web page but for any project on and in the net. Furthermore it should also nurture the discussion whether or not a source-code itself can be an art piece.

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[6] Jasia Reichardt (1968): Cybernatic Serendipity – the computer and the arts, Studio International special issue.

The reasoning of the jury shows that art on the net is a difficult topic and that criteria for interpretation have scarcely been developed. Not only the conceptual insecurity of the jury is illustrated but also the dilemma of cultural production as well as cultural transmission in the information age: when art becomes a synonym for culture then also cultural achievements - especially achievements of the techno culture – can be stylised to artistic works. But what is more important in the IT and Esprit context is that this 'success story' was actually driven by the existent needs of individual users. Once the common platform was established (the kernel) different interests, approaches and expertise expanded it and eventually resulted in "the largest collaborative programming effort ever / the new king of the hill / the most dynamic, interesting and exciting development on the operating system scene today / a lesson in hard work and well-earned rewards / the first major evolution in operating systems since MS-DOS."[7]

The paradoxical situation within this striven-for transformation is that only now a connection between innovation and technological progress towards the human being becomes possible. Consequently, technological and economic structures show their functional power only by including a less comprehensible and freely applicable category: the myth art. This realisation is not new, though it surprises again and again: art creates 'meaning'. Linus Torvalds and the entire Linux-community might well be charmed that their source code can be seen as art. Behind this, however, an atavistic conviction is hidden namely that art is able to create 'perfection' and 'significance'; an obvious correspondence to the worldwide debates and economic wars over the best hardware and software. At the moment individual productions are less prominent in the current art enterprise, the art discourse is moving towards a socio-political awareness of the necessities of cultural work referring to the society. It is this field of tension from society (or multiple users) to the individual, which we intended to 'exploit' in the eSCAPE project. Societies are defined by their members and we were interested in how these members are constituted on their individual level. We were interested in how members transformed information into inspiration, or, to be less poetic, into knowledge and practical action.

During the last three years ZKM has investigated whether and how creative energies should be invested in multidisciplinary technology development work. This process started by setting up some basic requirements. Especially in the field of technology, artistic involvement usually is equated with design as some kind of enterprise that makes an artefact more 'attractive', or: 'aesthetically decorative'. However, looking closely at objects that are considered as being 'well designed' we realise that design and functionality are deeply intermingled. In these cases developers have searched for designers with whom they could closely collaborate towards the same goal. The successful product is then generally a user-friendly, sensible and attractive device. The artist-developer team, on the other hand, is a different combination of expertises with a different approach. It is not the

[7] Doc Searls: Linux Journal, July 1999.

developer's point of view that serves as a starting point but the artist's. So the first real lesson that was learned through the artistic involvement right in the beginning of the project and which carried through was that for productions of this kind, anchored in radically new tools and processes, traditional professional collaborative structures were no longer valid. New structures had to be developed. We had to establish a new area of competence and a redistribution of responsibilities. An important category of persons effectively involved in these new collaborative art experiments were people who had a synthetic vision of the work in progress, and who, at the same time, could keep sight of the final aesthetic goal. Most of the time these translators and mediators were the media artists themselves who sustained and consolidated the collaborative work.

Throughout the project we were dealing with technological tools that had a powerful shaping effect on contemporary media art that necessarily required collaboration with technical and scientific specialists. It became vital for these people to be able to communicate closely and freely with their artist co-workers, to identify and elucidate the real technical constraints and liberties, so that these were constructively taken into account during the creative process. As far as the artists' technical culture was concerned, this had to be sufficient for them to grasp the conceptual implications of the technology being used, and thereafter to deduce the aesthetic meaning of these implications. Any concept is the bearer of meaning, and technical concepts are no exception to the rule. Artists must understand this in order to work effectively with technological tools. Often the aesthetic meaning that underpins technologies are not immediately apparent, and free and open investigation is necessary to identify and exploit their artistic implications. In particular, artists must be sufficiently familiar with the technologies they are using to understand any possibilities of change or reconfiguration. All these experiences, dialogues and processes we summarised under the eSCAPE's characteristic 'aesthetically informed'. In the following sections its effect in shaping the project's development will be described.

Collaborative structures for experimentation

The 'artistic involvement' developed in phases, and at the end of every phase an overview and evaluation was completed. The first step in order to outline a concept for an interactive art piece is to reflect upon **what needs to be taken into consideration** in respect to the installations' content as defined by the artist: space, location, ownership, validity, timelessness, sensitivity, access, platform, rights, channels, relationships, and so on. More or less simultaneously an integrated **'information' architecture** is laid-out and **dedicated tools** are defined. What seemed striking during this initial conception-phase was the fact that the people involved concentrated on what was *not* available instead of being preoccupied with what *was* available. The resulting interactive installations of the eSCAPE project proved to be **meaningful spaces**, based on concepts for **3D**

information visualisation, each offering an environment within which **knowledge became manageable**:

The (Distributed) Legible City

DLC is an extension and development of the interactive installation *The Legible City* of 1989. The new version was designed as an art multiple for many participants. *DLC* allows several users to interact and explore together within three virtual cities made out of text. While the original *Legible City* was implemented on a high-performance graphics workstation serving one viewer using a real bicycle as an interface, *DLC* is made up of three consoles using standard PC hardware as computing platform, consumer 3D accelerators for the graphics and voice/data modems for connectivity and to facilitate audio conferencing. The original custom-made bicycle and projection screen has been replaced by a slightly modified home trainer and computer monitor. The motivation for constructing a shared version of *The Legible City* was that the environment appeared conductive to social encounters – that the cities themselves might be a natural conversation piece for participants who found themselves together within it.

The artist felt a growing need to define aesthetic frameworks for the technological development of new social interaction and interface paradigms for content-rich, interconnected, shared virtual environments.[8] The original version has been used as a context to explore these issues. *DLC* adds a space of multiple user social engagement to the space of interactive spectacle.

DLC allowed the project to construct a city-like structure and assess its utility by placing this piece in front of the general public at the ZKM as well as at other public exhibitions and events. Lessons learned from studying this art piece have informed the design of the Tourist Information Centre in the second year as well as the final physical eSCAPE. In particular the use of a mixture of symbols and mimics of real world buildings.

Nuzzle Afar

The same arrangement is set up at various locations. A dark abstract space is visible on the monitor. The visitors are invited to explore the shared virtual space with the aid of a trackball. By means of the interface the participants control their own movement and perspective in the computer-generated 3D environment. The temporal movements within the space leave traces behind them, which can be followed by other participants. An abstracted avatar visualises the current location of the individual visitor. With *Nuzzle Afar* Masaki Fujihata provides an exemplary presentation of a 3D communication and interaction space that offers different levels of encounter and possibilities of shared experience. In contrast to classical conceptions of virtual environments enabling shared experiences, as for instance those used in MUDs or MOOs, Fujihata's system permits not only the

[8] Jeffrey Shaw, Adrian West: escape deliverable 4.2, 1999, p.33.

simultaneous exchange of position and orientation data, but also of the entire visual and acoustic material.

The developers of Library Application of the second year were inspired by the traces in the *Nuzzle* world, as they saw them as a possibility to visualise history and remembering using navigation and interaction through the space.

Place ~ a user's manual

A motorised platform stands in the middle of a panorama architecture. Three projectors project an image onto a 120-degree surface of a cylindrical screen. A mounted video camera serves as an interface. Using the camera, the viewer directs the projection along the surface and his own movements in the virtual environment. The viewer explores a space that is defined through an emblematic relational system of photographed landscape panoramas.

Place takes up the tradition of the panorama in painting, photography and film history and extends it to the genre of simulation. At the same time it combines two essential elements of the 19th century: the central observation platform and the circular image. Because the virtual panoramas and the architectonic structure of the actually experienced space are inseparably joined to each other, the conditions for the complete submersion in the visual event are fulfilled. Yet the navigable world is a static one. The voices and noises of the spectator can temporarily trigger architectonic phrases. Languages here embodies on the one hand power over the arrangement, but above all localisation within the virtual space.

Place is an interesting metaphor for the representation of related places, and the navigation and transportation between them. Especially the partitioning of the space into cylinders offered ways of classifying and structuring the virtual space in the Tourist Information Centre and in the physical eSCAPE.

The Web Planetarium

The Web Planetarium names a spatially dynamic representation of the Internet. The viewer moves through a three-dimensional planetarium: the actual browsing through the virtual space determines the constellation of abstract Internet pages. Symbols, as for instance a sphere or other geometrical forms, represent the individual sites, while the connections between them are represented as arrows. *The Web Planetarium* presents a conception of individualised storage and transmission of information. Anchored into EVE, the visitor is immediately situated between self-constructed bridges of knowledge.

The Web Planetarium informed the design of the abstract eSCAPE on several levels. First of all, the implementation in the EVE dome showed that the metaphor of the planetarium proved to be intuitive for the users' operation. Moreover, it provided an exploration of new layout algorithms and techniques for navigation through and interacting with knowledge via the click-and-zoom method of the work. In addition the navigation also allowed the user to actually rotate around the selected documents making him aware of neighbouring/referential documents.

10_dencies

10_dencies Sao Paulo enables the articulation of subjective experiences of the city through a collaborative process that was made part of the project's development. A group of young architects and urbanists from Sao Paulo, the 'editors', provided the content and dynamic input. They approached the city by asking "what are the forces that shape the city? What are the processes that create temporarily visible manifestations within the city?" The editors collected material (texts, images, and sounds) based on their personal urban experience. This material was put into a database by means of a specially designed editor tool. This tool also allows the editors to build individual conceptual 'maps' in which each editor can construct the relations between the different material in the data-pool according to his subjective perception of the city. On the computational level, connectivities are created between the different maps of the editors, a process that is driven by algorithmic self-organisation whose rules are determined by the choices that the editors make. The collaborative editorial work in the database generates zones of intensities and zones of tension, which are visualised as force fields and turbulence. The participants can modify and influence these electronic urban movements, force fields and intensities on an abstract, visual level, as well as on a content-based, textual level. The objects in this force field are purely symbolic and conceptual, and the parameters are not spatial or territorial, but relational and depend on the editors' approach to their urban material. The visualisation shows the intensity of relational forces in the data-pool as they are being constructed and transformed by the self-organisation. When zooming in, the keywords referring to specific materials in the database appear. By selecting them, it is possible to see or hear the respective textual, visual or auditory material on a separate monitor. This engagement with the projects and its material is fed back into the database and influences the relational forces within the project's digital environment.

10_dencies allowed the developers of the abstract eSCAPE and researchers to consider the ways in which the aggregate effects of multiple users could be shown. Additionally, the editor's interface of *10_dencies* provided a way of visualising the overall action and activities of other searches through the keyword browser. [9]

Reflections

By the end of the first year, the project was able to provide a set of basic concepts for interactive art pieces which were associated with the project's objectives as

[9] Andy Crabtree etc: escape deliverable 4.1, p.60.

well as the actual interactive art pieces themselves: *The World Generator*[10], *The Distributed Legible City, Place~a user's manual, Nuzzle Afar, The Web Planetarium, 10_dencies*. Instead of providing 'the big eSCAPE picture' we thought that it might be better to concentrate on providing several different concepts for 'meaningful spaces' as well as tools which helped to make the inherent knowledge manageable. These spaces were then meant to be studied. Consequently those results would feed into a more general landscape: small patches should make it easier to see how they should be applied to an electronic landscape as a whole. Each artistic concept presented a unique platform with a unique software package and unique tools.
Another advantage of allowing the commission of interactive installations such a dominant role within the project can be found in the resulting product itself. Each finished installation (or installation phase) presented a test and study environment within which the viability of the various concepts could be tested by a very divergent mass-audience. Within the framework of the ZKM Media Museum the installations were set up and the museum's visitors (people aged between nine and seventy) had the possibility to interact within them. Even though in almost everything we do today, we have to improvise, people do not like to be watched (and probably even less to be studied) when finding *ad hoc* solutions when under pressure. Interactive art proved to be one form of consciously improvising and offered us the possibility of consciously studying people improvising. The studies undertaken in the second year[11] have shown that interacting with media art serves learning through experimentation without risk, independently from the context and location (museum, fair or conference) in which these pieces were set up.

However, understanding the potential of specific features and bundling them up are very different things. Each medium chosen by the artist is distinguished by a particular vocabulary, construction and modifiers and these together establish within it a limited but rich set of possibilities[12]. Furthermore, each artistic expression is the visualisation of a specific cultural knowledge. So if the virtual space/s to be set up within the project is to be a meaningful space for the user, one has to be conscious of the interconnections and dependencies of information, organisation and navigation. Only then it is possible to identify a set of organisational principles for building meaningful spaces. And only by establishing these tools and defining them as a 'common language' is it possible to develop an eSCAPE (or concept for an eSCAPE) visualising static and/or fluid knowledge independent of its content.

So what properties of artistic endeavours have been exploited in the development of new technologies and how sustainable has such a migration been in practice?

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[10] The interactive installation *The World Generator* enabled participant at remote locations to select and place 3D objects as well as construct and navigate through virtual poetic world/s. The participants selected objects from a rotating menu system and co-operated with other participants to generate a new world. The menu system contained various component parts, including 3D models, poetic text fragments and texture maps (still and video).

[11] these studies are reported in the eSCAPE deliverables 4.0, 4.1 and 4.2.

[12] see above for the description of the interactive artworks.

The Distributed Legible City

Represented as *avatars* in the virtual space, several users are able to interact and explore together the three virtual cities. A bird flying above the participants serves as a *way-finding assistant* to other avatars to whom one can talk when close enough. The influence on the development of the physical eSCAPE has been at a practical level of providing a better understanding and developing techniques for navigating around a three-dimensional rather static *space based on a map*.

Place~a user's manual

The essential feature in this art work is that it turns *electronic space/s into place/s*. It potentially offers to the physical eSCAPE the opportunity to amend and alter the various cylindrical worlds to match the individual demands or social purposes of the user community, suggesting a useful way of *linking the virtual and the real* through the use of panoramic projections.

Nuzzle Afar

The temporal movements of the various users who simultaneously visit the computer generated 3D space leave *traces* behind them, which can be followed by the other participants. The feature of the traces provided the user with a *sense of location* in relation to others as well as to the space as a whole. For developing the abstract eSCAPE, the colourful traces became the starting point on reflections on the exploration of representing the activities of others by offering a possibility of *visualising indexing mechanisms* as history or user navigation.

The Web Planetarium

The concept for this artefact describes it as a conceptual demonstrator for how hyperlinked and structured information sites can be visualised three-dimensionally and navigated in a '*meta space'*, using the *spatial metaphor* of outer space to describe the human-computer interaction. The general layout and placement algorithms provided us with a useful starting point for the abstract eSCAPE. Also the virtual movement towards an object after selecting it as well as the possibility to rotate around it and thus bringing 'neighbouring' sites into view proofed viable.

10_dencies

10_dencies offers a self-organising collaborative landscape that visualises **s***patial presentations of non-spatial/abstract information.* In this dynamic, continually modifying information terrain the entities are continually open to forces of change, showing the emerging relationships between information. The *user behaviour is represented by the visualisation of his browser activities*. This behaviour presentation was analogous with our need to consider the search effects of the users in the abstract eSCAPE.

Comparing all these concepts for interactive installations with each other, two generally different kinds of meaningful spaces can be crystallised, representing either **physical or conceptual / abstract space**. The former is represented in maps or drawings of physical objects (as in *DLC* or *Place*). Conceptual or abstract spaces are used when graphical space is used metaphorically in order to create a spatial representation of non-spatial information (as in *10_dencies* and *The Web-Planetarium*). However, in *Nuzzle Afar* a hybrid space was involved, a combination of the abstract and the physical space. These various expressions for virtual spaces were to some extent determined by the fact that virtuality (the Internet, cyberspace or any other form of VR) can not refer to any agreed grids or metrics. This missing physical context became the challenge of the eSCAPE project in the second year, by actually focusing its efforts on the physical as well as the abstract space. Important aspects for both directions were organisational ground rules. Studies of the art pieces clearly showed that it helps the user to know where he is and how his location relates to others in the same space as well as how it relates to the space as a whole. The map in *DLC* as well as the traces in *Nuzzle Afar* are virtual tools, giving the user something like a sense of the parts and the whole.

In the first year of the eSCAPE project the ‘artistic involvement’ became a valuable resource in three respects: first of all it interpreted and *transformed the project’s objective of 3D information visualisation into three-dimensional meaningful spaces* with the intention of being valuable to their audience/users. What is meant by this is the process of turning information into knowledge - a process established by the context in which the information is presented in the virtual space - and intentionally of turning knowledge into value – a process that happens as an interaction between real and virtual space, between user and visualisation.[13] This development corresponds to Max Bense’s conception of ‘aesthetic information’, the process of movement from the aesthetic minimum conditions to maximum conditions. He describes as the aesthetic ‘minimal conditions’ materiality, realisation themes, process themes and communication and as aesthetic ‘maximum conditions’ triadic sign function, order relation, aesthetic uncertainty relation and value relation.[14]

Secondly, by abstracting the characteristics of the various approaches, the two essential kinds of electronic spaces could be defined, as an abstract and as a physical one.

Thirdly, *an abstraction of the art works provided us with a set of ‘organisational principles’ or structure*. This structure consists of: space, direction or axis (time and space respectively), division of the space and links.[15] Each interactive art piece performed the consequences of the use of these four spatial relations in the scenarios defined by the artists. But characteristic to all pieces was that only those consequences were calculated which were relevant to the artistic content and meaning and which supported the immersive impression of the works.

A fundamental feature in the process of designing the interactive art pieces involved in the eSCAPE project was the establishment of a very clear structure in which to interact, though without demanding any particular order of operation. This feature became crucial also for the design of an eSCAPE, be it physical or abstract. The virtual spaces themselves invited speculation in the form of actions. Each of the studied art works offered the ability to navigate a continuum of

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[13] The transition of knowledge into value is the aim of every knowledge management software.

[14] Max Bense (1965): Aesthetica. Einfuehrung in die neue Aesthetik [Aesthetica. Introduction to New Aesthetics], Agis Verlag, Baden-Baden.

[15] Compare also Yuri Engelhardt: The basic tools of meaningful spaces, Amsterdam 1998.

possibilities. However, the parameters for all possibilities have to be established initially. Consequently the exploration of the consequences of the established structure has to be part of the creative process.

Trying to define and develop some consequences of the use of these four spatial relations in the context of an abstract and a physical electronic landscape, the actual relation between user and virtual presentation, in other words of 'turning knowledge into value' became the main task of the third year. This was the main challenge for developers and designers alike. However, we have to distinguish here between two kinds of knowledge: [a] explorative knowledge and [b] inventive knowledge. While the explorative knowledge stands for the visualised information in the virtual spaces, the inventive knowledge stands for the dependency between fact and action, referring to those characteristics of the artworks that informed the demonstrators. Information and/or knowledge as presented and offered in the various artistic and artistically informed demonstrators only become valuable once the users are able to transform them independently. The awareness of these three levels was only possible through permanent feedback: dialogues between artists and programmers established the 'How' of their piece, while the dialogues between ethnographers and artists as well as ethnographers and developers established the 'What'. The viability or the 'Why", on the other hand, only became apparent within the dialogues amongst the users and between users and ethnographers.

By the time the last project phase began, an eSCAPE had evolved to a meaningful space as an engine for intensifying content, that is information about information coming from various sources. While the goal of the abstract eSCAPE was defined as a software package for the user, visualising non-spatial information spatially, the physical eSCAPE was meant as a 3D-toolkit for building independently individual, specific-purpose eSCAPEs. However, despite these two completely different intentions extra information would be added by the users/operators to an existing database. Additionally, connections within the database would be 'made by itself'. For the abstract eSCAPE factual text information served as content, while the physical eSCAPE provided its information as a map of physical cylinders.

Regardless of the fact that the project elaborated into two directions by offering an abstract and a physical strategy, these meaningful spaces have a common structure: space, axis, division, link. Consequently both virtual worlds consist first of all of a space and a time that follow rules different from the real world. These two data spaces are entirely symbolic spaces, consisting of information. That explains their utopian character. They do not have a definite and exclusive space; they are permanently de-localised and re-localised. The virtual spaces consist of circulation, nets, connections through which the users are able to navigate. The integrated objects do not have a definite identity; they can change from one condition into another, from one form into another.

This utopian space corresponds to a simulated, virtual time that has its particular properties. This time cannot be reduced to the actual time of the interactive device (though this is an important but limited aspect). This virtual time is an autonomous time, without any reference to the time in the real world, without past, present or future. In comparison to the recording time of photography or cinema, or the direct time of video, television or radio, this time does not consist of completed or to be completed events, but of pure eventualities. Synthetic time is like a synthetic image, a virtuality: more or less a stock of moments, durations, simultaneities, interrelations of causes and effects, which cannot just be reversed, but which are totally re-definable and repeatable, in other words re-initiateable time.

However, despite this tremendous fluidity, the method we applied was quite structured: for each landscape we developed individual parameters, based on the content and the organisational principles. In both approaches, these parameters shaped the kinds of variational excursions that might be made by the users. Furthermore, we integrated in both eSCAPEs the idea that they can simultaneously be inhabited and redesigned, an aspect derived from the interactive installation *10_dencies*, an installation that presented dynamic data by evolving the idea of a generative structure.

We started the process of actually designing the abstract and the physical eSCAPE by analysing the 'lessons learned' and 'best practices' of each interactive art piece and their software. Moreover, the design had to consider that a tool (software or toolkit) permanently needs modification, basically because it is just impossible to anticipate every consequence in real and in virtual space. In this respect we could learn from the examples Knowbotic Research provided the project with by developing an interactive art piece as a framework for 'information evolution'. Consequently, we needed 'smart tools' for the design as well as for our users, and in order to achieve this, we specified a set of basic design principles as a generative grammar:

- Explore *alternatives* to ensure that the chosen strategy is currently the best one.
- Realise that the appropriateness is *dependent on the task*.
- Provide *multiple access* structures building also on current developments in small-scale devices, wireless communication, embedded computing etc. to ensure reaching a wider audience and to be location-independent.
- Provide an *overview* of the space and/or develop segmentation-strategies to make the space manageable.
- Be *consistent* otherwise a virtual space is neither logic nor convincing.
- Be *visually attractive*. With visual attractiveness it is possible to direct the user's behaviour.
- *Avoid graphical details that do not contribute* to conveying the knowledge concerned.
- *Avoid unintended graphical ambiguities*.

- *Provide a dynamic system that can be shaped and exploited* only then it is possible to understand and handle complexity.
- *Respect conventions!*

On the basis of this generic generative grammar, derived from the concepts, development, studies of interactive art works that answered the predefined eSCAPE themes, the abstract and the physical demonstrator have been designed.

The physical eSCAPE demonstrator

This eSCAPE uses cylinders as metaphors for the virtual spaces as spaces without boundaries, which are organised on a map. This visual form is consciously inspired by the interactive installation *Place ~ a user's manual* as it reminds one of a digitally enhanced version of human meeting and gathering places. Meant as a toolkit in a three-dimensional format for other 'knowledge architectures', it actually establishes the corporate memory of the project, by offering various interactive art pieces, architectural concept extraction, knowledge structuring of an engineering system as well as a tourist information system. Using the dedicated tools, these components are meant as starting points and inspirations for own concepts and developments, offering the possibility to enlarge the existing virtual space. This system supports social encountering and exchange between the users in order to allow them to translate the presented information into action by constructing their own virtual environments.

The physical demonstrator offers information technology that can be diffused into everyday settings, and might lead to new ways of supporting and enhancing people's lives that go beyond the possibilities of the Internet.

The abstract eSCAPE

The abstract eSCAPE uses spatial relation to convey information, a feature that is clearly inspired by *10_dencies* and *The Web Planetarium.* In *10_dencies* the third dimension was not an essential element of the advanced display. It used a two-dimensional graphical interface structured by axis and links. The successful idea was that here interactions were represented graphically, while also giving numerical information. In the final demonstrator complexity is reduced to two dimensions when specific knowledge is displayed. However, the metaphor for a three-dimensional spatial model provided in *The Web Planetarium* has been further abstracted in order to maintain and make the relational view of retrieved knowledge more plausible: knowledge is turned into value, when the individual user transforms the in formation conveyed in the spatial relations into something of value for him. Only then the software can be assessed as successful.

The abstract demonstrator is able to adapt and change. Based on how the people use and interact with the software, new functionalities and new forms of use will emerge.

Pandora

In this chapter we have outlined the eSCAPE working-process form the ZKM's point of view. We described the transformation and synthesis of various artistic concepts into two meaningful electronic landscapes making the access to modern information technologies as simple as possible and integrating existing systems in new and innovative solutions of 3D information visualisation. Based on our experiences of studying interactive art works the eSCAPE end-products are meant as solutions that enable the user to manage the electronic application/s on his own while staying in charge of the content which can be managed without any programming knowledge.

One goal for both eSCAPEs was that the users would be able to manage their contents independently. In order to minimise the extent of communication and to be able to react flexibly to new situations, they need a system which is:

- user-friendly and applicable
- intuitive to understand
- easy to learn
- reliable and stable.

In order to design electronic landscapes that fulfilled these goals we first specified a generative grammar as a set of design principles. This grammar was a logic consequence of the lessons learned and practices applied and modified during the first two years of the project by everybody involved: artists, developers, scientists, researchers. On the basis of the generative grammar, we developed for the physical eSCAPE modules that can be combined variably, which enables the user to suit his requirements individually and effectively. With the editing-tool information can be kept up-to-date and be transmitted directly into any network using WWW-communications. The access to a network will be accommodated to the internal structures or preferences.

Throughout the process of the eSCAPE project, artists came up with completely new ways of thinking about the design process for information technology, or to be more precise, many new ways of thinking about the design process and thinking about innovation. Right at the beginning of the project they offered ideas as approaches that did not start with any given technology being imposed on a situation, but instead presented ideas that helped to shape completely new technological concepts and tools. They proposed scenarios which confronted visitors to a public institution with 'innovative products' that helped establish new understandings of technology's use. The artistic involvement acted both as a design catalyst and as comment on evolving solutions. Artists, social and computer scientists and designers together explored and distilled ideas, generating new awareness and energy for innovation. The final eSCAPE products are the outcome of a mature relationship between these people that resulted in the sophisticated integration of ‘soft’ and ‘hard’ concepts. In the project we were confronted with the question of whether contemporary designers have to alter their process to accommodate a scenario where the same information might appear differently in multiple locations and we realised that with the continuously changing content and unique information recipients uniquely situated, a top-down design is not appropriate. We tried to develop more flexible working methods and studied improvisation in interactive art works as a way of achieving them.

One big challenge during the last year was the design of the interfaces as they come between the user and what he wants. Developing the right iconography for an eSCAPE also refers to the danger that each new interface means that people continually have to learn completely new alphabets. And it is in this area that the next challenge lies: in developing modular and generic tools which are as familiar as an everyday object. We are convinced that in this field engaging media artists would provide a rich source for practical and conceptual creations.

Chapter 2: Social Science Perspectives on eSCAPE

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The purpose of this chapter is to assemble and consider the social science work, that has already been conducted and reported in previous deliverables, in order to provide a methodological framework for the study, design and development of electronic landscapes. This chapter focuses on considering the nature of space and the need to understand the ways in which this space is used in practice.

This presentation also provides an account of how researchers from a social science background contributed to the eSCAPE project and communicated with the other researchers involved. As a result it provides a useful resource for those who wish to undertake this form of development or research.

Space as a social construction

Although developing many and varied understandings of space, in recent years a widespread view is to see space as a 'social construction', a notion which occasions no little dispute and confusion.[16] In addressing the issue of space, a multiplicity of perspectives elaborate various themes. These range from classical modernist concerns with the functionality of spaces and places; to the social and political character of economic decision shaping space and places; and, finally, to the more *avante garde* concerns of post-modernist literature and their emphasis on matters to do with gender, sexuality, identity, diasporas, and so on. For our part, however, we wish to understand the notion of social construction *methodologically*, as a way of bringing to the fore the idea that spatial arrangements are integral to the social organisation of everyday interaction. In other words, we wish to bring to view the manifold ways in which space and spatial arrangements are features of *coordinated social action*. In talking about space as a 'social construction' we intend no more, at this stage, than to point to some commonplace features of the social organisation of everyday life.

As we have noted in earlier deliverables, the interest in the sociality of space emerged in the pioneering research of the Chicago Department of Sociology during the 1920s and 1930s and was directed at charting the social characteristics of urban space.[17] The main concern was to lay out the geographical distribution of social factors, such as income, employment, social class, ethnicity, religion,

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[16] Hacking, I. (1999) *The Social Construction of What?* Cambridge, Massachusetts: Harvard University Press.

[17] Short, J.F. (ed.) (1971) *The Social Fabric of the Metropolis,* Chicago, University of Chicago Press

mental disorders and so on. This ‘ecological approach’, as it became known, towards the study of urban life revealed that urban living was characterised by non-random patterns of settlement, land use, and life styles.[18] For members of the Chicago School, the ecological or spatially distributed patterns of city life were very much patterns denoting significant variations in the character of social life. The important feature of these studies, and why at the time they were pioneering, was that they were informed by a sociological conception of urban environments. Spatial distribution and arrangements were seen as the outcomes of not only economic and political decisions but importantly of patterns of life bound up with ethnicity, social class, religion, etc. Whether a person lived in the city centre, suburbia, downtown, or in the ghettos was something that did not simply happen by chance but rather, was a direct product of the ways of life people lived together. In 1920’s Chicago, for example, spatial distribution was a reflection of living in an emerging capital economy under the auspices of what would now be considered discriminatory attitudes embodied in and reinforced through statutes and laws which segregated various sectors of the urban population.

Of course, spatial arrangements have been part-and-parcel of social engineering, to use this phrase, for centuries, certainly from the advent of architecture and, later, civil engineering. These disciplines are explicitly concerned to design spaces and spatial arrangements in order to meet various and multifarious human needs and requirements. It is perhaps from disciplines such as these that we get the popular idea of bounded space, such as rooms, roads, buildings, and so on, as a stage or an arena within which social activities take place. This is often associated with the additional notion of bounded space as *constraint,* as opposed, say, to the ‘wide open spaces’ and the ‘open road’ of popular image. While the concept of constraint does indeed point to important features of spatial arrangements, this is by no means all that needs to be said about them.

Moving beyond constraint

While respecting the interests outlined above, our own approach to and treatment of space and place is rather more interactionist in focus insofar as we are interested in trying to explicate *how space is interwoven* within the real world, real time construction of ordinary courses of spatially situated action. Although thematic interests of the kind noted earlier do a great deal of morally responsible work as it were, unfortunately they tell us little in any actual detail as to just how space and place are socially constructed in action. Thematic concerns talk a great deal *about* the social construction of space but tell us little *of* that construction as a real world, real time feature of coordinated human action. In this respect emphasis on the constraining features of spatiality, although clearly important, fail to go far enough and, indeed, as an exclusive emphasis can be misleading. At the very

[18] Park, R.E. (1926) The urban community as a spatial pattern and moral order, *The Urban Community* (ed. Burgess, E.W.), Chicago: University of Chicago Press.

least, an equal emphasis needs to be placed on the *enabling* features of spatial arrangements. A useful analogy here might be the social organisation of traffic systems which consist of the coordinate activities of persons – 'drivers' and 'pedestrians' – who, within the bounded spaces of roads, sidewalks, junctions, etc., have the task of controlling their travel by coordinating their actions with those of other road users. It is a task which is done in and through the travel, moment by moment. Although the coordination is done within a framework of rules, some having legal force, and arguably constraining, the rules also enable the activity to take place, enable the coordination to be done, and done without central direction. It is in this sense that we want to develop an appreciation of space and spatial arrangements as a coordinate resource in the practical accomplishment of the activities of everyday life.

As we suggested above, one way of thinking about space as a coordinating resource is to construe it as an arena, a stage upon which social actors construct their courses of action. Space and its material arrangements become, as it were, the setting in which social activities of particular kinds occur and get done. This view, of course, is consistent with the mundane observation that within social life, certain spaces and places are tied to particular activities. That is, for a number of vernacular labels used to describe spaces and places there is a strong presumption about the activities which occur in them. In a phrase, they are category bound.[19] Thus, and for example, classrooms are spaces organised for teaching; restaurants places organised for eating; libraries are spaces where books are stored; roads are spaces for the movement of vehicles, and so on. There is, in another words, a strong sense to the notion that particular spaces and their material arrangements are tied to particular social activities.[20]

One implication of the 'arena' metaphor is to see space and place as a 'container', a conception reinforced, no doubt, by the sheer physicality of the material arrangements of space; arrangements which mark off and mark out various arenas of activity. However, while accepting such features of space and place, our approach is to understand these as elements of common sense understandings pertaining to the use of particular spaces and their arrangements. In other words, and to state the point in general terms, we do not deny the physicality of a great many spatial arrangements, but rather choose to see these as *socially relevant* features which can, and are, used as a resource for the accomplishment of everyday activities. After all, the walls of a room are physical objects but can be, variously, a prison, a place of refuge, ensuring the privacy of a bathroom, places for hanging paintings, and so on. To stress the point: this is not

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[19] The notion of 'category bounded' is owed to Sacks (1992) "The baby cried. The mommy picked it up", *Lectures in Conversation* (ed. Jefferson, G.), Volume 1, Part III, Spring 1966, Lecture 1, p.236-251, Oxford: Blackwell.

[20] This is, of course, not to say that the activities bound to the spatial label are the only things that will or can take place in the particular space. In other words, the point is about the 'grammar' of natural language – what it makes sense to say – and how these enters into making the sense that the world has for us as a resource for the accomplishment of the social organisation of everyday life.

to discount physicality but to understand it from the point of view of the social construction of space and the meanings it can acquire in everyday action.

From the unreflective and unconstructive point of view of everyday life

An important preliminary set of considerations in developing an appreciation of space as a coordinate resource is to understand what is meant by 'everyday life'. In the first instance, and as a second methodological policy, we use the term to refer to the world as it is ordinarily experienced by people, in the course of going about their daily affairs. The contrast here is with a world constructed under the auspices of some theory or explanatory model of ordinary action. A focus on everyday life is theoretically unmotivated, or 'unreflective' and 'unconstructive', and, instead, seeks to describe the socially organised features of the experience of everyday life, features that enable us to have the experiences that we have.

From this point of view, the focus on space and spatial arrangements begins from how it is observably and reportably understood and used by ordinary persons as a resource for 'going about their daily affairs'. As ordinary people, acting in ordinary ways, we know and presume as a condition of our acting, that people, objects, places, and the rest, are spatially situated and distributed. From the unreflective and unconstructive point of view of everyday life, space is not an abstract phenomenon of the kind that preoccupies cosmologists.[21] Space and spatial arrangements on the conception being sketched out here are worldly and very much embodied in the activities that we do.[22] It is in this sense that we want to explore the social construction of space and attention to the *embodied* character of space-in-action. This provides our third methodological maxim.

Space embodied: mutually intelligible material arrangements

Attending to the embodied character of space-in-action brings out the 'mutually intelligible' character of the material arrangements of which space is composed – of the shared sense we entertain of particular material arrangements as 'streets', 'buildings', 'roads', 'walkways', 'pedestrian crossings', 'sign-posts', and the rest. The mutual intelligibility of space's material arrangements points to two related and generic features of the social construction of 'spatiality'.

1. The material arrangements of space are manifestly visible and constructed for their visibility.
2. The visibility of material arrangements is public and widely known.

The visibility of the material arrangements of space is a precondition of their sociality. For the ordinary member of society matters to do with spatiality –

[21] This is not advancing any kind of argument which would set up the social constructionist point of view against that of physicists.

[22] Merleau-Ponty, M. (1962) Space, *The Phenomenology of Perception*, London: Routledge.

walking, shopping, displaying intimacy, driving, finding a bathroom, etc. – do not require the exercise of some deep mystery open only to adepts, but the practical use of what 'anyone' knows about the organisation of the world in which they live.[23] Mutual intelligibility points to the mundane fact about daily life that we are involved in a world which is encountered as an observable, recognisable, reportable, in short, accountable, ensemble of distinct places. Thus, in the normal course of daily events we can recognise places where we can catch buses or trains, places where we can eat, places where we can report a crime, places where we can buy groceries, places where we cannot go without invitation, places which are private and which are public, places where we can drive cars, places where we are likely to be able to obtain illicit substances with some safety, and so on throughout the immensely rich ways in which material arrangements of space enter into, and are intimately connected with, a huge variety of social activities. Material arrangements of space have a 'conventional' and relatively 'stable' character which means that spaces are overwhelmingly 'readable' for what they are and for the activities which take place within them.[24]

Intersubjectivity and 'readings'

The 'readability' of material arrangements might be construed of as a thoroughly subjective affair. Within much of social and cognitive science, the term 'subjective' in various ways refers to the point of view of the individual and stands in contrast to the 'objective' world or reality. From here on in matters become complicated, not only in the various ways in which the distinction becomes a matter for theoretical and empirical inquiry in the social and the cognitive sciences, but also because it is very often intertwined with philosophical, particularly epistemological, debates and presuppositions. Nonetheless, the general issue here is about how unique individuals, living within their own 'subjective' worlds, develop the capacity to see and know about the world 'out there', the world independent of their own perceptual and cognitive capabilities, and independent of whatever theories we might propose abut that world. In sociology, the fact that individuals can and do see the 'objective' world differently – that people hold different beliefs, have different aspirations, have different attitudes, different interests, disagree about events in the world, and so on – means that 'subjectivity' is taken to be a key element in the explanation of social action. Often, the production of explanations consists in the principled attempt to reconcile 'subjective' points of view with 'objective' and 'scientific'

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23 And by 'anyone' we mean any competent member of the ordinary society; any one who is familiar with the material world in which they live - babies aren't, by way of example, they have yet to develop such a competence; someone who had spent their entire life as a nomad in the desert would lack the competence too but like the baby, could acquire it.

24 This is not to say that we are always and invariably correct in our 'reading'. Anyone can make mistakes. Moreover, the conventions of visibility can be used deliberately to conceal such as illegal activities in the way that, for example, during Prohibition the illegal sale of alcohol was fronted in various ways in order to escape the gaze of the law – or at least those who had not been bribed.

perspectives. Such an enterprise is fraught with difficulties and one that, more often than not, ends up treating 'subjective' points of view as flawed points of view, as ideologies, on reality; points of view which the sociologist, having special training, may correct through the application of 'objective' procedures of investigation.

The approach exemplified here departs in significant ways from the above conception in that it adopts the methodological policy that the world experienced by the individual members of society is neither 'subjective' nor 'objective' but *inter-subjective* in character. The term 'inter-subjective' is no mere change of vocabulary but indicates a marked difference in the kind of attention given to practical action. It starts from the position that the individual members of society are active constructors of mutually intelligible courses of practical action (in and through which 'objective' reality is reflexively produced). In constructing mutually intelligible courses of action, individual members use competences which are tied to the performances of the activities they are engaged in. In order for their courses of action to be mutually intelligible – in order to see what is being done at any particular point in time and to act appropriately – such competences have to be shared and known in common in much the same sense that the use of language involves knowing, and being able to use, a shared medium. This means that although individuals have their own view and perspective on the world, much of this is under the auspices of a practical presumption of a reciprocity of perspectives. As a condition of being able to operate in the world 'as we ordinarily know it', individual members of society act on the principle that the 'world as I see it' will be the 'world as others see it' for practical purposes here and now. Members' experience of the world has an egological character, then, in the sense that individuals develop their understandings of the world under the auspices of 'my experiences' but such understandings are irremediably embedded in a presumption about the reciprocity of perspectives in that, and precisely because, 'my experiences' are irredeemably tied to the performance of socially organised activities. That is, to the use of shared competences comprising and providing for a world known in common. There is, of course, a great deal more that could be said about these matters but we wish to do so in the context of spatiality, taking the use of the shared competences comprising a world known in common as a methodological maxim for considering space-in-action.

A world known in common

The mutual intelligibility of the world of everyday life, including spatial arrangements, reflects a 'world known in common'. However, this term is not intended to imply that somehow the members of society carry around 'in their heads', so to speak, a corpus of knowledge about the world which they happen to share and which they apply in the course of their activities. Rather, it refers to a presumption, an orientation, used by members and, as such, is an aspect of their commonsense methods for producing the intelligibility of the world. That is, society's members use this presumption in the practical organisation of their daily lives. It is, to put it another way, a precondition of the very possibility of sociality and is exhibited in the most elemental characterisations of spatially situated activities. Take, for example, 'driving in traffic' once again. This is massively and intricately dependent on the presumption of a world known in common; a presumption displayed in knowing which side of the road to drive on when going in a particular direction, that traffic lights are signals and convey instructions which have to be obeyed, that flashing lights on cars indicate the direction in which a driver intends to turn, that other lights on cars are break lights, and so on. These, and other material arrangements of space, place and equipment, are recognised and trusted by drivers who are expected to share in the common understandings of the conventions and practices tied to the competent use of those arrangements and equipment in the course of accomplishing driving in traffic.[25]

The competent use of the material arrangements of space draws attention to one of the features of spatiality which is insufficiently regarded by cognitive and subjectivist approaches. Namely, that spaces and places are intentionally organised in ways that make their features publicly available and usable as features of spaces and places in a world known in common. Road signs are a classic example of this, as are room numbers, floor indicators in lifts, warning signs, addresses, floor plans, house numbers, etc. In other words, many material arrangements assume the character of standardised 'representations' which are used to 'guide' members around the spatially distributed social world. These are, if you like, practical representations which 'stand for' and 'indicate' places and their distribution in commonly understood ways. The competent use of standardised 'representations' is tied to what 'anyone' knows about the activities embedded in the spaces and places the 'representations' elaborate. That is, competent use involves knowing about practical arrangements of places - knowing 'what goes on' there. Such 'representations' may be seen as commonplace features and resources of everyday life that are firmly rooted in the accomplishment of the practical activities comprising a known in common world.

The social construction of space (respecified)

So far we have suggested that 'space' may be treated as a 'social construction'. That is, as something that is in significant respects 'put together' by people in the course of the lives they live together. Traditional sociological approaches to the social construction of space have emphasised the notion of 'constraint' and draw attention to the ways in which spaces and places shape and control action.

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[25] Of course, the ordinary society's members are not naïve about the fact that the world is not invariably known in common. The notion does not imply that everyone knows the same things nor that the presumption can always be relied upon. After all, those who are not car drivers will only know some of the things involved in 'driving in traffic'. Drivers also know that sometimes some drivers will not obey traffic conventions. However, despite the fact that society's members know that the presumption of a world known in common cannot always be relied upon, it is not possible to dispense with it in the practical conduct of daily life since these depend upon the *reciprocal understandings* of parties to the occasion, whatever it might be.

Adopting a different methodological orientation towards the study of the social construction of space we have, instead, set out to understand how space is actively interwoven with courses of action. Consequently we construe of space as a ‘coordinate resource’. That is, as a resource people use in coordinating their actions and in getting their daily activities done. In order to investigate this phenomenon we make a number of methodological elections. We begin by suspending thematic interests in space and the commensurate construction of theories or explanatory models. We replace that standard methodological policy with the alternate one of inspecting everyday life. As such, we direct attention to the embodied activities that people do – activities that are observable and reportable. Preliminary consideration of embodied activities draws our attention, firstly, to the mutual intelligibility of the material arrangements of space and, secondly, to the intersubjective competences tied to the performance of social activities which provide for a mutually intelligible world known in common. The notion of intersubjective competences providing for a world known in common draws our attention to space-in-action. Here, and under the auspices of the competent use of material arrangements and equipment of spaces and places known in common, the practical relationship between space and action is specified as a ‘representational’ one rooted in the accomplishment of the practical activities of daily life. In the following section we provide an extended example of our approach based upon one of the eSCAPE studies of, in this case, the Distributed Legible City.

Displaying the Distributed Legible City

The aim of this Section is to provide an example of the kind of studies done in the project under the auspices of the methodological precepts reviewed above. Further details of the study can be found in (eSCAPE Deliverable 4.0).[26] Here we use the study to bring out some of the main elements of framework deployed in the field studies done of eSCAPE.

Previous studies of the Distributed Legible City (DLC) focused on its public use and its set up for public use. These studies drew our attention to one primordial phenomenon everywhere at work in the social construction of space. Technically, our interest in the set up of the DLC was in developing an understanding of how virtual environments are configured for action in the real world. This interest trades on the recognition that virtual environments are irremediably embedded in real world settings and that much may be learnt for the design of virtual environments in developing an awareness of the work involved in making the technology work *in situ*. Rather than reiterate particular findings in any great detail, what we want to do here is draw attention to the constituent features of the construction of spatiality in real world, real time environments. In doing this our purpose is two-fold: first, to promote a sensitivity to the social

[26] eSCAPE Deliverable 4.0 (1999) *Towards a Common Methodology* (eds. Hughes, J.A., Crabtree, A., Rodden, T.), Esprit Long Term Research Project 25377, Lancaster University: Computing Department. ISBN 1 86220 078 5

construction of space as the accomplishment of the practical activities of everyday life and, secondly, to inform the design of novel information technologies exploiting spatiality.

Attention to the practical actions or 'lived work' of the set up revealed a host of practical contingencies and collaborations. On arriving at the exhibition centre, the staff responsible for setting the DLC up found that the display was too small. A series of practical negotiations followed. Parties to negotiations initially consisted of the set up staff, the exhibition's chief organiser who had the authority to approve modifications to the fabric of the exhibition space, and a technician who the chief organiser consulted on possible modifications that could be made. Together, the chief organiser, the technician and the set-up staff formulated and agreed upon a specific modification to the fabric of the exhibition space, which satisfied the respective interests at work. Thus, modifications that did not interfere excessively with co-located displays, that were technically achievable, and allowed the DLC to be presented to the public in an appropriate way were approved.

Having formulated, agreed upon, and approved a specific modification; alterations to the fabric of the space could then be made which, in their turn, occasioned other problems. In the first instance, the technician notified a co-worker that modifications were to be made to 'this' specific part of the exhibition space and issued instructions as to the changes to be implemented. Following this, two engineers removed exhibition-provided computing equipment from the space. Another two engineers then arrived on the scene and, having consulted the set up staff as to 'just what' changes were to be made, began to disassemble the partition walls of the display space to extend it. At this point, a 'complaint' was registered both with the DLC's set up staff and with the chief organiser by the set up staff of the adjoining display. This was about the loss of 'promised' publicity space brought about in the course of removing particular wall partitions. The chief organiser resolved the situation in bringing the two set-up teams together and posing the question as to the necessity of the modification. In response, the DLC set up staff explained that the technological requirements of the display required a specific layout, hence the need for modifications. The explanation was accepted and the agreed modifications proceeded. After the display space had been extended, another engineer then reconfigured the space's lighting and the work of modification was, at that, completed.

The purpose of telling this story about ordinary troubles encountered in the course of setting up a virtual environment is to draw attention to a common phenomenon at work in the social construction of real world spaces, an appreciation of which is of direct relevance to virtual environments of a public character. That is, of direct relevance to the design of virtual environments that are or will be shared by any number of users. In recounting the troubles and the efforts to resolve them, the story draws attention to the situationally relevant *background expectancies* which help to shape the practical action that transpires on this occasion.[27] By ‘background expectancies’ we refer to the manifold ways in which persons expect, presume and assume, take-for-granted, anticipate, count on, take on trust, and know about (etc.) the situations and occasions in which they act. Many of these are banal, such as the expectancy that if JH were to look out of his office window he would see a three story building just across the quadrangle and that if anyone else were to do so, they would see the same building. Other expectancies are less banal and involve anticipations which are more problematic. Arranging to meet someone at a particular time and place is likely to be subject to all kinds of contingencies. We know, another background expectancy, that sometimes trains fail to arrive on time, that cars sometimes break down, that sometimes arrangements to meet others may be subject to alterations at short notice, and so on. Such expectancies are ‘background’ because, for most of the time, they are not reflected upon, subjected to serious inquiry, or made manifest; they are taken-for-granted for all practical purpose. They can, of course, be made manifest when things do not turn out as expected. However, though for most of the time background expectancies are tacitly held, they are integral to processes of *making sense of the world* as becomes apparent precisely when background expectancies do not conform to anticipations. It is on such occasions that the work done by background expectancies, the things that in the course of our everyday lives we take on trust, is revealed.

By way of additional example, on arriving at the exhibition the set up team find that modifications need to be made to the display space. They do not just set about making modifications but, instead, set out to obtain permission to make modifications on the presumption that, as with many other exhibitions of this kind, there will be someone in charge, some who is responsible for the organisation of the display space and from whom they will need permission. As a most mundane matter of fact, they *expect* to obtain permission. Their subsequent actions take place with respect to this set of background expectancies and, in doing so, make them manifest. Some changes to the exhibition space have to be warranted, that is, require permission. Thus, it is against the background of organisational concerns – access to particular display spaces, flow of persons, technical requirements, safety, and the rest - that cases for modification are concertedly formulated in the course of ‘negotiation’, made and / or found reasonable, and their instantiation warranted

Background expectancies are ‘natural facts of social life’. They are integral to practical action and constitute understandings which, for most of the time, are taken on trust, taken-for-granted as the conditions for particular actions on specific occasions. Such expectancies are not psychological phenomena located ‘in the head’ of individual members of society but, rather, institutionalised knowledge shared, oriented to and known in common by members and embodied in the construction of the familiar scenes and events of everyday life. As Garfinkel (1967: 53) describes matters:

[27] Garfinkel, H. (1967) Studies of the Routine Grounds of Everyday Activities, *Studies in Ethnomethodology,* Englewood Cliffs, New Jersey: Prentice-Hall.

> Common sense knowledge of the facts of social life for the members of society is institutionalised knowledge of the real world. Not only does common sense knowledge portray a real society for members, but in the manner of a self fulfilling prophecy the features of the real society are produced by persons' motivated compliance with these background expectancies.

A general implication for design that may be drawn here is that insofar as members orient to space and place – the key focus of eSCAPE – on the basis of known in common background expectancies, then facilitating this has to be an important design consideration. This is not an argument for electronic landscapes to simply reproduce the background expectancies of spatiality as used ordinarily in everyday life (assuming that these could be determined), but it is an argument for giving serious consideration to the organisation of electronic spaces so that they can come to be known in common in both meeting and developing the relatively stable background expectancies of users.

Schemes of interpretation

The known in common background expectancies, of which institutional knowledge is composed, are employed by members to make sense of the settings their actions are embedded in and the scenes and events they are party to. It is through members' motivated compliance with background expectancies that they accomplish practical actions as familiar actions taking place in familiar places. Further, background expectancies can be formulated as explicit schemes of interpretation for making sense of some scene or event. The following account of DLC in use elaborates this point.

The DLC is a virtual environment based on The Legible City, a 1990 multi-media art installation conceived by Jeffrey Shaw.[28] The virtual space allows users to cycle around Manhattan, Karlsruhe or Amsterdam. Within this environment, users may encounter other people and talk to them but they do not encounter buildings and street furniture. The virtual environment is instead composed of coloured 3D letters which may be cycled straight through and which form sentences appropriate to the urban location in which the user is virtually situated. In the course of interacting with the DLC the user-cum-virtual-tourist may traverse various routes that reveal commentaries about the respective city or fragments of texts associated with specific areas therein. Seen from the designer's point of view, the subtle and somewhat esoteric content comprising the environment would be a 'talking point' promoting social interaction. In other words, the design plan had it that the novel structure of the Distributed Legible City – the text-form cityscape – would provide a basis for social interaction insofar as users would orient to and employ the 3D text-forms as a resource for initiating and conducting interaction. Users did indeed orient to and use the 3D

[28] Shaw, J. (1998) The Legible City, *Presence and Representation in Multimedia Art and Electronic Landscapes*, eSCAPE Deliverable 1.1, Esprit Long Term Research Project 25377, Lancaster University: ISBN 1 86220 052 1

text-forms, but not at all as expected. Below we consider the plan-in-action in considering the DLC-in-use by members of the general public.

Interaction with the DLC took one of two basic forms: instructed or serendipitous. Instructed interaction consisted of a demonstrator or previous users and onlookers instructing new users in the actions to be taken to accomplish use. Serendipitous interaction consisted of uninstructed experimentation and, as a rule, lasted for a much shorter duration. As reported in Deliverable 4.0, serendipitous interaction pointed to the need to provide practical instruction to new users if they are to become competent users of novel technologies.

Below we consider a course of instructed interaction with the DLC with an eye towards explicating how space is implicated in the accomplishment of use. It should be said that whether engaging in instructed or serendipitous interaction, users approached the installation in the same way. The bicycle was seen and understood as a familiar object in a familiar world having familiar uses much as the headset and microphone spoke for itself. Thus users would mount the bicycle and don the headset and start pedalling, often speaking into the microphone to see if anyone was 'out there'. The following sequence of interaction makes visible just what engagement with the virtual environment thereafter turned upon.

1. User: OK
2. Demonstrator: So, just experiment a little bit riding around and
3. User: Yeah, OK (user starts pedalling).
4. Demonstrator: So you're in Manhattan, and the other cities are Amsterdam and Karlsruhe.
5. User: OK.
6. User: You can't see where you're going.

Figure 1. Riding around the virtual cityscape

14. User: I want, I want to meet this person, so
15. Demonstrator: Just go up the street here (points in the direction of a visible street entrance).
16. User: Up this? (user turns towards a street to his left).
17. Demonstrator: Yeah, up that street here (points to the particular street).
18. User: Up here? (user cycles into the street).
19. Demonstrator: Yeah.
20. User: OK. We should be able to meet each other?
21. Demonstrator: Probably, at the intersection.

Figure 2. Traversing the city streets

22. Demonstrator: Just - straight ahead.
23. User: OK.
24. Demonstrator: Should be just around the corner there (points to a place on the screen).
25. User: OK. I can go down there? (user nods at a side street entrance he is cycling past).
26. Demonstrator: It should just be, may be here (points to a place on the screen)
27. Demonstrator: There! (demonstrator sees and points out another user's avatar)
28. User: Oh yeah!

Figure 3. Finding other users in the city

29. Demonstrator: You should be able to talk to them - if there's someone on the bike. I'm not sure, 'cause people get on and off.

Seen from the point of view of action, the demonstrator and user did not orient to the DLC as a novel artwork or technology *in undertaking actual use*. Instead, for all practical intents and purposes as observably embodied in their work together, the demonstrator and user oriented to and undertook interaction with the DLC as they would a very *familiar space:* namely, an urban environment. In the course of interaction and the accomplishment of use, the DLC was not seen and understood as some radical environment challenging basic conceptions of space but primarily, as a city (or more precisely, "cities"). The point is not a trivial one for with that mutual recognition a host of background expectancies were brought into play and utilised for practical purposes here and now. Namely, interacting with the virtual environment or, specifically, "riding around" the "cities".

Having invoked the notion of 'cities', the novelty of the virtual environment was ignored and users instead undertook action as they would in an urban environment. Central to the accomplishment of action – to 'riding around' and 'meet[ing] this person' - were the ways in which the demonstrator and user *made sense* of the environment. Utilising background expectancies normally and naturally employed in interacting with urban spaces, the DLC was seen and understood to consist of familiar material arrangements of place. Namely ‘streets’ and ‘intersections’. Such arrangements are commonly known to have standard uses. Thus, the demonstrator and user invoked notions of going ‘up’ and ‘down’ streets, and of going ‘straight ahead’ or ‘just round the corner’ at intersections in making sense of the actions they were engaged in together. Just what is commonly known, then, is that material arrangements of space and place may be drawn upon and used to provide directions. Thus, the demonstrator and user employed common understandings of the arrangements of urban space to establish a mutual sense of where they were going and how to get there - ‘go up the street’, ‘that street’, ‘at the intersection’, ‘straight ahead’, ‘just around the corner’, ‘go down here’, ‘here’, ‘there’.

In accomplishing these actions, known in common background expectancies of the arrangements of urban spaces were used as a scheme of interpretation for getting the activities done. Although presenting users with a virtual environment consisting of novel textual arrangements which may be cycled straight through; the DLC was nevertheless oriented to by persons as a real world urban arrangements of space. That the DLC consisted of textual forms that could be traversed in novel ways was of no practical relevance to persons interacting with the virtual space. Instead, the DLC’s textual forms were treated as if they were solid structures, and the spaces between them as highways and by-ways. Users cycled down and around the city streets, trying to avoid colliding with what for them were ostensibly buildings.[29]

Background expectancies were, and are, used then as a resource for undertaking and accomplishing action. They furnished a scheme of interpretation for making sense of the space and the events that occur there as familiar events taking place in familiar ways. In these ways users made sense of DLC and made it into a facsimile of an urban environment. Thus, in the manner of a self-fulfilling prophecy, the DLC was socially constructed in action as a familiar space. As Garfinkel (1967: 36) again expresses the general point:

> The member uses background expectancies as a scheme of interpretation. With their use actual appearances are for him recognisable and intelligible as the appearances-of-familiar-events

The instance is suggestive in showing that, at least in this case, persons employed a ‘natural sense’ of the ordering of the electronic space by using a scheme of interpretation derived from the urban landscape. The point is subtle, complex and of potential significance for the design of electronic spaces in raising questions about how far designs should rely upon the ‘natural sense’ of spaces. In particular, as we have pointed out, the material arrangements of some spaces cannot be divorced from the activities which take place within them, arrangements which may well be employed as part of schemes of interpretation. Such

[29] It was in the course of trying to avoid collisions (not always a straightforward matter due to the turning parameters of the bicycle) that users found out that the text-forms were not solid structures. This made little difference to their course of action however (beyond causing some surprise and even confusion) and users, more often than not (though not without the occasional exception) sought to resume a natural, real-world mode of traversing a cityscape.

commonsense understandings may well furnish background expectancies to be used in making sense of the place and what can be done there. Consequently, in developing virtual environments for public use, designers may benefit from employing familiar representations of the material arrangements of space and place insofar as such representations provide naturally intelligible resources for interaction in the environment.

Interactional competence

Background expectancies and schemes of interpretation do not, of course, apply themselves. There is an interactional competence involved. By way of elucidation: one of the background expectancies at work in the normal course of our interactions in urban environments is that we will be able to find our way around them in the course of getting our activities done. In other words, that the environment will provide us with the means of ‘getting around’, of navigating. This might involve using maps and signs, landmarks, following instructions or even asking someone. In various and expected ways, the space will provide for its navigation. In the case of the DLC, navigation was not only provided for in the instructed interaction between users and the demonstrator in using the material arrangements of the cityscape as wayfinding devices but also, through the use of a 2D map.

Maps are commonly used artefacts often made available at appropriate places, in city centre’s, on the internal walls of particular buildings, hotels, railway stations, city squares, and so on. Maps may be part and parcel of the material arrangement of space and, as pieces of equipment used by people to do wayfinding. The DLC map is a 2D map which overlays street-plans of Amsterdam, Manhattan, and Karlsruhe on the 3D environment and displays user positions within the respective cityscapes through small, uniquely coloured triangles. Such maps are intended to furnish and maintain an orientation to space, to assist users in discovering and following a route, and ultimately, to help them get to a particular destination. Rather than pursue an abstract discussion, below we consider the DLC map-in-use.

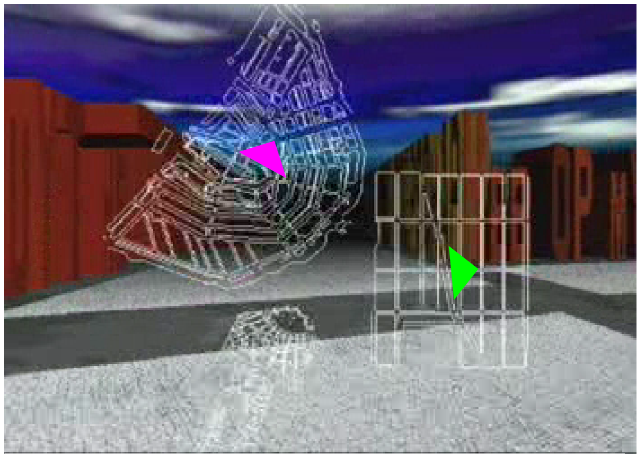

Figure 4. The DLC map displaying user locations

6. User: You can't see where you're going.
7. Demonstrator: Yes you can. If you pull up the map you see the little triangle (the demonstrator pushes a button on the handlebars and pulls up a map). You see.
The user presses the button on the handlebars and the map comes up on screen again.
9. Demonstrator: Yeah. See. You're this little triangle (he points to a triangle on the map) and you go in that direction (he points out the other users triangle on the map).
The user looks at map.
10. User: Where am I?
11. Demonstrator: You want to turn around [inaudible] to meet the person.
12. User: I see, then I can meet the other, OK.

Figure 5. Finding out where you are and where to go in the virtual city

The user turns around and starts cycling in the direction that has been pointed out to him. He has the map pulled up as he cycles along.

13. Demonstrator: You don't have to use the map all the time - you just go along the street you know.

As the sequence of interaction makes visible, in encountering 'practical troubles' of location and direction people expect to be able see where they are now and where to go next, and expect some means of finding these things out to be furnished by the environment. These expectations are met through the provision of a 2D map which the demonstrator points out and instructs the user in its employment. The map comes to be understood familiarly as a resource for wayfinding. As such, the map is understood not as any map but as map relevant to present purposes. It is a map of *this* place and other *relevant* places. It provides a means of navigating *these* places. Just how the map provides for navigation requires articulation by the demonstrator – the map does not explicate its own meaning. Thus, the user is instructed that 'you're this little triangle' and that 'you go in that direction' and implicitly, to that point (the other triangle), to meet the other user. In instructing the user in the sense of the map's features – that you are situated in a city and that *this* triangle is *you* here and *that* triangle the *other* over there – the demonstrator explicates the map for the user. In effect, the map is an 'occasioned map' whose sense is constructed in the user's presence and in the course of using the apparatus.[30] Importantly, it is a map constructed and explicated for this particular user, in this situation, and responding to the practical 'here-and-now' encountered troubles.

A rather different situation emerges in the course of serendipitous use. A great many users discovered the map in the course of investigating the virtual environment. Although several people engaged in serendipitous use managed to figure out the meaning of the map (through pulling up the map, cycling around and observing one of the triangles move around too) the vast majority of users could not make sense of the map and quickly brought their interaction with the environment to a close. As the course of instructed use makes visible, map use relied on the demonstrator filling in the gaps encountered in making sense of the map's features. In the absence of someone or something to fill in those gaps, users could interpret the map's features and its use was, as such, unintelligible. In undertaking serendipitous use, users expected the map to explicate its own meaning. The features by which it should do this (such as an adequate index, for example, or "you are here" indicators) were not provided however. The map failed to comply with people's common sense expectations of maps then. In attempting to use the map, users expected to find an *inscribed* scheme of interpretation through the use of which they could make sense of the map's features and thus employ the map for current purposes.

The 2D map is a material arrangement of the virtual environment which is employed as a piece of equipment for the accomplishment of wayfinding. Although developing support for wayfinding is an essential aspect of eSCAPE design, the general point we wish to draw attention to in considering map use in the DLC is that space is not simply constructed out of material arrangements but rather, and as the map makes visible, that material arrangements are *used in*

[30] See Psathas (1979) for a discussion of maps in much the same vein. Psathas, G. (1979) Organisational Features of Direction Maps, *Everyday Language: Studies in Ethnomethodology* (ed. Psathas, G.), New York: Irvington.

methodical ways for getting activities done.[31] The use of material arrangements reveals that action in space consists of the application of known in common interactional competences that are tied to the particular material arrangements composing space. These competences may consist of the use of streets and intersections as wayfinding devices or the use of maps, for example. Space socially constructed, then, through the known in common and methodical use of its material arrangements. Insofar as the design of virtual environments is predicated on familiar representations of the material arrangements of space, then the general design implication here is that support for the known in common and methodical use of familiar arrangements may go some considerable way in promoting the uptake of novel technological environments insofar as they provide a basis for undertaking spatially situated interaction.

Spatially situated interaction

It is the competent use of known in common background expectancies and schemes of interpretation through which persons interact and coordinate their actions. Such interactions take place within a spatially organised environment. Just as users construct the virtual space in socially organised ways as familiar space where familiar events take place, then so too they order their interactions in the virtual environment. That is, they order their interactions as familiar actions, taking place in familiar places, and in familiar ways.

30. User: How can see if there's someone on [the other bicycle]?
31. Demonstrator: You should be able to talk to them if there's someone on. When you see the person you do that - talk to them.
The user initiates a conversation:

> Hello. Are you out on the right?
> Yeah. Yeah. I'm trying to reach you.
> Yeah. Getting closer now.
> You, you shouldn't go that fast!
> No. This is terrible. You're too fast.
> Yeah. OK. Thankyou. I'm coming.
> I'm too tired.
> OK. I'm following you.
> OK. Where are you going? Have you been drinking!
> Yeah. Just behind. Coming round. Trying to drive into you now.
> Ohhh! Oh – missed.

The user turns handlebars to the left in an attempt to relocate the other avatar. He cannot see the other avatar as he is turning. The user pulls the map up and checks it to see the other avatar's location. The demonstrator points out that the other avatar is on the users right. The user cycles round to the right but still can't see the other avatar.

[31] For an extended treatment of issues here, see Crabtree, A. (2000) *Remarks on the Social Organisation of Space and Place*, Journal of Mundane Behaviour, Volume 1, Issue 1.

Figure 6. Interacting with other users: orienting to avatars

32. User: OK (the user removes the headphones and gets off the bike). So, it's very exhausting!
Following a brief conversation with the demonstrator the user leaves the display area.

As the interaction of users 'within' the DLC makes visible, persons order their interactions as familiar actions, taking place in a familiar place, and in familiar ways – doing greetings and coordinating actions in much the same way that 'anyone' may do when meeting in a public place. A greeting serves to establish a mutual orientation to an another. Establishing a mutual orientation to each other consists not only of talking but also, and critically, in the administration of a required procedure of interaction, namely 'minimally acceptable looking'.[32] Administration of this procedure provides for the management of co-presence in real world, real time public spaces and for the initiation and subsequent coordination of joint courses of action. In and through administering minimally acceptable looking, persons exhibit for one another an orientation to the activities they are engaged in, to their relationships in the doing of their activities, and their appearances to one another and other onlookers.

As the talk between the users makes visible, it is a presumption of naturally occurring social interaction that administration of the procedure will furnish sufficient interactionally relevant information. Thus, following the greeting, the user asks "Are you out on the right?". An affirmative response provides for continued interaction. Looking at and being able to see the other user's position is crucial to the initiation and ensuing course of joint action. That is to say, that minimally acceptable looking is not simply administered at the beginning of interaction but throughout interaction. Thus, in administering the procedure, in looking at and orienting to one another in the course of their actions, the users first come to initiate a course of joint action – "Yeah. Yeah. I'm trying to reach you … Yeah. Getting closer now" - and then undertake to coordinate their efforts – "You, you shouldn't go that fast! You're too fast. I'm coming. I'm following you. OK. Where are you going? Yeah. Just behind. Coming round. Trying to drive into you now". Throughout the verbal exchange, the users spatially and temporally extended course of joint action *turns upon* repeated observation of an unfolding situation (concerning, for example, the speed at which the users are travelling and their spatial relationship to one another) which must constantly be monitored and brought under coordinated control.

[32] Sudnow, D. (1972) Temporal parameters of interpersonal observation, *Studies in Social Interaction* (ed. Sudnow, D.), New York: The Free Press.

Interaction between users situated 'within' the DLC elucidates the critical character of minimally acceptable looking. Although the headset and microphone supported verbal communication,[33] the apparatus supporting visual orientations (the exercise bike and fixed interface) was inadequate for the accomplishment of joint courses of action insofar as the apparatus failed to support the endogenous temporal order of coordination. In attempting to coordinate a 'face-to-face' (avatar-to-avatar) meeting, the users sought to coordinate their actions such that they would be co-located in the same proximal space: "Yeah. Just behind. Coming round. Trying to drive into you now. Ohhh! Oh – missed". Following the 'miss', one of the users undertook a series of manoeuvres in an attempt to re-locate the other user. The attempt to re-locate the other user consisted of the attempt to administer the minimally acceptable looking procedure, and in the attempt to re-establish a mutual orientation, but the user could not administer the procedure within a reasonable time frame (nor could a great many other users).[34] Consequently, the user (like so many others) became frustrated and brought the attempts to a close.

In the course of its use the DLC induced a form of 'structured anxiety' through the technology's failure to support *ordinary interaction procedures* or 'methods'. In using the DLC persons can do pretty much what they please – cycle after one another without talking, follow others, or just sit and chat. Nevertheless, trying to achieve an orderly course interaction was problematic due to the difficulty of transforming ordinary monitoring procedures into coordinating actions and achieving a relatively seamless flow of monitoring – action – monitoring – action, and so on, until some semblance of joint activity was produced. Two general implications derive from these experiences. One the one hand, failure to be sensitive to and support temporal features of 'witnessability' ordinarily built into spatially situated action may be of critical importance to the design of embodied virtual environments. And on the other hand, developing a sensitivity to ordinary interaction methods may also be of considerable importance in providing *resources* for user interaction with virtual environments (in contrast to embodiments of persons 'therein'). In either case, developing such a sensitivity will consist of attending to the ordinary methods whereby people order their interactions together.

Putting space together in action

Attending to the 'lived work' involved in the set up and use of the DLC brings out the embodied work by which spatially situated action is accomplished; work

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33 With some instruction – users natural propensity is to talk into the microphone immediately. That is, on mounting the bicycle and donning the headset. They had to be instructed, then, that they could only talk to other users when in visual proximity.

34 This resulted in a radical redesign of the DLC to support social interaction through the use of Head Mounted Displays. See Crabtree, A., Rouncefield, M., Pettifer, S. (2000) Designing Virtual Environments for Social Interaction, *Proceedings of Virtual Reality International Conferences 2000*, Laval, France.

which exhibits the fact that space is not so much a container for action but is actively constructed through coordinated actions. The following are some transsituational themes of the social construction of space relevant to the design of electronic landscapes.

Making Sense of Space and Place

Sensitivity to the importance of background expectancies and schemes of interpretation in making sense of spaces and places and the role they play in enabling the production of coordinated action is an important design consideration, particularly where novel VR environments are concerned. Nothing decrees that virtual environments should replicate real world spaces. Nevertheless, it is important to make virtual environments publicly intelligible.[35] As we have argued in previous deliverables, like any environment, VR environments need to be learnable. In effect, design must create the conditions such that background expectancies are met or, alternatively, that users can form stable background expectancies.

The Use of Material Arrangements

Although the approach used here emphasises the social construction of space, this is not to the exclusion of any consideration of the materialities of spatial arrangements. On the contrary, it is such prosaic materialities as walls, doors, roads and pavements, fences, etc., which help provide for the sense of space as enduring, external and objective. These qualities are, from our point of view, qualities accorded to material arrangements by means of the shared common knowledge embodied in interactional competence. Such materialities will need to be provided for in VR worlds which, of course, have their own materialities arising, in the main, from infrastructural and design considerations. However, in creating a virtual space, it is important to provide the means of interacting within virtual environments.

Interaction Methods

In distributed and populated electronic spaces, it is important to provide effective means for supporting interaction with other users and, in unpopulated worlds, the space itself. This will involve, on the one hand, making provision for the self-administered monitoring and coordination of user interactions within the VR world. And on the other, providing means for persons to make sense of the spaces and places where their actions are located, and in the ways in which they use the 'materialities' of the space in local accomplishment of interaction.

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[35] The issue will be addressed at greater length in the following strand of the deliverable, where we consider the development of an 'abstract' virtual environment. That is, a virtual space that does not resemble a real world place but does furnish a publicly intelligible scheme of interpretation promoting its use.

The ‘socially informed’ construction of virtual spaces

A great deal of excitement surrounds virtual reality (VR) and, in some quarters, this has turned into hype and exaggeration as heralding a ‘brave new world’, a ‘new era of human subjectivity’, radically new ways of interacting and forming communities. Such wild optimism is, of course, often counter-balanced by an alternative pessimism about just the changes that others find so exciting and promising. All of this apart, however, our point of view seeks to convey a different impression. We see participants in VR worlds engaged in a day-to-day business, exploiting local knowledge, mobilising everyday skills and competences, managing contingencies and problems as and when they arise as best they can. We see ordinary interactional competences consisting of practices for managing turn-taking, displaying attentiveness and orienting to presence, and the rest, all deployed in the attempt to make unfamiliar and practically troublesome arenas for action recognisable and reliable. Interaction within the VR world will trade upon the skills and competences of a world known in common rather than the putative ones often associated with ‘cyborgs’ or ‘postmodern subjectivities’. Social interactional activities, be they in the real or the virtual world, remain obdurately worldly.

What is being outlined in these studies then, is an account of the virtual world as a ‘worldly’ place, a place that relies on the kinds of fundamental understandings of ‘a world known in common’ that we discussed earlier. The DLC, for example, was ‘worldly’ in the sense that it existed as an intersubjective world, the intelligibility of which depended upon its social organisation by parties to its use, predicated upon their practical orientation towards it as a ‘world known in common’. These observations, alongside the account of the social organisation of space herein, make plain the central importance of one of the main issues within the VR community, namely, the extent to which the parameters of the real world can be relaxed to take advantage of the functionality’s provided by electronic media? Since communication at a distance may be virtually instantaneous, do we need to represent distance in a VR world? What minimal embodiments can we use effectively? How far do we need to reproduce the proximal aspects of bodily spacing? And so on.

At the other extreme would be the ideas of violating most if not all of the parameters of the real world. A crucial issue here, however, concerns how users are to learn a world which violates, or suspends, their taken-for-granted, known in common intersubjectivities about space and its arrangements. From what has been said earlier, it should be reasonably clear how deeply ingrained spatiality and sociality are, which means that suspending any sense of our common understandings is likely to produce bewilderment unless the world is so constructed that it can be investigated and learned. In other words, it must provide for itself as a learnable world – and it is this feature which is important rather than the debate about whether or not a VR world must be a facsimile of our ‘real world’.

It should be stressed that this observation is an important one within the context of the eSCAPE project as to speak of an ‘inhabited virtual world’ is to speak of a public place in at least the minimum sense that the ‘world’ must be learnable by ‘anyone’. To reiterate, in making this contention we are drawing attention to the intersubjective nature of the social organisation of space, and are arguing that the most fantastical of environments will also require such an underpinning for it to be a populated world. Clearly we already see crucial elements of these requirements reflected in the characteristics of a world known in common and we see furthermore that we ignore such principles at our peril. It seems reasonable to contend that an eSCAPE affording joint action must support the thematic elements of intersubjectivity as outlined in this document.

Accordingly, if the ongoing design of eSCAPEs is to fulfil these aims it might be worth considering some of the thematic elements identified not only as ‘sensitising’ themes for those constructing such environments but also, as furnishing general design principles. Does the environment provide a publicly intelligible scheme of interpretation whereby persons can make sense of what goes on there? Insofar as familiar material arrangements are employed, may those arrangements minimally be used in expected ways? Do interaction devices support ordinary methods of interaction? Such technical undertakings may be informed by ethnographic studies of the interactional work-practices that require support by a *given* environment if it is to be an intersubjectively intelligible arena for interaction.

In essence, we see the ethnographic work undertaken by Lancaster within the eSCAPE project as a means of exploring intersubjectivity through the fieldwork at ZKM, at various exhibitions, and in alternate settings of cooperative work. The resonance of these studies is provided through a sustained focus on the concerted ordering of the virtual world by those who are party to the activities taking place by way of their mundane commonsensical interaction skills. Across all the studies, virtual reality is observably and reportably ‘worked up’ as an orderly arena for action through the ordinary interactional competencies of participants. The utility of virtual space, and embodiments within it, arises through the interaction of participants in coping with the contingencies brought about in using an unfamiliar set of resources and in rendering those resources ‘familiar’ for all practical purposes. The utility of virtual space and user embodiments is *not* given by technical arrangements alone then. Their usefulness as bearers of interactional significance has to be worked up, worked on, maintained and repaired in the light of ongoing activity in *both* real and virtual worlds. The kind of skills involved in working up such utility, and in providing these environments with their collaborative nature, are not ‘new’ ones in the sense that they are no different from the kinds of mundane interactional competencies displayed in the social organisation of everyday life in real world settings. Just what those mundane competences consist of in any particular setting, naturally, remains to be explicated.

The role of ethnographic inquiry

While much could be said about the role of ethnographic inquiry in a design context, we take it that it's primary point and purpose is to perspicuously investigate settings that are of particular relevance to the design task. The investigation of 'perspicuous settings' stands in contrast to traditional social science modes of investigation whereby social organisation is accounted for in terms of generic theoretical policies and representations.[36] In this latter mode of inquiry, social organisation becomes a theorist's construct produced through the use of accepted procedures of constructive analysis, rather than the real world, real time methodological procedures used by members to organise the concerted activities which constitute some setting's daily work. We take it that VR systems will be used by and embedded in the concerted activities of ordinary users in a multiplicity of different settings and for a wide range of activities, in contrast to being used by the professional sociological analyst *qua* analyst. What we need to appreciate in approaching the design of VR systems is the social organisation of the setting as seen and understood by parties to that work. Furthermore, we need to develop an appreciation of particular aspects of social organisation that are of relevance to the design task.

The design task in the eSCAPE project has been one of developing virtual environments or spaces. Consequently, the focus on social organisation is directed towards developing an appreciation of the social construction of space and place. The design task furnishes a practical focus and directs us to find settings where the social construction of space is a practical issue for some setting's staff and whose investigation will actively inform the design endeavour. Investigating such perspicuous settings provides us with a fundamental research policy. Given the formulation of a design task – that of developing virtual environments, for example – we need to look at the practical actions of persons who, as part of their ordinary affairs, have the task of organising spatial arrangements. Furthermore, we are concerned to develop general infrastructures, tools and paradigms rather than specific computer support for a specific real world environment.[37] Accordingly, we seek to observe workgroup's who, as their day's work, enable us to bring out the kind of considerations they themselves attend to in the course of constructing spatial arrangements.

The set up and use of the DLC is one such perspicuous setting.[38] Set up and use is accomplished by a specific workgroup consisting of set up staff, exhibition

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[36] Garfinkel, H. & Wieder, D.L. (1992) Two Incommensurable, Asymmetrically Alternate Technologies of Social Analysis, *Text in Context: Contributions to Ethnomethodology* (eds. Watson, G. & Seiler, R.M.), New York: Sage.

[37] Although the development of specific environments has been part of the project's exploration and demonstration of general infrastructures, tools, and paradigms.

[38] Naturally, there have been a number of other perspicuous settings investigated in the course of the eSCAPE project as and when particular design tasks have emerged. Such as the investigation of a library in the course of developing and demonstrating the application of generic infrastructures (eSCAPE Deliverable 4.1) And a tourist information centre in exploring the interconnection of a multiplicity of virtual environments (eSCAPE Deliverable 4.2). And the investigation of a fitness

organisers, technicians, demonstrators, and users. In and as of their day's work together the members of this work group knowingly construct the spaces their actions are embedded in and reflexively re-produce. Their day's work together teaches us the following lessons:

- That space and place is socially constructed in and through the use of known in common background expectancies that are oriented to and used concertedly as schemes of interpretation to make sense of space and the actions that may be undertaken and otherwise go on there.
- That the material arrangements of space and place are drawn upon and used in methodical ways as coordinate resources in the accomplishment of action.
- That social interaction in space turns upon the local administration of ordinary interaction methods whereby people exhibit for one another an orientation to the activities they are engaged in, to their relationships in the doing of their activities, and their appearances to one another and other onlookers alike.

In adopting a performative orientation to social organisation and in inspecting space-in-action, the work of the DLC work group not only sensitises us to the specific work-practices whereby the day's work is socially organised but also, to the social organisational phenomenon those practices elucidate: the *social construction* of *place*. As a social organisational phenomenon, the day's work of the DLC shows us that the social construction of place consists of the use of known in common background expectancies as schemes of interpretation, the methodical use of the material arrangements that comprise space, and the local administration of monitoring and coordination control methods. These are constitutive features of the organisational phenomenon; features which are transsituational and may be oriented to and fleshed out through ethnographic inquiry in other settings being designed for. In other words, they elucidate a framework for investigation into alternate settings. A framework that provides a concrete focus for the design of virtual environments whereby developers may consult the social organisation of the day's work in settings being designed for, thus grounding research and design in practical socially organised situations of use.

centre in exploring the feasibility of installing the DLC in such an environment for purposes of experimentation along with a host of investigations into the use of novel technologies (eSCAPE Deliverable 4.0).

Chapter 3: Computer Science Perspectives on eSCAPE

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In this chapter we wish to consider the methodological experiences of the eSCAPE project from the perspective of the computer scientists involved in the development of electronic landscapes. As in the chapters addressing social science and artistic involvement we wish to reflect on the different interests that computer science as a discipline brought to the project and the ways in which these unfolded during the development of the project.

The experiences reported in this chapter essentially represent a history of the project seen from the perspective of those involved in the development of virtual reality. As in the case of the other chapters in this deliverable we take as our starting point the research issues driving the formation of the eSCAPE project and the expectations of the computer scientists involved in the project. We shall then consider how these issues matured during the development of the project and how our understandings of electronic landscapes have developed. In doing so we wish to consider how the computer scientists involved in the development of the electronic landscape reason about the nature of these spaces.

It would be unwise to suggest that the diverse set of computer scientists involved in eSCAPE were driven by a single research goal. In fact, given the diversity of computer scientists involved it would be very surprising to find that the community of technical researchers involved in eSCAPE would agree on a single goal. Consequently, from the outset the notion of an electronic landscape was a deliberately general term used to promote a convergence of a set of concerns that range from middleware for cooperating users to high performance graphics and embraced both theoretical concerns and development of applications. This diverse set of research issues can be broadly grouped into three different classes of research challenge:

- Supporting mechanisms and virtual environment development.
- Novel Application development.
- New concepts and theories.

During this chapter we shall consider the different approaches made to the development of these research areas throughout the project. We found that during the project lifetime some of these grouping would have more visibility and that the project lifecycle was significant. In particular we found the initial stages of the project focused on the development of new techniques that were put to use within the development of applications and that these were then reflected on to develop new generic architectures, theories and framework for design. In this chapter we shall end with the presentation of one of the design frameworks to emerge from our considerations.

From the outset the motivation of the computer scientists involved in the project were grounded within two related but distinct research traditions and cultures. The first research community focused on the development of shared environments that promote cooperative work while the second research community focused on the development and exploitation of advances in virtual reality. At the start of the eSCAPE project these two distinct research traditions were starting to converge around the notion of collaborative virtual environments that supported a number of potentially geographically remote users. The general principle was that the needs of a community of users could be met by allowing them to collaborate within a shared artificial space. Before we consider the research challenges driving those involved in the development of these environments it is worth briefly reflecting on the emergence of CVEs and the challenges that these environments set for the researchers involved in eSCAPE.

The Emergence of CVEs

CVEs can be seen as the result of a convergence of research interests within the virtual reality and computer supported co-operative work (CSCW) communities. Within the virtual reality community CVEs represent a natural extension of current commercial single-user VR technology to support multiple participants. This extension allows better support for a range of applications. For example, the communication between instructors and trainees central to simulation and training applications can be supported. Visualisations may also be shared and discussed between by teams of scientists or decision-makers. Finally, the ever-expanding variety of multi-player games and rides demonstrates the potential of CVEs in leisure and entertainment, the most notable examples being games such as Doom and Quake. In all of these examples, participants will often be physically dispersed and communicating over a computer network.

Within the CSCW community CVEs represent a technology which may support some aspects of social interaction not readily accommodated by technologies such as audio– and video–conferencing and shared desktop applications. Studies of co-operative work in real world environments have highlighted the important role of physical space as a resource for negotiating social interaction, promoting peripheral awareness and sharing artefacts[39]. The shared virtual spaces provided by CVEs may establish an equivalent resource for telecommunication. CVEs also have the potential to support crowded on-line situations where tens or hundreds of participants negotiate social engagement by dynamically forming sub-groups. Crowded virtual trading floors and virtual

[39] Bentley, R., Rodden, T., Sawyer, P., Sommerville, I., Hughes, J, Randall, D. and Shapiro, D. (1992): "Ethnographically-Informed Systems Design for Air Traffic Control", *Proc. CSCW'92*, 123-129, Toronto, November 1992

shopping malls are potential examples. Finally, CVEs may enable participants to discuss and manipulate shared 3D models and visualisations in such a way that each can adopt their own viewpoint and can naturally indicate to others where they are looking and pointing.

The research interest in CVEs has been complemented by considerable commercial activity developing and implementing international standards for multi-user virtual worlds. In particular, the “Living Worlds” working group is building on and extending the Virtual Reality Modelling Language (VRML97) standard, a widely adopted IEEE standard for single-user interactive 3D graphical worlds. Many companies are currently building Internet-oriented CVE systems, often based on extensions to the VRML standards, or alternatively on proprietary technologies[40].

The focus on space and spatial models

Underpinning the emergence of CVEs is a turn to space and spatial environments and much of the work in the development of collaborative virtual environments is based on understanding and exploiting space. This focus on space and spatial models provides a strong motivation for the related turn to artistic and social science perspectives. Essentially, by developing richer understandings of the nature of space and the best way to represent space within computational platforms the computer science researchers seek to provide better support to those involved in the development of these models.

Considering the ways in which CSCW researchers have turned to space and space based systems to support and promote cooperative work can best convey the importance of the focus on space. It also offers some insight into the core motivations underpinning the turn to the different disciplines within eSCAPE and the need for those involved in eSCAPE to work together to address these concerns.

Shared Interaction and Cooperation

The starting point for much of the consideration of the shared space within eSCAPE lies within the CSCW research community. The CSCW research community has seen the development of a number of systems to support real time cooperation. These systems have their roots in shared drawing and shared screen systems. The issues surrounding the management of these systems have focused on a consideration of the management of these interfaces and the development of interaction techniques such as WYSWIS[41] and interface coupling[42].

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40 Damer, B. (1997): “Demonstration and Guided Tours of Virtual Worlds on the Internet”. *CHI’97 Supplementary Proceedings (demonstrations),* Atlanta, US, ACM Press

41 Foster, G., Stefik, M. "Cognoter: Theory and practice of a Colab-orative tool", In Proc. CSCW'86, Austin, TX, December, 1986, pp 7-15, ACM Press.

42 Dewan, P., Choudhary, R., "Flexible User Interface Coupling in a Collaborative System", In Proc. CHI'91, New Orleans, LA, April, 1991, pp 41-48, ACM Press

These shared interface systems initially focused on the development of techniques to support a small numbers of users. For example, the development of the ClearBoard system[43] considered the issues surrounding the use of shared interfaces by two users. Similarly work on shared drawing focused on a small number of users[44].

The application of shared interface systems in real world settings saw some re-examination of the basic principles of sharing. Perhaps the most notable of these is the re-examination of WYSIWIS[45] and the subsequent development of a number of techniques to manage the separation between public and private interfaces. These techniques included the development of coupling techniques and the construction of techniques to support the tailoring of cooperative user interfaces.

As technology matured and the development of systems that allow real time shared interaction became more stable researchers considered the development of a variety of different applications that supported this form of interaction. The need to allow the rapid development and construction of cooperative applications saw a growing shift toward the development of toolkits. These included the development of Groupkit[46] and the emergence of Rendezvous[47].

Underpinning the development of these shared interfaces was a growing acceptance of a common model. The general strategy agreed was to consider multi user interfaces in terms of different views on a pool of shared data. Work continued to focus on the development of appropriate models of distribution and how the issues of shared information may best be support. This focus led to a general consideration of the architecture of shared interface systems and how best to provide responsive interaction while sharing information between remote users.

The development of the World Wide Web and the subsequent establishment of a large user base for distributed multi-user applications saw some shift in focus in shared interface systems and CSCW systems more generally. Rather than consider the need to develop interfaces for a small number of users the growth of the Internet allowed the rapid deployment of systems within organisations. As a result researchers needed to consider the issues of developing systems that supported a large number of users and provided facilities to allow users to manage this interaction.

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43 Ishii, H., and Kobayashi, M. "Clearboard: A Seamless Medium for Shared Drawing and Conversation with Eye Contact". In Proc. CHI '92, Monterey, CA, May 3-7, 1992, pp. 525-532. ACM Press.

44 Tang, J. C., "Findings from observational studies of collaborative work", In International Journal of Man-Machine Studies, 34(2), 1991, pp 143-160.

45 Stefik, M., Bobrow, D. G., Foster, G., Lanning, S., and Tatar, D., "WYSIWIS Revised: Early Experiences with Multiuser Interfaces" In ACM Trans. Office Information Systems, 5(2), 1987, pp 147-167.

46 Roseman, M., Greenberg, S. "GroupKit: A Groupware Toolkit for Building Real-Time Conferencing Applications", In Proc. CSCW'92, Toronto, Canada, October, 1992, pp. 43-50, ACM Press.

47 Patterson, J. F., Hill, R. D., Rohall, S. L., Meeks, W. S., "Rendezvous: An Architecture for Synchronous Multi-User Applications" In Proc. CSCW'90, Los Angeles, CA, Oct., 1990, pp 317-328, ACM Press.

The need to consider the management of interaction has tended to focus on the development of techniques to support the process of users coming together and techniques to allow different contexts of interaction to be supported. Many of real time cooperative systems have turned to some form on spatial metaphor to support this.

The emergence of Shared Spaces

The need to provide techniques that allow users to manage multiple simultaneous interactions saw the rapid development of spatial approaches to CSCW. Nearly all real time cooperative systems exploit some form of spatial metaphor as a means of presenting the system to users. As was the case in the initial development of the Rooms metaphor[48] the use of spatial techniques is often aimed at providing a set of simple, easy to use techniques to manage interaction.

The application of spatial techniques and arrangements is also a focus for study for those interested in MediaSpaces[49] and has seen the development of a range of different physical shared spaces augmented with multimedia connections. These spaces have tended to focus on the physical arrangement of spaces and the inclusion of different media within these spaces. However, in doing so they have also often exploited spatial metaphors as a means of controlling the media. Perhaps the most notable example of this is the Cruiser system[50]. A similar use of a spatial metaphor can be seen in the Portholes system[51] with its structuring of space.

The use of a shared space has also been exploited in MUDs and MOOs to support a disparate community of users. These simple text based environments often exploit some form of spatial metaphor to support communities of users. The general model of interaction is to allow a number of users to enter some shared "world" and allow their interaction to be seen by other users. These systems have recently been extended to provide 3D interfaces to these virtual worlds and a number of systems exist that support these virtual worlds[52].

The development of shared virtual environments within the CSCW community has seen the development of a number of cooperative virtual environments. These systems place users within a 3D virtual environment and provide facilities that allow them to navigate these environments and interact with each other. These environments have been used to support various forms of teleconferencing and cooperative applications such as the cooperative browsing of information.

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48 Henderson, A.J., Card, S.A., "Rooms: The Use of Multiple Virtual Workspaces to Reduce Space Contention", ACM Trans. on Graphics, 5(3), 1985

49 Gaver, W., et al. "Realizing a video environment: EuroPARC's RAVE system." In Proc. CHI'92. 1992. Monterey, CA, USA: ACM

50 Root, R. W. "Design of a Multi-Media Vehicle for Social Browsing" In Proc. CSCW'88, Portland, OR, Sept., 1988, pp 25-38, ACM Press

51 Dourish P., Bly S., "Portholes: Supporting Awareness in a Distributed Work Group", Proc. CHI'92, Monterey, CA, May 1992, ACM Press, pp 541 547

52 The Contact Consortium, http://www.ccon.org/

The emergence of 3D virtual environments has been balanced by a growing application of spatial techniques within 2D shared interfaces. Many of these are based on the notion of shared workspaces and the partitioning of these workspaces. These include the ORBIT system with its use of locales[53]; the use of rooms within the Teamwave system[54]; and the use of workspaces within CBE[55] A spatial approach is also exploited within the Piazza system[56] with its focus on users sharing information as a means of supporting work.

Striving for a common understanding

It is clear from that some common agreement on the development of applications to support real time cooperative interaction has started to emerge. The core of this agreement is an exploitation of the concept of some form of shared space that provides a focus for interaction.

This shared space provides a number of significant features that are provided to users to allow them to manage the interaction.

- Activities can be partitioned in a number of distinct shared spaces (often the use of rooms, worlds or locales are used to describe these spaces)
- The shared spaces allow resources associated with the cooperative interaction to be gathered together.
- Information can be shared between users by placing them within shared spaces
- Users can be considered present within these shared spaces when they access the information and resources within them and this presence is reflected to others

Essentially the majority of shared cooperative systems agree on the need to allow resources and information to be shared, the provision of techniques to structure this sharing and the need to allow users to be aware of the activities of others. However, despite this broad agreement in the majority of systems, we still have a diversity of approaches to managing this situation. Most do not provide any form of interoperability with other cooperative systems. In essence, each of these cooperative systems behaves as a closed world with limited access to other forms of cooperative system.

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53 Kaplan, S. M., Tolone, W. J., Bogia, D. P., and Bignoli C. "Flexible, active support for collaborative work with ConversationBuilder", In Proc. CSCW'92, Toronto, Canada, Oct., 1992, pp 378-385, ACM Press

54 Roseman, M., Greenberg, S, "TeamRooms: Network Places for Collaboration". In Proc. CSCW_96 (Boston, MA, Nov.16-20, 1996), pp 325-333, ACM Press.

55 Lee, J. H., Prakash, A., Jaeger, T. "A Software Architecture to Support Open Distributed Collaboratories", In Proc. CSCW'96, Boston, MA, Nov., 1996, pp 344-353, ACM Press

56 Isaacs, E., Tang, J. C., Morris, T. "Piazza: A Desktop Environment Supporting Impromptu and Planned Interactions", In Proc. CSCW'96, Boston, MA, Nov. 1996, pp 315-324, ACM Press

One reason for the lack of cooperation between different systems is that there is little common understanding on the nature of these environments and how these environments can be brought together. We see this mismatch demonstrated in the different approaches to modelling and understanding spaces that have emerged to date. In fact striving for this model of space through the investigation of electronic landscapes represents one of the main lessons to be learned by researchers involved in eSCAPE.

Models of space and awareness

We all feel we have some knowledge of ordinary physical space and those with a scientific background are used to encoding this in the x,y,z coordinates of Cartesian geometry. The Cartesian view of physical space allows a unique labelling of space and allows us to understand the relationships between locations in terms of their coordinates alone. Scientifically it has been of tremendous importance and practically it enables both global navigation and civil construction projects. In virtual reality it is this Cartesian 3D space that is emulated, and in desktop interfaces Cartesian 2D space. One of the requirements we have is to have a measure of nearness and Cartesian geometry supplies this with the familiar Pythagorean (as the crow flies) distance:

$$\mathrm{dist}^2 = x^2 + y^2 \qquad \text{– 2D space}$$
$$\mathrm{dist}^2 = x^2 + y^2 + z^2 \qquad \text{– 3D space}$$

The awareness model of Benford et al [Benford, 1995] was designed to deal with proximity and attention in shared virtual environments. It is thus formulated within a strongly Cartesian spatial framework. Some of the concerns driving this model were pragmatic: "how can we know when an object is not the centre of a user's attention and so render it in less detail?", "how can we know to whom to transmit a particular user's audio so as not to drown everyone in a uniform babble?". The concepts of *aura*, *nimbus* and *focus* (and in later work *third party objects*) introduced in this model capture a relative notion of 'nearness': "what can I see/hear?". The fact that this is set within a Cartesian virtual reality environment means that there are already clear 'nearness' clues given by the scaling of objects with distance.

Despite its influence and conceptual power, Cartesian geometry is not as universal in the physical world as first appears. Cartesian coordinates are themselves built upon Euclidean geometry, which for almost 2 millennia was seen as self-evident. It was only comparatively recently (17C) that alternative regular geometries were discovered: spherical geometry (the surface of a sphere, where there is too little 'space' as one moves farther away) and hyperbolic geometry (where there is too much 'space' as one looks further away - cabbage leaf geometry!). Still more recently with general relativity it has become clear that large scale space is neither Euclidean nor regular, but instead 'curves' as it is influenced by anything and everything that has mass or energy. At the quantum level things are still worse and it appears that space may become fractal.

In mathematics there are a number of fields of study aimed at understanding alternative kinds of space. Important historically was the study of the geometry of regular spherical and hyperbolic space, following in the same vein as traditional geometry with theorems about triangles, circles etc. and a whole study of spherical trigonometry. More interesting for virtual environments are various kinds of 'space' that are less regular and embody more abstract notions of 'nearness'. Two common abstract mathematical models of space that capture aspects of nearness are Metric Spaces and Topological Spaces.[57] Both of these abstract mathematical spaces capture an idea of nearness. In the case of Metric Spaces this is a numerical measure of the distance between two points which satisfies the 'triangle inequality':

$$\mathrm{dist}(a,c) + \mathrm{dist}(c,b) \geq \mathrm{dist}(a,b)$$

This effectively says that if you want to go from A to B, it is always as fast or faster to go directly rather than to stop of at some other place C on the way – a reasonable minimal property of distance.

In the case of Topological Spaces, the idea of nearness is captured by ever-decreasing 'neighbourhoods' which contain a point and all sufficiently close neighbours. In both these kinds of spaces, the main interest in mathematics is in the notion of a series of points which get ever closer without reaching a given point (convergent sequences); they are treated like 'rubber sheets' which can be stretched as much as you like so long as they aren't torn (continuous mappings). Hence, even in the case of Metric Spaces which have a numeric measure of distance, the important factor for their mathematics is not the absolute measure of nearness, but the use of the numbers to see whether things are getting closer.

More abstract notions of space can be found in Rodden's formalisation [Rodden, 1996] of the Benford et al awareness model. The spatial model underlying Benford et al's work was clearly Euclidean, but largely implicit. Rodden's work looked at awareness over a graph structure as is found in the web and many other computational domains. Nearness in such a space can be measured by number of arcs traversed or similar weighted measures both of which yield Metric Spaces. However, the critical properties of nearness in this work do not depend on these particular properties of the underlying graph. This suggests that we need models of space which may be stronger in that we would like some absolute sense of nearness, and weaker in that we don't need the complex mechanisms needed to discuss convergent sequences etc.

A final form of mathematical 'space' which is relevant is the Differential Manifold. This is used to model curved space-time in General Relativity. This is not directly relevant as a model of the kinds of location found in virtual space or much-slower-than-light-speed physical space. However, the ways in which relativity has challenged our understanding of 'space' in the physical world has a lot to teach us about the challenges of 'virtual' space. One particular point is the way general relativity models space using mathematical structures called Differential Manifolds. Because space curves and may have 'singularities' (such as black holes) and even distant linked points (wormholes), it is impossible to use a single co-ordinate system to refer to all points. Instead, the models consist of a number of patches, each of which has 'ordinary' Cartesian co-ordinates. Where the patches overlap there is a gentle transition between the co-ordinate systems (in mathematical terms they are related by a smooth function). Virtual spaces, such as the web, may similarly have no global map or model, but if we can establish patches with well defined structure and clear transitions between them then there is some hope for lost users.

Not only is space in general relativity not flat, but its shape and 'size' change in time. We have all heard of the expanding universe. This doesn't mean simply that the stars are flying apart through space, but instead that the *space itself* between the galaxies is stretching. This at first sounds as if it is only of interest to cosmologists. However, it is also precisely the experience of those using wireless communications when their connection is broken. Before the break they establish a sense of 'nearness' in virtual space with other people and things on the network. Then when the connection breaks this virtual geometry suddenly changes – things that were near suddenly become far away. It is precisely the difference between this and 'normal' space that makes such disconnections so disturbing, especially if a collaborative system engenders any sense of immersion.

The feature of space in General Relativity that is perhaps most well known (although not necessarily understood) is that time and space are dealt with on an equal and interlocked basis: the time–space continuum. This blending of time and space can also be found in more mundane areas of virtual environments and interface design.

The Aether model of Sandor et al.[Sandor, 1997] adopts a graphical network as its underlying space, very like Rodden's model. However, whereas both Benford et al and Rodden have declarative definitions of awareness, the Aether model adopts a more process-oriented mechanism whereby the influence of an object (*aura*, *nimbus* and *focus*) percolates through the network, getting weaker as it passes from node to node. The choice of this mechanism was largely driven by implementation considerations of producing an 'awareness engine', but is, of course, very like the physical transmission of sound and light. The Aether model has an implicit measure of nearness given by the rate at which network links and node attenuate influence, but also the Aether model explicitly introduces time as part of its awareness model. Whether in physical space or virtual, as soon as one takes into account transmission delays, space and time become inseparably interlinked.

This interlinking of time and space also becomes important as we consider different sensory experiences [Dix, 1996]. Different senses give us different 'cuts' through time-space. For objects within sight, we can consider the speed of light as practically instantaneous. Hence a quick glance around tells you about an area of space at a particular instant in time. If you want to know where something was a few seconds ago, you need to have looked then and remember. Imagine, however, that you are a dog or mole and are working using a sense of smell. As you sniff at a particular location you get some idea of the various creatures that have passed and even recent weather conditions at that point. That is smelling tells you about recent time at a single point of space. If you want to know what happened at other locations you need to have smelled there and remember. Finally consider a creature that uses sonar such as a whale or bat. Because sound takes time to travel through water or air, he echoes heard at a single moment correspond to close things recently, but further things longer ago. Figure 8 shows how each of these give us a particular cut of space-time.

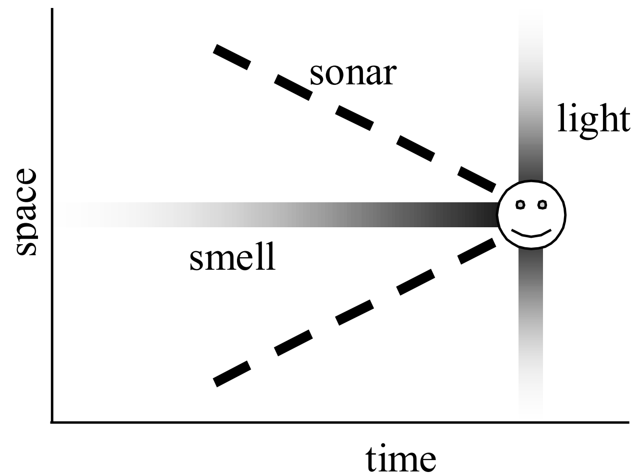

Figure 1. Different cuts through space-time

In virtual space, network delays mean that we have sonar-like mixing of time and space. But also computer systems embody a memory of interaction – traces of past commands, windows opened for a previous purpose and never closed, copies of possibly out-of-date information – more like the world of smell. To add to the confusion, these different cuts through time-space are typically all presented visually!

In this section we have considered the computational view of the nature of space and the need to develop a common understanding of this space. This understanding of space may be developed in a number of ways and later in this chapter we shall briefly consider a semantic model of space that has emerged from the investigations within eSCAPE. More generally, this section has highlighted the need for us to review and reconsider many of the assumptions underpinning space and shared spaces. Within the eSCAPE project the vision of development of a shared electronic landscape that linked together a range of different shared virtual environments was seen as a means of exploring the development of these common understandings. However, in order to explore this vision we also needed to directly address a number of key research challenges within CVEs. These research challenges formulated a driving agenda for the eSCAPE project.

Agreed research challenges for CVEs

The focus within eSCAPE in developing CVEs that support rich social interaction in densely populated virtual worlds is an ambitious goal, and one that requires addressing a variety of technical challenges. In this section we wish to briefly review some of the research challenges currently facing CVEs that have also motivated the work of the computer scientists within eSCAPE. A number of research challenges may be presented as motivating the work of eSCAPE.

Scalability and Interest management

The requirement to support real-time interaction between large numbers of simultaneous participants distributed over a wide area network makes CVEs a challenging class of application, especially with regard to scale. The scalability of CVEs can refer to the graphical and behavioural complexity of virtual worlds and their contents, especially avatars, as well as the number of simultaneous participants that can supported. Limitations on scalability arise from a variety of system bottlenecks. Large numbers of active participants generate high volumes of network traffic especially movement updates and audio packets. Servers on the network may have to process this data, for example in computing a consistent copy of the world from many update messages. Even if the core network and server facilities can sustain a CVE, the “last mile” network connection to each participant’s machine can easily become a bottleneck, especially for domestic access via the Internet using dial-up modems. Finally, even if the information can be delivered to a participant, their local computer must be able to process it and render the shared virtual world at a satisfactory quality while maintaining a sufficiently rapid response to the participant’s movement and other actions.

Human perceptual and cognitive limitations provide a significant guide in developing responses to the problems of scale. By arranging the virtual environments so that each participant is not overloaded and sees and hears “enough” of the world but no more, the problems of scale can be diminished. In this case “enough” is defined in terms of their interest in the world and its contents, and may be constrained by features of the world such as solid boundaries. For example, a participant need not receive audio packets from objects that are too far away to be heard or update messages from objects that are behind a nearby wall or that are deemed to be uninteresting. However, participants’ interests will dynamically change as they explore a world and so the challenge for CVE developers is to design flexible and dynamic interest management schemes. The best-known examples define interest through the division of virtual space.

The issues of scale and management of scale underpin many of the advances within the Deva system developed during eSCAPE. Essentially, the need to manage interest requires the platform to allow some form of interest management to be supported. This interest management needs to be informed by the nature of virtual spaces and their uses in practice. The development of the various applications within eSCAPE allow a range of new mechanisms to be developed and when we talk through our tour of the advances in Deva later in this chapter we shall see some of these developments in practice.

Distributed architectures

CVEs support varying numbers of geographically distributed users and keep participants up to date with changes in the world and other forms of communication and interaction (e.g., network audio). Supporting these users represents a major challenge and CVE systems vary significantly in the ways in which they handle the issues of distribution. Essentially, three basic architectures are exploited by CVEs:

- **Client-server**: each "client" program – for example, each participant's application – communicates only with a common server program, which is responsible for passing messages on to other clients as appropriate.
- **Peer-to-peer unicast**: each individual client program sends information directly to other client programs, as appropriate.
- **Peer-to-peer multicast**: is similar to peer-to-peer unicast, except that the same information is sent simultaneously and directly to many other client programs, normally using a bandwidth-efficient network mechanism (such as IP multicast).

Although we have presented these as alternatives, a single CVE system can combine multiple approaches, for example for different media, different stages of participation or for different groups of participants. A key area of current research is exploring new methods of combining these architectures to effectively support a range of applications and media over mixed infrastructures (networks and computers).

The development of a range of different virtual environments within eSCAPE has allowed an exploration of these challenges in practice and has allowed the computer scientists involved to reflect on these lessons and amend the architecture of these environments appropriately. For example, in the development of the abstract demonstrator reported in more detail in Deliverable D4.4 we have seen the development of a generalised architecture that integrates a range of information servers into a shared electronic platform that exploits multicast. The generic architecture also acts as a server to a diverse set of interfaces.

Migrating design lessons from 2D interfaces and CSCW

The dominant approach to collaboration in CVEs assumes that each participant sees the same content, albeit from different perspectives. However, the experience of the CSCW community in designing collaborative 2D graphical user interfaces, suggests that this approach may actually hinder people's ability to collaborate.

Early experiences of shared interface systems based on the principle of WYSIWIS (What You See Is What I See) led to a re-examination of some of the principles of sharing and the need, for example, for public and private interfaces and different views on shared data. Some of these early lessons concerning the nature of co-operation have been migrated to CVEs and some systems now offer users ‘subjective’ views on shared worlds [Smith96]. These subjective views can reflect the different interests and roles that users inhabiting shared worlds may have. For example, participants inside a 3D architectural model may see different overlays for wiring, plumbing and networking; and the virtual cameras used to capture the action in inhabited TV (see sidebar) might be visible to the performers, but not to other on-line participants or viewers.

The relationship between CVEs and other forms of shared interface has also been explored as part of a “space versus place debate” within the CSCW community. Those arguing for “space” propose that it is independent movement within a shared co-ordinate system, combined with the representation of others’ positions through avatars, that underpins CVEs support for social interaction, for example, in allowing participants to point at objects. Those arguing for “place” maintain that social behaviour is engendered by other important aspects of an environment beyond the provision of a shared co-ordinate system [Harrison96]. Although not exclusive, these points of view have led to different emphases in the design of on-line shared environments; space leading to navigable CVEs with avatars, and place leading to more generalised abstractions that suggest conventions of conduct or that support ease of navigation.

The need to learn from the social underpins our involvement with the social within eSCAPE and our experiences in uncovering a world known in common within year two (D4.0). The developing supporting mechanisms based on this and embodied within the physical electronic landscapes such as the Placeworld (Deliverable D4.4) exploits this. For example, we see within the development of Placeworld the use of a ground plane and paths as a means of providing legibility of the environment. We also see within this the use of history trails and the physical representing of history as a means of exploiting the new forms of space and providing a means of allowing users to exploit different experiences of the space.

New Kinds of human factors

In considering how user studies may inform the development of CVEs it has become clear that new methods, to those typically used in evaluating single user VR systems, may be required. Studies of single-user VR have tended to draw upon individual perceptual psychology for their orientation in exploring issues such as immersion, usability and motion sickness. The use of CVEs to support co-operative work and social interaction presents new challenges for human factors - how can we understand the nature of *social* interaction within a CVE?

For this reason studies of CVEs within eSCAPE have turned to a broader range of social scientific methods to study CVEs and to inform CVE design choices.

Studies of early trials within eSCAPE used ethnographic techniques to characterise how conversational mechanisms were exploited or adapted in shared virtual worlds. This work has contributed to avatar design, by showing that even graphically simple avatars could effectively represent participants on some occasions. We see these avatars used within the Placeworld landscape described in Deliverable D4.4. We have also seen the need to learn from these lessons. For example, we found that others trust in avatars would break down when they were found to be unoccupied, for example when their owners were away attending to events within their local environments [Bowers96]. We thus reflected this in providing a glow or halo effect to avatars that effected these environments. Further studies highlighted difficulties with the use of humanoid style avatars.

In this section we have considered the general underpinnings motivating the involvement of computer science within eSCAPE. These assumptions underpinning those involved in the project and the need for linking with art and design have prompted a concern to ask fundamental questions about the nature of CVEs and the development of electronic landscapes. As we have already said, a diverse set of computer scientists have been involved in eSCAPE and it would be unwise to represent these different positions as presenting a common reasoned position. Each of the different experiences within the project have made links at different times.

Rather than proffer a single generic solution we would strongly suggest that the links between disciplines and traditions within multidisciplinary development are made in practice. These links are often driven by the pragmatics of particular concerns and offer particular experiences. In the second section of this deliverable we shall consider some of the illustrative experiences we have had within eSCAPE.

Before we consider project wide experiences within the second part of this deliverable it is worth briefly reflecting on the experiences within eSCAPE from the perspective of one of the researchers involved. In order to do this we shall end this chapter by presenting the experience and reflections of one of the main researchers within the project. In this final section Steve Pettifer at AIG in Manchester presents a tour through the eSCAPE project from his particular perspective.

A computer scientist's tour through eSCAPE.

Virtual Reality promises a lot; it is easy to envision complex shared Virtual Environments (VEs) in which people at different geographical locations communicate and work together within CAD, Engineering or Social contexts. This vision is tantalising and must surely bring some benefit if it can be realised. And yet, building VR applications of any sophistication is hard work, as evidenced by the lack of compelling examples of industrial strength demonstrations of this technology in serious use. In truth we are yet to find the ‘killer application’ that beyond any doubt or hesitation verifies that virtual reality is the perfect user interface. On the other hand, there are enough tantalising demonstrations of proof to reinforce the potential of the field.

Until recently technological limitations were the clear brake on progress for VEs. The graphics challenge is perhaps the clearest example. For practically useful VEs the performance required was previously only available on high-end workstations. However new generations of PC graphics cards are remedying this.

Beyond the technology the key task is that of writing software. The scale and complexity of this task is often underestimated. It is here that the major problems lie. We do not at this time have adequate frameworks to simplify this task of implementing virtual worlds. Today, a person wishing to implement a challenging VE application has two broad options. First, the most sophisticated VEs are usually bespoke applications constructed from the graphics layer upwards. This is guaranteed to provide the necessary flexibility, but is a substantial undertaking akin to writing a high level application in assembler. The only alternative has been is to use an off-the-shelf VE builder. These fall into different categories, (for example, VRML builders at the lower end, up to VE systems such as DIVE and MASSIVE at the more ambitious extreme). Excellent though such offerings are, they tend to impose a particular view of how a VE should be structured. Perhaps it is too early to know how best to do this without unduly limiting what can be achieved with them.

The software support challenge to facilitate large-scale VE applications is twofold. Firstly to find techniques and algorithms to address specific needs in VEs. Collision detection, parallelism, distribution, synchronisation, navigation and so forth all require work of this kind. Secondly and perhaps rather harder, it is to find frameworks that allow all the parts to be put together in "flexible yet powerful" ways. The rather trite nature of such a statement belies the difficulty of quantifying that task.

Putting the technology to work

It has long been recognised that meaningful advances in computer technology can only come about by using it to build prototypes against the demands of real applications [3]. In the field of Virtual Reality, the considerable demands placed upon the technology in order to generate even the most basic of environments has meant that the choice of ‘driving problem’ has traditionally been directed mainly by technological concerns (for years the rendering of a teapot on a table at interactive frame-rates provided enough technological challenges to keep researchers in the field busy). For example, the single-user MAVERIK system [14] used as one of its initial applications the visualisation of real-world process plants. These CAD models constitute very complex man-made objects, the rendering and management of which does not yield to traditional graphical optimisations or generic virtual environment techniques. CVE systems too have been used mainly to investigate technical issues such as the system level mechanisms for networking, event distribution or provision of audio or video links between users. Even the investigation of virtual human representations has been technically oriented.

However, the end purpose of a CVE is to support the processes of collaboration between users; the technological challenges that must be overcome are of course merely a means to an end. There is an existing body of work looking at user needs but this is primarily from the perspective of usability. What has been missing is a broader perspective that recognise the situated and social nature of the processes in collaboration. It is thus necessary to study a "real world" situation to determine "real" requirements for CVE technology. Problems that determine the success or failure of a system can only arise in such a situation.

The AIG’s involvement with the eSCAPE project was based on this belief; that in order to build collaborative virtual reality systems that can really provide the collaboration-supporting features needed by users, we must have some understanding of what the processes of collaboration are. Our experience has shown that understanding the high-level requirements of an application or application area has significant impact on the very lowest levels of design in VR architecture .

In this section we describe some of the issues that drove the original design of the MAVERIK and Deva systems, to what extent the existing applications have been able to shape the architecture, and to what extent the applications have been limited.

VR systems development

In 1991 the Advanced Interfaces Group at the University of Manchester set out to develop a multi-user Virtual Reality system for dealing with large-scale virtual environments. The result was a prototype system called AVIARY [23] that included a novel framework for the management of multiple environments. At the time, limited support both of hardware and software for networking and rendering meant that most of the development effort had to be aimed at just making the system work, never mind satisfying the extensive real-time constraints of VR.

A prototype application was constructed for the system based on real-world aviation data, and aimed loosely at providing Air Traffic Control (ATC) personnel with a 3D visualisation of aircraft flight-paths. With no real hardware support for 3D graphics and limited networking available, it was clear that the gulf between what might in principle be possible in Virtual Reality and what could in fact be supported by existing technology was significant. Though very much a prototype and thus inappropriate for 'real-world' use, the ATC application highlighted important issues in the system's architecture. In particular bottlenecks were identified in the inter-process communications and rendering models used by AVIARY and many other comparable systems.

Design effort shifted from AVIARY to two complementary new systems: MAVERIK, a single user rendering and spatial management kernel aimed at eliminating the graphical bottleneck; and Deva, a distributed object management layer designed to provide coherent shared virtual environments over wide-area networks.

In spite of the substantial effort required and in the absence of other systems that could be modified to suit the new architectures it was decided to develop these systems ‘from the ground up’. In the case of MAVERIK, the implementation of which is now essentially complete, the decision to implement a ‘pure’ system rather than a demonstrator of concept based on existing system software appears to have paid off. MAVERIK has been used successfully inside eSCAPE and elsewhere to implement single user applications that would be significantly more difficult to implement using other methods [14].

MAVERIK, however, has the advantage in terms of design of dealing with relatively ‘low level’ problems, such as rendering and spatial management (e.g. not “what is the best position for this object in space in order to make it socially appropriate” but “which algorithm is best in order to make the polygons for this object appear on-screen fast enough for interactive rendering”). MAVERIK provides a novel architectural solution to a problem area that is primarily technological and where the difficulties are well understood (e.g. maintaining an appropriate frame rate for interaction, rendering scenes requiring diverse representations, handling user input appropriately). In this sense the requirements placed upon the system are clearly defined, and its ability to meet these requirements readily measurable (e.g. take an application that is difficult to render, and measure the resulting frame-rate).

On the other hand Deva, the multi-user sister system to MAVERIK, aims to address issues that are much less clearly defined such as the relationships between users in a Collaborative Virtual Environment, or the affordances of the environment itself. Finding a meaningful measure of success or an application that clearly drives the development of the system's support for CVEs has proven to be difficult. The following subsections outline two existing applications that have been constructed using Deva and MAVERIK, highlighting their difficulties as driving applications.

The Fishcages

This somewhat esoteric ‘application’ developed along with the system, and is no more than an aggregation of the novel features of Deva and MAVERIK. It consists of a number of ‘cages’ in which ‘fish’ of different types swim about (see Figure 1). Users (usually two for demonstration purposes) are represented by animated avatars, and may interact simply with the environments that are represented by the cages and their contents, with one another, and with the environment they exist in themselves.

The application demonstrates the system's novel object orientated engine, its distributed nature and its integration with MAVERIK. In spite of its unusual nature, it has proven a useful tool for describing the architecture of the system to computer scientists. However, it in no way drives the development of either system in anything other than the most trivial manner (e.g. "It would be nice to have a different sweater on the second user's avatar") since it is a demonstration of existing features.

The Distributed Legible City

The Distributed Legible City (DLC) was the first ‘real’ application built using Deva, and was constructed within the auspices of the eSCAPE project. It was an attempt to build an engaging environment for multiple users in which to study social interaction within a virtual world. Indeed, other than fulfilling this goal of being an ‘engaging environment’ - that is providing some reason for interaction - there were no other real end user requirements. The decision to base the environment on an evolution of Jeffrey Shaw's 1990 multi-media installation 'The Legible City' [22] was purely opportunistic.

The art piece on which it is based consists of a darkened cuboid room in the centre of which is mounted a modified "touring cycle" facing a large back-projected screen. Seated on the bicycle, the visitor to the installation is presented with a three dimensional "street-level" view of one of three cities: Manhattan, Karlsruhe or Amsterdam. A liquid-crystal display, mounted on the handlebars of the bicycle, shows an overview map, including the position of the cyclist in the virtual world, and a single large button transports the user between the three cities. Physically pedalling and steering the cycle causes the viewpoint in the virtual environment to move accordingly. Each city is represented in the virtual world not by buildings and traditional "street furniture", but rather by solid letters forming sentences from texts appropriate to the location.

The original version of The Legible City was a single user virtual environment, installed within a purpose-built room, consisting of a custom built and instrumented tour bicycle, liquid crystal display and high-end graphics engine and projection system. The software responsible for rendering the letter-filled streets of the city was written in ‘raw’ OpenGL.

The Distributed Legible City extends the original work to include multiple participants, and aims to provide an engaging shared virtual environment in which "cyclists" seated on modified exercise cycles and situated at geographically distant sites can tour together around the three virtual cities communicating with one another via an audio link and headset.

Two versions of the installation were constructed. The first consists of a 21-inch monitor mounted in front of the user's cycle as the main output device. The second adds a head-mounted display for each user and retains the monitor only as a secondary output device for onlookers to watch the goings-on in the environment.

The move from ‘desktop VR’ (using a fixed monitor) to an immersive environment (using the Head Mounted Display) was prompted by results from ethnographic study of the installation in situ [20]. In addition to influencing the development of the piece, the studies revealed that actual user behaviour in the environment diverged radically from initial expectations and from observed behaviour of single users in the original piece (i.e. whereas in the first piece there was nothing but the environment to investigate and engage with, in the distributed version the interaction was dominated by issues involving finding other inhabitants in the virtual world). From a system designer's point of view at least, it became clear that social interaction and user behaviour in such environments is poorly understood and that ‘reasonable assumptions’ made in the design phase were badly founded.

In terms of general principles that guide future development of the system and its applications, however, it has proven difficult to extract clear design issues from such an experience. The difficulty primarily arises from the "undefined" nature of an artpiece, what is expected from it, and what is expected from those experiencing it.

For example, the initial design of the Distributed Legible City was considerably more ambitious than the eventual installation, including such notions as deserted areas between the cities where words spoken by the users during conversation influenced the text of the surrounding environment, creating new word-structures based on the interchanges between the inhabitants. Other ideas included clouds of "dust" formed by such utterances that would be thrown out from the back of the cyclist's biker-avatar as if kicked up from the road by the rear wheel. In practice, such extensions to the piece turned out to be impractical to implement during the time available.

However, with a brief of making "an environment that will engage the users" and "providing freedom of artistic interpretation", determining what the end user requirements are is difficult (especially since identifying what is actually "engaging" and what might constitute "successful interaction" under such circumstances is especially difficult). In this instance it would seem that such details as the introduction of new buildings based on conversation would have made little improvement to the environment, since other issues, primarily locating one another and achieving a "comfortable" conversational co-orientation, dominated user behaviour. In spite of the difficulties uncovered during the design of such a widely specified virtual environment for this finding on user interaction alone, the work could be considered successful.

Toward a Semantic Model of Space

Earlier in this chapter we stressed the importance of space as a common theme across the project and that much of the exploration of electronic landscapes was about developing an understanding of the nature of space and its relation to the user interaction. We would like to conclude this section on the computational view of eSCAPE by presenting a semantic model of space from the perspective of a computer scientist.

It is worth noting that the model presented here focuses on the extent of the space and lacks the subtlety reflected by social science and artistic traditions explored in the complementary chapters. The reason for ending with this model is not to offer this as a solution but to highlight how insular a computational perspective is. The form of semantic model presented here needs to be complemented by the understandings provided from the other disciplines involved in eSCAPE. The links between this model and the other perspectives is one that happens in practice and in the following section we shall provide some examples of the different ways in which these links have been made manifest during the project.

A semantic model of space

As discussed earlier, existing awareness models are focused primarily on virtual space taking lessons from physical phenomena and are based on different underlying models of space. In order to support this range of approaches to awareness we need an abstract model of space that includes both Euclidean space and network space. We do not need the full richness and complexity of the mathematical spaces, but we do need an explicit formulation as we need to be able to talk about several simultaneous spaces and their relationships.

Kinds of space

The fundamental concepts we require are *location* and *nearness*. So we define a 'Space-Kind' to include precisely these two plus some functions relating them:

Space-Kind =	Location	–	set of elements representing 'locations'
	Nearness	–	partially ordered set of 'nearness' values
	dist: Location $\times$ Location $\rightarrow$ Nearness		
	…		

The Location set depends on the precise kind of space. In 2D Cartesian space it would be the set of all (x,y) coordinate pairs, on the web it would be the set of all URLs, in a building it would include locations such as 'floor 3', 'room A 312', or 'north-east stairwell'.

The Nearness set will normally contain a minimal element 'HERE' representing 'at the same place as'. In the case of Cartesian space it is simply positive real numbers and 'dist' would be the normal as-the-crow-flies distance. In other spaces Nearness is a less precise concept and has values such as, 'on the same web page', 'at the same site as', 'in the same room as', 'in the same building as'.

The Nearness measure need not be a total order. For example, in a geographical information system we may be able to locate roads within towns and so 'in the same road as' is obviously closer than 'in the same town as'. However, if we look in the countryside it may simply be able to tell us 'on the same mountain as'. Is this a closer measure than 'in the same town as'? Although this Nearness set is intended to give some idea of absolute distance, we need to be careful. A very clear lesson from the mathematical studies of metric and topological spaces is that non-local measures of distance need to be treated with extreme caution. In our context we want to be able to conclude that if A is a device and X and Y are objects in a space such that:

dist(A,X) < dist(A,Y)

It is fair to make A's behaviour more dependent on X's presence than that of Y. However, if A and B are devices such that

dist(A,X) < dist(B,Y)

We should be extremely cautious about making any strong statements about the comparative strength of the relationships A–X and B–Y.

This does not mean we never use absolute judgements of distance. We have to be able to say things like:

> If object X is in the same room as device A, then A shows a representation of X in its screen.

However, when designing such rules we have to be aware that 'in the same room as' could mean a broom cupboard or an auditorium.

Some kinds of location have a natural idea of containment. In an office complex 'room A 315' may be on 'floor 3' of 'building A'. Similarly, the hierarchy of a web site leads to a natural hierarchy of locations. In Cartesian spaces locations are mutually exclusive, but one can have regions of space, for example 'all points within 3 miles of Great St Mary's Church Cambridge'. In order to capture both these uniformly we allow a space to have a set of regions which may either be a subset of locations (in the case of a hierarchy), or represent well formed sets of points (in the case of a Cartesian space) or some other domain specific concept:

```
Space-Kind =   …
               Region          –       sensible areas
               contains: Region × Location → Boolean
```

Spaces and bodies

As we have already noted, even in the physical world we have several simultaneous ideas of space: longitude and latitude, town-street etc. In the virtual world this multiplies further. So our model of the world has a number of spaces each of a particular kind and with other domain specific attributes:

```
World     =    Spaces          –       set of elements representing 'locations'
               kind: Spaces → Space-Kind
               attr: Spaces → Attributes
               …
```

People, devices and passive objects also inhabit the world as we have discussed previously. We call these collectively 'Bodies'. These again have various domain specific attributes, but the crucial question is the location of a specific body. This is not absolute, but defined relative to a specific space (e.g. GPS coordinates):

World	=	…		
		Bodies	–	(Bodies = People + Devices + Objects)
		attr: Bodies $\rightarrow$ Attributes		
		loc: Bodies $\times$ Spaces $\rightarrow$ Location		

The 'loc' function is partial as there may be 'spaces' for which a particular body has no clear relationship: for example, there is no sensible answer to the question "what URL (web location) is my tea cup at?".

Our semantic model of space is based on the concepts of *Space* & *Bodies* and a representation of location. This form of semantic model can be used to support a corresponding computational model to allow users and applications to share a common awareness of a space and the bodies that inhabit that space. In fact, both Deva and Dive the two major platforms used in eSCAPE can both be seen as embodying this model. Each use an object-oriented model with a small number of simple objects that can be made shared across a distributed information space. This allows the state of defined objects to be accessed by a number of different devices.

While this model provides the core computational framework for representing these spaces it does not really convey the nature of these spaces or how they might be used. These understandings have required us to turn to other disciplines in the project in order to inform the development of electronic landscapes. In the second section of this deliverable we shall consider some examples of how these lessons have been learned in practice as a means of conveying the general lessons of allowing multiple disciplines to work together within this domain.

Section Two. Common Experiences

This section complements the disciplinary perspectives provided in the previous section by focusing on the strategies we have developed towards bringing the perspectives (art, ethnography, and design) together in practice and getting the work of design done. Essentially we will present an outline method for this form of development in practice and illustrate this by following the design, development and assessment of one of the main eSCAPE demonstrators.

This section has four main chapter each presenting different aspects of the development of an initial version of the abstract demonstrator for use within a public library. The chapters within this section present in turn the main stages involved in developing inhabited information spaces that are informed by the needs of users and inspired by the work of interactive artists.

> ***Chapter 4 – Artworks as Exploratory Vehicles*** gives a concrete example (Web Planetarium & 10_tendencies) of the use of interactive art as an provider of "blue sky" research concepts. The chapter presents the notion of a 'generative grammar' and explains what it amounts to for all practical purposes and how the artworks serve as blue-sky vehicles for the exploration of research concepts.
>
> ***Chapter 5 – Grounding "Blue-Sky" Research Concepts*** gives a concrete example (a public library) of how blue sky research concepts may be grounded in everyday practice through the presentation of detailed ethnographic studies of everyday settings.
>
> ***Chapter 6 – Configuring "Blue-Sky" Research Concepts*** gives a concrete example (Library demonstrator with 10-dencies interface) of how the two perspectives (art and ethnography) may be put together in practice in the development of an application to support information discovery.
>
> ***Chapter 7 – Calibrating "Blue-Sky" configurations*** provides a reflection on the importance of situated assessment and evaluation as a means of driving development and of informing the future generation of new concepts.

Each of these short chapters essentially provides an illustrative description of a four stage method for the development of electronic landscapes that maps the creative and radical nature of the interactive art works with the situated nature of the social science based studies.

Chapter 4: "Blue-Sky" Research: Artworks as Exploratory Vehicles

Annika Blunck, ZKM & Knowbotic Research

The focus of this chapter will be a reflection on the way in which a range of different interactive media pieces, developed during the project, were used to inform the construction of applications. During the development of the project a clear two pronged approach to investigation and development emerged. Essentially, inhabited information space demonstrators were married with artistic investigations. The demonstrators focused on links with real world user communities and with the development of a range of new forms of environment to meet the needs of particular applications.

Somewhat in contrast to the development of demonstrators artistic investigations explored the limits and boundaries of the possible. The aim was to explore radical alternatives and to learn from these explorations in order to inform the development within an application setting. In essence, this two pronged strategy provided the core means of involving artists with other researchers and provided the principle mechanisms to allow different traditions to converge.

This strategy also developed within the context of two main demonstrators, an abstract e-scape and a physical e-scape. Each of these distinct electronic landscapes supported different forms of application and promoted different interactive experiences. These two distinct demonstrators were also supported by a wide range of interactive art installations within the development of the electronic landscapes.

In this chapter we shall explore the ways in which this relationship emerged and the ways in which the art works became used as exploratory vehicles for demonstrators to be used by real world users. In doing so we shall consider the development of a 'generative grammar' which underlies both demonstrators. This generative grammar has emerged as a consequence of the applied system of 'lessons learned' and 'best practices' in order to recycle the positive and negative learning experiences by allowing them to constructively influence the succeeding actions and project-phases. Furthermore, it serves as the basis for us – social and computer scientists, researchers and designers alike – to explore the transformation of knowledge into value in alternative 3D-structures.

Basic Considerations

In 1997 the ZKM was looking for artists "likely to actively participate in dialogue with counterparts from a wide array of disciplines, and provide energetic feedback to other project members".[58] These artists were meant to develop an artistic interpretation of the project's set goals and requirements. Such proceedings were, even for commissioning art-works, quite unlikely and triggered some discussions regarding share-ability of the targeted experimentation, copyright, access and knowledge. To a large extent these discussions were based on the 'evolution' of the definition of an 'original'. During the 20th century the definition of an original artwork has passed through several stages of permeability and finally was dissolved with the advent of video and later computer generated art. Simultaneously this digital revolution endangered the artist's tacit knowledge, defined in the source codes of their software packages: so far today's copyright laws have not been revised to protect them sufficiently. The main reason why these artists were not immediately willing to share their knowledge with a totally new set of collaborators was because while it is their own, they are the guardian of its quality, once it is given to somebody else it is out of their control.

After the first months it became clear to the partners that the artists, computer and social scientists had mutual interests aplenty. But what was less clear was the question whether they also had a mutual understanding. The artists admitted that they had problems in understanding what the 'confirmed' social and computer scientists actually wanted and needed. The problem was that the researchers spoke a language in which the artists and designers were not yet fluent, not that within eSCAPE the kind of perspective or assistance they as artists could provide was not needed. It eventually developed that an entire year was needed in order to learn the common language. We felt the necessity to point out these practical, though unexpected, 'troubles' at the beginning of the project.[59]

The artists involved in eSCAPE were dealing with technological tools that had powerful shaping effects on their art, and that necessitated collaboration with technical and scientific specialists. It became vital for anyone involved in the process of developing these art pieces to communicate closely and openly in order to identify and elucidate the real technical constraints and liberties, so that these were constructively taken into account during the creative process. One fundamental basis was the artist's technical knowledge that allowed him to grasp the conceptual implications of the technology being used and thereafter to deduce the aesthetic meaning of these implications. Very often technologies had to be investigated in order to identify and exploit their aesthetic implications. Playing three-dimensional computer games is one thing, but artists and designers have a lot more trouble presenting serious information in three-dimensional formats. The project's openness to what kind of content/information should be in an eSCAPE

58 S.J.Norman (1998) *eSCAPE deliverable 1.1*, Lancaster, p.233.

59 See Deliverable 1.1 Appendix. The definitions and descriptions presented there supported a better understanding for and of the various expertise within the project and established the necessary trust for the dialogue.

turned out to be dangerous[60] as well as challenging.[61] It became clear that it meant something different for each artist and partner, though it was commonly agreed that its quality had to be the visualisation of information processing.[62] Important, however, was that all interactive art pieces offered a context of the application's use which meant that each artist and their collaborators had to outline and imagine the practical use of their technology in advance of its actual use.

Moving Towards an Abstract eSCAPE

The abstract eSCAPE addresses the organisation and presentation of data: its transformation into valuable, meaningful information. We based our research on interactive art because this discipline is essentially story-creating and telling, is at once both ancient art and new technology. Media have always effected the telling of stories and the creation of experiences, but currently new media offer capabilities and opportunities not yet addressed in the history of interaction and performance. In particular, the demands of interactivity are often misunderstood by all but the most experienced storytellers and performers. How these skills are expressed through interactive technologies and what demands and interests audiences have for these remained to be understood at the beginning of the project. We turned to media art for new ideas and cogent explanations in order to study sources of information about these issues and the techniques used to meet them.

After writing, visual design techniques in disciplines such as graphic design, videography, cinematography, typography, illustration and photography are usually the first to be recognised and employed, but the disciplines that communicate through other senses are just as important. Sound design, engineering, musical and vocal performance are also useful in the appropriate circumstances. In fact, sometimes they are the only appropriate media for communicating a particular message. Tactile, olfactory and kinaesthetic senses are rarely employed, often due to technological or market constraints, but are just as valid and can add enriching details to experience. Interactive media art employs techniques with which we communicate to others through our senses. The disciplines of these "sensorial media" are worlds unto themselves, with their own history and tradition. To learn each well takes time and skill. Therefore, it is crucial to learn at least an overview of the important issues and techniques of each discipline so that they can be employed properly when presenting ideas and communicating messages. In each of these areas, artists, social and computer

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60 The 'danger' behind the looseness of the concept became visible at the presentation of the first year's achievements in Nyborg when the audience were unable to grasp how the project might look or feel in the real world and what the actual direction of the project was.

61 By not restricting the project to one specific content or information visualisation, the two-folded direction in the second year was possible. For the project these two paths cover the core of information visualisation as described in section 2.1.

62 E.g. turning information into action.

scientists participated in employing the various media in support of the project's information and interaction goals and messages. Our method was to *explore alternatives in order to know that the chosen strategies are the best*.

These levels of understanding were significant because they defined the boundaries within which we created and communicated. While information design primarily focuses on the representation of data and its perception, our emphasis was the creation of compelling experiences. Interactive art showed us that information has to be organised, transformed and presented in a way that gives it meaning. Information is not at the end of the continuum of understanding but at its beginning: it can be transformed through negative as well as positive learning experiences into knowledge and further into value. Brenda Laurel stated that interactive media/media art "is not about information, it is about experiences"[63] and in creating these experiences for the users, information, with which to build experiences, must be understood and properly structured. Previous deliverables described the extent to which knowledge could be gained through experiences in the involved interactive art pieces. In both *10_dencies* and *The Web Planetarium* the artists provided strategies through which knowledge could be turned into value, by building compelling interactions with tools such that the patterns and meanings of the meaningful information could be learned by others.

These two art works also show that there are many types of experiences each of which orients to different types of knowledge. Some knowledge is personal, while other is local, meaning that it is shared by people with shared experiences. Global knowledge, on the other hand, is more general since it is based on shared agreements of communication. Hence, to communicate a specific message to a larger audience is more difficult then to a smaller one.

Value is more vague and abstract. It is the result of contemplation, evaluation, retrospection, interpretation and communication – all which require personal processes as well as more than one user. Value cannot be created like information or knowledge. The two offered demonstrators, the abstract and the physical eSCAPE that we define as two generative structures, only allow to create experiences that offer opportunities and describe processes.

In the first two years of the project we learned that interacting with media art pieces served learning through experimentation without risk. The studied art pieces often lacked immediately obvious aims, but functioned almost instinctively to serve the process of development. Learning occurred here through actions, conducted within set rules, free from threat or consummation. Beside this, another distinct advantage of introducing interactive art was its playfulness. The irreversibility of so many traditional processes is rooted in the physical law of material. It is impossible to play around with a physical medium indefinitely, but when rearranging bits, processes may be reversed completely without any loss of quality affordance. Additionally, we realised that the structure of the interactive

[63] Brenda Laurel (1990): *The Art of Human Computing Interface Design* Reading, Addison-Wesley Publishing Co.

art pieces contained variables that invite modifications along established parameters.

Another basis for the project was the creativity of the users. We started from the assumption that people are naturally creative and that they are more interested in experiences that allow them to create instead of merely participate. Furthermore, the evolution of the project allowed for adding content to a predefined set, resulting in a generative tool-set or database as *10_dencies* and *The Web Planetarium*. Both applications are designed to grow and become more valuable over time with participation from the users. So the project starting point was the users and their behaviours: in order to develop meaningful applications for communication technology, thus we started by developing and studying interactive art pieces. Though this was not the ultimate goal of the project, we realised after some time that both artistic vision and computing were prone to abstraction and the point was to get them coincide.

When the last project phase began, we had reached a point at which the creative concepts of the artists had 'adapted the language' of the social and computer scientists. The interactive artworks, each originally forming a self-contained and independent virtual space, had been transformed by the knowledge gained by the ethnographers and developers during the process of the project into two generative structures. It needs to be pointed out that even though, looking at both demonstrators, it seems that visually some artworks were more influential than others, the artistic input has been performed on all levels, some easier to grasp than others. The importance of the artistic share for both 'generative end-products' should not be underestimated. Right at the beginning of the project the interactive art installations supplied a sensibility for the medium. As described earlier, the approaches offered by the artists comprised *essential starting points* for the further practical and conceptual creations within the project. Additionally, they provided the project in the first year with completely self-contained spaces, which, on the one hand made it extremely difficult to open them up again or modify them,[64], and on the other, this 'functioning independence' made the partners aware of the importance of a synthetic vision of the work-in-progress whilst simultaneously keeping the final goal in sight. Throughout the project the artistic concepts and the dialogues between artists, developers and researchers formed an essential part of the 'eSCAPE-think-tank'.

So by the time this last project phase began, an eSCAPE had evolved to a meaningful space as an engine for intensifying content, that is information about information coming from various sources. While the goal of the abstract eSCAPE was defined as a software package for the user, visualising non-spatial information spatially, the physical eSCAPE was meant as a 3D-toolkit for

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64 This aspect became apparent during the evolution from the *Legible City* to the *Distributed Legible City*. In the original version only one visitor cycled through the textual space and the interaction was clearly established by the relation between user and 3D-text. When offering several users represented as avatars to navigate the same virtual space simultaneously, and allowing them to communicate via headphones, the visitors' focus shifted from exploring the 3D space to looking for other users and communicating with them; the textual space itself was a mere platform for these (inter)activities.

building independently individual, specific-purpose eSCAPEs. However, despite these two completely different intentions, in both cases a database with already existing information extra information would be added to by the users/operators. Additionally, connections within the database would be 'made by itself'.

Regardless of the fact that the project elaborated into two directions by offering an abstract and a physical strategy, these meaningful spaces have a common structure: space, axis, division, link. Consequently both virtual worlds consist first of all out of a space and a time that follow rules different than in the real world. These two data spaces are entirely symbolic spaces, consisting of information. That explains their utopian character. They do not have any physical dimensions, no physical and permanent space. They do not have a definite and exclusive space; they are permanently de-localised and re-localised. The virtual spaces consist of circulation, nets, connections through which the users are able to navigate. The integrated objects do not have a definite identity; they can change from one condition into another, from one form into another.

We developed for each electronic landscape individual parameters, based on the content and the above mentioned 'common structure' or organisational principles. In both approaches, these parameters shaped the kinds of variational excursions that may be made by the users.

In the following sections we examine two artistic generative structures in more detail, outlining the content as well as the consequences of the given parameters and presenting the generative grammar as a consequence. Additionally the section will demonstrate the importance of elaborating meaningful applications by actually using people as a starting point. In each of the two cases we exploit the experiences of development migrated to real world demonstrators.

The Web Planetarium

The Web Planetarium is a 3D visualisation of hyperlinked information and web sites using the metaphor of a planetarium. This application provides a three-dimensional interpretation of html-structures in the form of spheres and other geometrical forms while linking to other pages are presented as arrows. Each object is a 3D representation of a corresponding web page. Once the user is inside such an object the hyperlinks of the page are visualised as additional small objects that are clickable. Clicking on one of these objects extends the *Web Planetarium* with additional 'planets'. Navigating the Web, the user constructs his own constellation of the planets, thus visualising the 'history' of his browsing activities. If previous visitors have entered the planetarium already, their 'behaviour' is documented in various visual properties. The user is able to zoom into, in other words being transported to, a specific site by either clicking on a link, an arrow or its spherical visualisation.

Informing the demonstrators

This interactive artwork is a three-dimensional space that the users are able to navigate two-dimensionally. This approach simplifies the structure of and orientation within the virtual environment. In *The Web Planetarium* the users play a less dominant role then their activities. For this reason, the artists chose a user-representation other than that of an avatar: their presence in the virtual space is inscribed in the virtual space itself: their interactions ‘inhabit’ the dark space with the objects. This openness and expandability of the system allows for exploring formats of presentation of dynamic activity information and complex interrelations. Additionally the general layout and placement algorithms provided us with a useful starting point for generating an abstract information space.[65]

The 3D computer-generated environment offers the public a metaphor of the universe. It is an extremely intuitive metaphor in which the planets represent html-sites. Each planet is texture-mapped with textures derived from the underlying web page. This makes them not only visually attractive but also provides them with a unique appearance: a feature that supplies two advantages: individual web pages are recognisable from a distance, and facilitating public understanding of complex interrelations.

The interdependence of content and purpose of *The Web Planetarium* is quite apparent: on one hand a single user’s browsing activities is visualised, displaying to himself (and others) relations and dependencies. On the other hand this form of visualisation and organisation allows the users to become aware of neighbouring sites and explore them and their potential relation to their own ‘path’. These dynamic features brought the database ‘to life’ and provided the meta-information space with a communicative aspect. Studies of the work showed, however, that the audience took the metaphor of the universe too literally. They were navigating the virtual space in the sense of “What I see is what is there!” and did not expect that their browsing activities could change the constellation of the displayed ‘planets’.

Studying the users’ behaviour of *The Web Planetarium* informed the design of the abstract eSCAPE in several ways. First of all *The Web Planetarium* is a grid within which requested information is displayed and organised. The organisation of the data is handled by the parameters of the work. The ‘surplus value’ produced by *The Web Planetarium* arises from processing the information gained by the arrangement and visualisation of the data. From this point of view the metaphor of constellations “in the vacuum” is absolutely suitable. So when constructing an abstract information space, one must take into consideration that *appropriateness is dependent on the task.* Furthermore, the ‘surplus value’ can only be achieved if the entire information space is comprehensible. In this interactive work, the user gets an idea of the dimension of the space as well as of the existing quantity of information. Additionally the arrows or links between the objects organise the environment. With the help of this structure the user is able to ‘invisibly’ move through the meaningful space in order to study and evaluate the relations and dependencies of the inherent data. *Overview and segmentation strategies* prove to be imperative for a 3D information world. The piece also showed how important

[65] Crabtree, Rodden, Fahlen, Blunck (1999) *eSCAPE deliverable 4.1*, Lancaster, p.53

the visual level is. Because the design of each site is different it is easy for the users to recognise the individual sites if they have navigated the space before. Or their attention might be drawn to the visual level in inviting them to explore individual sites that might hold and direct their interest. Some users were disturbed by the fact that the various sites were represented by different forms but there did not seem to exist a link between form and content. We had to realise that *we have to avoid graphical details that do not contribute to the content. Each feature has to be convincing and logical.* Features that do not have any justification for the content irritate or at least distract the user. As already mentioned, the metaphor of the planetarium proved to be advantageous and disadvantageous at the same time: on one side it is neat on the other side it undermines the liberties of the system. In order *not to allow any graphical ambiguities* the metaphor had to be further abstracted. Because the system uses a generative structure, in other words that it can be both inhabited and further developed, at the same time the structure of *The Web Planetarium* is revealed in its transformation. The advantage of *providing a dynamic system* is obvious: when designing a digital information space it is impossible to explore every consequence of an establish structure – by designing an open system that is able to present knowledge, as well as process it, complexity becomes manageable. This aspect requires that the information space is a multi-user environment. Value can only be produced when other people's knowledge is accessible and can be evaluated. The more information is offered in a consistent, structured space, the more value can be produced. Connecting this aspect with current developments in ubiquitous computing *multiple access* becomes an inevitable conclusion.

I0_dencies

IO_dencies deals with the possibilities of agency, collaboration and construction in translocal and networked environments. The project looks at urban settings in Sao Paulo, analyses the forces present in particular local urban situations and offers experimental interfaces for dealing with these local force fields. Sao Paulo was chosen to bring about a confrontation between different cultural environments, which suggest specific interrelations between traditional ways of building, economic and political conditions, and electronic communication structures.

The contact with the concrete city environment is maintained through working with local architects and urban planners who deal with the problems and challenges of the city they live in. The aim is not to develop advanced tools for architectural and urban design, but to create events through which it becomes possible to rethink urban planning and construction and arrive at a notion of process-oriented collaborative agency. Knowbotic Research tries to engage with the friction and the heterogeneity of the urban environment by merging the closed and rational system of digital computer networks with the incoherent, rhizomatic structure of the urban space. The project investigates the productivity of such merged, translocal networks as tools for the creation of topologies of interventions and connective actions.

The Sao Paulo project enables the articulation of subjective experiences of the city through a collaborative process that is part of the project's development. A group of local architects collect text, image and sound material that reflect their urban experiences. With a specifically designed editor tool they upload their material to a database. Additionally, they arrange the material in conceptual 'maps' reflecting their subjective perception of the city. Connectivities are created between the different maps of the editors by algorithmic self-organisation. The collaborative editorial work in the database generates zones of intensities and zones of tension, which are visualised as force fields and turbulences. Another group of people, the users, can modify and influence these electronic urban movements, force fields and intensities on a visual as well as on a textual level. The objects in this force field are purely symbolic and conceptual: the parameters are not spatial or territorial, but relational and depend on the editors' approach to their urban material.

The visualisation shows the intensity of relational forces in the data-pool as they are being constructed and transformed by the self-organisation. A specially designed interface table makes it possible to experience the zones of intensity not only visually and acoustically, but also as physical force fields by means of a 'knob' with a magnetic mechanism which can be dragged and pushed over the projected visualisation. The knob also has functions that make it possible to zoom in on and out of the visualisation. When zooming in, the keywords referring to specific materials in the database appear. By selecting them, it is possible to see or hear the respective textual, visual or auditory material on a separate monitor. This engagement with the projects and its material is fed back into the database and influences the relational forces within the project's digital environment. The networked project facilitates the fusion of reception and construction by several connected translocal users.

The discursive practice of *IO_dencies* places itself outside any architectural framework. The city does not consist of buildings and infrastructures, but of a heterogeneous field, of lines of forces, by lines of action and interaction. These lines form the coordinates of an urban topology that is not chiefly based on the human body and its movements in space, but on relational acts and events within the urban machine. These can be economic, political, technological or tectonic processes, as well as acts of communication and articulation, or symbolic and expressive acts.

The created interfaces allow for collaboration - they are open interfaces, i.e. tools that can be changed and improved through their usage. They are adaptive to both editors and users and the ongoing processes. The interfaces attempt to give the users' actions and interventions into the force fields a presence over time.

IO_dencies is a virtual space that is not meant as a social space but as a knowledge architecture for multiple users. While social spaces ask for the visualisation of other participants, a knowledge space asks for a different kind of ‘user representation’. Therefore the users are presented via their browsing activities in *IO_dencies*. This presentation of action and activity corresponds to the necessity of visualising search effects of users in ‘corporate memory databases’ charting the interests of the users, so that mutual interest as well as conflicts can be recognised. In this piece a third dimension is not the essential element of the advanced display: it uses a two-dimensional interface structured by diagrams, replacing pages of algebra with a simple graphic. The ‘secret of success’ is that they represent interaction graphically while also giving numerical information.

In order to meet the current and future challenges, an optimum utilisation of the available knowledge is required, while at the same time a continuous improvement of the knowledge within the project is essential. *IO_dencies* meets these challenges by allowing us – as researchers *and* as users – “to explore how to present dynamic activity information and complex interrelations at an aggregate level and offer us a direct migration to allow the presentation of a search history”.[66] But the configuration of *IO_dencies* with its various levels and entities as well as the possibility to access different types of information were too complex for the unprepared user to grasp. Without an explicit help it was nearly impossible to understand the structure and retrieve specific information. Knowledge requires structure to support, if the increasing complexity should be handled.

Informing the demonstrators

In the previous section design strategies have been elaborated, taking the features and studies of *The Web Planetarium* as an example. The concept of the ‘generative grammar’ is not based on one artwork at all. As already mentioned in Chapter 1 (Artistic perspectives on eSCAPE) it is the result of evaluating and abstracting the concepts of each art work and each of their studies. The following paragraph will show in short that independently of the team developing the *Web Planetarium* the team working on *IO_dencies* applied similar strategies with the same results thus informing the design of both the abstract e-scape, and, to a large extent, the physical e-scape.

IO_dencies as well as any other interactive art piece involved in the eSCAPE project seem to be based on the Bauhaus dictum: “form follows function”: *appropriateness is task dependent*. *IO_dencies* tracks how you communicate, which information you are interested in, measuring quantity, length, frequency and type of information you retrieve and then readjust the system. It is a dialogue through representation, not technology that replaces the ambiguity of human language. Because *IO_dencies* offers a representation of language that can be supported with technology it provides a *shapeable and exploitable dynamic structure* appropriate to handle permanent changes and complexity. The installation grew from the motivation to show how the combined effects of a

[66] ebenda p.61.

disparate collection of real world users may be reflected on a real world electronic landscape as different users' manipulation and use of entities in the landscape demonstrate different effects on the users. Clearly the whole concept is based on a *multiple access structure*.

In this interactive artwork a set of users was provided as editors. To a certain extent they were instrumental to the project in order to produce knowledge through imagination and experience. They used their tools to organise their perception of the focused real world. The self-organisation on the other hand provided the users with an overview of the entire database. The user had the possibility to approach the information space in steps, getting a more and more detailed insight into the organised interrelations and dependencies of the displayed data. Without such an *overview and segmentation* this application would be impossible to comprehend. The distribution of the keywords, the various scale and operators, provide a very clear structure in which to work but demand no particular order of operation. The application itself invites the user to speculate and 'move onwards'. Visual attractiveness is here reduced to the particle flow which moves and accelerate over force fields thus making the intended visualisation of information and clustering more obvious. The *importance of visual attractiveness* was clearly recognised by the design team, and the public usage of the application confirmed their assumptions. But even though *IO_dencies* did *not include any graphical details that did not contribute to the overall content* of the piece, the multiple-layer structure of the system was too diverse for the users to handle. This fact defined our last 'generative rule': *to respect conventions!*

Creative Concepts with new Tools

Our visual landscape starts with that which is seen, extends into the realms of complex perceptions and serves as the basis for navigating our lives. eSCAPE reflected upon two computational directions that can be seen to extend the role of landscape visualisation beyond visual representation of what is seen. eSCAPE does not provide solutions, but developed a set of competencies (in the form of an abstract and a physical demonstrator) that are able to turn knowledge into a communicable unite. In eSCAPE we focused on three-dimensional data visualisation because we recognised that no single structure would meet all requirements when computing interest groups/users need to share the same information structure. For *The Web Planetarium* and *IO_dencies* both, as well as for all other interactive art works involved, the idea was to foster a team-based approach to innovation. None of the projects just involved artists and/or designers, but also enlightened social and computer scientists whose determination to establish ambitious goals is a precondition for progress in design and IT development. In an era of continuous innovation, shared creativity is blurring the boundaries between developer, designer, artist and user. When the eSCAPE project started, we asked for proposals for interactive art works that would add value to information and to the demonstrators, or to the process leading towards the demonstrators. We turned to artists with a thorough understanding of information technologies, because we intended *to create new knowledge and not to cover old ground*.

eSCAPE's real end products are ideas, knowledge and relationship as they evolved from the permanent dialogues between everybody involved. Our initial vision was to start from the widest possible spectrum of research opportunities, but very soon we had to realise that we could not fall back upon a common platform for the different disciplines involved, we had to build it. Once done, new solutions and ideas emerged which we thought were more suitable for achieving the project's objectives than those originally envisaged. Knowledge, ideas and relations gained from the involvement of interactive art as described above provided a rich source for conceptual, and, ultimately, practical creations. Currently we are convinced that inventing generative structures that incorporate patterns of growth as in the dynamics of natural systems will be a decisive and interesting future direction of information and communication technologies. In this sense, neither the artworks nor the demonstrators are end-products, but visionary and explorative steps in a new direction, possibly leading to new use of technology and new commercial propositions.

In this chapter we have considered the role of the artistic investigations as exploratory vehicles and as mediums to investigate and try out radical interaction possibilities. Essentially, we have suggested a broad generative grammar where the art pieces are used to explore potential possibilities prior to their use within electronic landscapes. This approach has focused on two distinct electronic landscape demonstrators, the abstract demonstrator and the physical demonstrator.

Within eSCAPE art pieces have essentially emerged as the engines of radical research concepts that may be taken up and used within practical electronic landscapes. Essentially, we expect the artistic investigation to suggest the unexpected and to propose "blue sky" research concepts and ideas. The question remains in terms of the practical everyday activity of putting these concepts to work how do we ground these concepts. In the following two chapters we review our experiences in grounding these concepts and in putting them to work within a particular application.

Chapter 5: Grounding "Blue-Sky" Research Concepts

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The eSCAPE project may be characterised as a "blue-sky" research project – a project directed towards the invention and development of innovative technologies for the future. Blue-sky research is, as such, essentially 'visionary' in character and not constrained by the demands of real world situations. There is a point, however, where blue-sky visions must make contact with real world situations if they are to be realised in the future. Ultimately, blue-sky concepts (such as the Web Planetarium and 10_dencies) must be *grounded* in the real activities, needs, and wants of people in their everyday lives. Ethnography, which focuses on real world, real time activities, provides one means of grounding blue-sky concepts in explicating practical requirements for future technologies configuration in everyday settings of use.[67] Ethnography's purchase in grounding blue-sky research lies in its ability to *contextualise* development. Future technologies are often conceived of in the absence of any specific use context. They are essentially abstract in character and lack any specific sense of circumstances of their deployment. The eSCAPE project, for example, conceives of future technologies that connect a variety of different electronic landscapes. What kind of landscapes? To do what in or with? By whom? To what end? And so on. These issues and more are nowhere specified in the vision, other than vaguely or generally. Technical challenges are, nonetheless, identified and addressed, and new technologies are produced. If they are to be used, however, there comes a point at which the technology must be grounded in practice. Suitable contexts must be selected if blue-sky technologies are to find their way into situations of everyday life. Settings, that is, in which the daily activities *may be* supported through the development and adaptation of the technology in question.

Configuring blue-sky technologies to support activities in specific settings not only serves to contextualise the technology but may also, in doing so, provide further input to its general development in addressing general features of technology usage (such as the use of navigation devices, access models, authoring tools, and the like).[68] In either case, design may be grounded through the investigation of 'perspicuous settings' (see Chapter 2: Social Science Reasoning.)

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[67] Rogers, Y. & Belloti, V. (1997) Grounding Blue-Sky Research: How Can Ethnography Help? *Interactions*, vol. 4, issue 3.

[68] Grønbæk, K. & Mogensen, P. (1997) Informing General CSCW Product Development through Cooperative Design in Specific Work Domains, *Computer Supported Cooperative Work: The Journal of Collaborative Computing*, vol. 61.

which serve to contextualise the technology and inform its development, adaptation, and application in confronting it with practical situations of use. By way of example, one strand of research in the eSCAPE project has been concerned with the development of 'abstract' electronic spaces (i.e. spaces having no resemblance to physical places). These may, in principle, connect a multiplicity of virtual environments or the information content (documents, audio, video, etc.) of particular abstract environments. In either case, it is necessary to support users in *accessing* and *identifying* relevant 'information' from potentially large amounts of 'data'. In order for the technology to find its way into situations of everyday life it is necessary to configure the technology to support such daily work. The question is, where could we go to find out what the work of accessing and identifying relevant information from potentially large amounts of data consists of? Where could we find a workgroup whose day's work consists of accessing and identifying relevant information from large amounts of data? Consideration of the 'problem' suggested that a library could well be one such perspicuous setting. Libraries house large repositories of information and are explicitly organised to enable public access to, and identification of relevant information from, large collections of data. Identification of the work-practices through which access and information retrieval is organised in libraries would serve to contextualise development, providing for the design of a concrete instantiation of an abstract eSCAPE and, at the same time, for the design of general interaction mechanisms for abstract eSCAPEs. Below we elucidate what grounding blue-sky concepts consists of as a practical activity.

Investigating Perspicuous Settings

The investigation of perspicuous settings consists of the explication of the work-practices whereby some setting's daily activities are socially organised. Below we explicate the work-practices in and through which library users and "help desk" staff in the library access and identify information of personal relevance from a large collection of data: the library catalogue. We choose the help desk as a perspicuous setting as it is a site of cooperative work which promises to 'tell us' much about the ways in which information access and identification is socially organised in real time. We describe the work that staff and users engage in together as a routine matter of course in order to produce an understanding of just what users are searching for. Considerable attention is paid to the talk that occurs at the help desk as it is through their talk together that users and staff work up mutually intelligible understandings of just what is being searched for and (thus) come to access the catalogue and identify information of personal relevance. Although treating talk as a methodological resource we place an emphasis on *work* and *not* talk as it is the work and not the talk of the setting that we are interested in and seek to ground blue-sky research concepts in. As Michael Moerman reminds us,

> talk is not an object of study in its own right. Talk is, rather, the locus, accomplice, and accomplisher of social organisation.[69]

Talk, in other words, is a tool that people use to get their activities done together. Rather than ask what is it *about talk* that engenders collaboration and cooperation (as Conversation analysis might do), we ask instead, *how* do people do *what* they *do* together in and through talking?[70] In taking this methodological stance our purpose here is to elucidate the cooperative work-practices in and through which concrete understandings of user requirements are routinely produced in the course of accomplishing information access and identification work at the help desk.

Cooperative work at the library help desk

Access to the library catalogue is primarily provided through Online Public Access Catalogues (OPACs) which allow users to formulate queries and identify information concerning the location and availability of materials within the library. In using OPAC users are obliged to repeatedly refashion their queries into something that can be expressed appropriately in OPAC. That is, in terms of the library catalogue's organisation. Where the query is initially well defined, such as when users have a reading list or a bibliography detailing specific items or, alternately know just what they want, this process works reasonably (eSCAPE D4.1). When the query is far less well defined, however, such as when a user wants to know about a broad albeit particular topic but does not know how to specify the query more precisely, then the user currently relies on other means of accessing the catalogue and identifying material of potential relevance. In situations where queries are hard to specify users often resort to the Service Desk or "help desk" whose staff have a broad working knowledge of the catalogue's organisation and its various contents. Developing an appreciation of the cooperative work that routinely occurs at the help desk provided a major focus for ethnographic studies which were subsequently employed to ground blue-sky research concepts. We briefly review the work of the help desk and consider the way in which users and staff "search" for information together.

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[69] Moerman, M. (1992) Life After C.A., *Text in Context: Contributions to Ethnomethodology* (eds. Watson, G. & Seiler, R.M.), New York: Sage.

[70] The two are by no means the same and may be of significant consequence to design insofar as cooperative *work* disappears in addressing the former question. Instead, we are presented with the formal workings of the 'turn-taking machine' (Sacks *et al.* 1974; Ruhleder & Jordan 1999). The interested reader might see Lynch (1993) and Lynch & Bogen (1994) for critical discussion of the methodological pitfalls of Conversation Analysis and a detailed elaboration of an alternative approach to the study of social organisation. Unfortunately, space does not permit such treatment here.

Sacks, H., Schegloff, E.A., Jefferson, G. (1974) A Simplest Systematics for the Organisation of Turn-Taking for Conversation, *Language*, vol. 50, issue 4.

Ruhleder, K. & Jordan, B. (1999) Meaning-making across remote sites, *Proceedings of the Sixth European Conference on Computer Supported Cooperative Work*, Copenhagen: Kluwer Academic Publishers.

Lynch, M. (1993) Molecular Sociology, *Scientific Practice and Ordinary Action*, Cambridge: Cambridge University Press.

Lynch, M. & Bogen, D. (1994) Harvey Sacks' Primitive Natural Science, *Theory, Culture & Society*, vol. 11.

Amongst a variety of everyday activities, work at the Library help desk deals with "search enquiries" and the management of restricted access materials. Situated at the desk are six computers which are used for "household management" and to access to the Library's online catalogue in the course of dealing with enquiries from users. Help desk staff characterise "a lot of the work" with users as consisting in "finding out what people want", as "getting details out of people", as "trying to find what they are looking for", or more generally and formally, as "filtering work". As noted above, users often turn to the help desk for assistance when they are experiencing difficulties in finding materials that might satisfy their information requirements. The following sequence of talk at the help desk involves two users and two members of staff. Their talk makes available the real world, real time, socially organised work involved in the accomplishment of "filtering work". Specifically, of the work involved in transforming 'specifically vague' descriptions of information requirements into precise descriptions that 'fit' the catalogue and produce useful results.

1. Sarah: Could you tell us where market - what was it - market intelligence?
2. Lisa: Yeah.
3. Sarah: Market intelligence
4. Sylvia: Marketing is C floor. [Inaudible] do you know how to use the screens?
5. Lisa: Yeah but
6. Sylvia: You need to find the classmark for the book.

The provision of a specifically vague description is the first action in an unfolding course of cooperative work. Here, the library users say that they are looking for something on "market intelligence". This is a very vague description insofar as it covers *many things* but at the same time, and without contradiction, it is also very specific as the information required is, in some yet to be articulated way, nonetheless understood to be connected to 'marketing'. Eliciting and / or providing a specifically vague description is the first action in a sequential order of cooperative work-practice. Library users furnish help desk staff with such descriptions as a matter of course. In furnishing them, the description circumscribes the search area.

Furnishing a specifically vague description does not provide for the accomplishment of the search however, only for the undertaking of a search in cooperation with help desk staff. In order to find and retrieve information that satisfies the users' information requirements, the connection between the search area (e.g. marketing) and the information requirement, which is in the users' heads, needs to be *articulated*.

Sylvia leaves the Service Desk, leads the two users (Lisa & Sarah) to a nearby OPAC terminal and
initiates a 'title' search.
7. Lisa: It's not a book.
8. Sarah: It's like information, information about these particular products and services. It's called market intelligence and leisure intelligence et cetera et cetera.
9. Sylvia: And is that the name of
10. Sarah: That's the name – market intelligence and leisure intelligence. It's not a book as such. It's usually in the reference library.
11. Sylvia: Is, is it a serial?

12. Lisa: Yeah.
13. Sylvia: It's a serial.
Sylvia initiates a 'serial' search on OPAC

As the talk makes available, articulating the connection between the circumscribed search area and the information requirement in the users heads consists of a course of *categorisation work* in and through which further descriptions are elicited and made intelligible in terms of the online catalogue's organisation. In accomplishing this work, help desk staff and the users together orient to and employ OPAC search categories to elicit and furnish library-relevant descriptions of the information requirement. Over the course of OPAC use, it is concertedly established by staff and users that the information requirement is not a book but a serial, which provides a rather more specific sense of just what is being searched for. Not just something in the area of marketing but a marketing serial. In terms of cooperative work-practice, the use of OPAC consists of the joint formulation of *preliminary* information requirement categories (e.g. 'books', 'serials', 'journals', 'maps', 'tourist guides', and the rest). As a routine matter of work-practice, preliminary information requirement categories are, in turn, used cooperatively as resources for articulating the information requirement in even finer detail and, at the same time in such detail, for purposes of working up potential categories of candidate solution.

14. Lisa: It's a journal.
15. Sarah: It's not so much a journal but it does come out every few months.
Sylvia browses the 'serial' search retrieval list
16. Sylvia: Is it marketing intelligence and planning? Is that the one?
Sylvia points to an item on the retrieval list
17. Sylvia: T6 – it's a journal.
18. Sarah: No. It's not a journal.
19. Sylvia: Do you want to check at that and find the journal itself?
Sylvia points to the item's classmark on the OPAC screen
20. Sarah: Been there.
21. Sylvia: But have you actually looked at the classmark?
22. Lisa: Yes.
23. Sarah: Yes.
24. Sylvia: You've looked at that and it's not what you're looking for?
25. Sarah: It's not what I'm looking for.
26. Sylvia: Right. But that's the title of the book you're looking for - marketing intelligence?
27. Sarah: Market intelligence, and its got a list of all the products and services - its basically a
reference book - and it tells you about particular market products and services and what to look for.
28. Sylvia: You've checked in the reference area?
29. Lisa: Well, no.
37. Sylvia: Right.
Sylvia takes the users to the reference area, returning alone to the Service Desk some three or four minutes later.
30. Staff: What was it she wanted? What did she ask for?
31. Sylvia: Marketing intelligence.
32. Staff: Marketing intelligence?
33. Sylvia: Which is a joke [inaudible]. She didn't want that. I eventually got out of her that it was breweries, which we've got in the reference area.

Articulating the information requirement in even finer detail consists of establishing a more precise sense of just what is being searched for. In terms of cooperative work-practice, establishing a more precise sense of just what's being searched for consists in the joint formulation of more *specific* information requirement categories. Although a marketing serial is being searched for, it is concertedly established in orienting to, and working on the basis of, preliminary information requirement categories, that the information required is not in "a journal" but a "reference book". With this information in hand, as it were, staff can act appropriately, taking the users to the *marketing section of the reference area* in the library and (thus) to a finite collection of potentially relevant materials. Cooperative work on the 'shop-floor' (in the reference area, for example) consists in narrowing the search down to specific items of interest through work-practices of 'scanning' books, serials, journals, etc.[71]

As the fieldwork material makes available, "filtering work" is all about articulating information requirements in terms that fit the library catalogue. This articulation work consists of the accomplishment of cooperative work-practices for the formulation of specifically vague descriptions and the transformation of those descriptions through the joint formulation of preliminary information requirement categories and specific information requirement categories. This continued refinement allows user to focus down on a manageable and sufficiently small collection of information in the catalogue.

Refining specifically vague descriptions into increasingly more precise information requirement categories is not without problems. When help desk staff experience difficulties in establishing a more precise understanding of just what the information requirement is then, as their talk makes available, *previous search activities* are routinely appealed to and elicited in order to establish a clearer sense of just what is being searched for. The formulation of more specific information requirement categories *turns upon* establishing the search history in the course of resolving practical troubles of understanding just what users are looking for. Such troubles occur routinely and are resolved through establishing where users have been and what they have looked at *prior* to turning to the help desk for assistance. In spelling out in detail just where users have been and just what they have looked, their search history is employed by help desk staff both to eliminate areas of the search and, alternatively, as in the case above (as is so often the case), to furnish new resources with which to elaborate and refine the search. Search histories are appealed to and elicited as a matter of course in the accomplishment of "filtering" work, providing for the narrowing down of the search and location of potentially suitable search materials.

It is worth noting that in the course of accomplishing "filtering work", the existing OPAC system is used in ways it was not designed for. OPAC is intentionally employed by staff and users working together not only to categorise information requirements in terms that fit the library catalogue's organisation (as intended) but also, and iteratively in accomplishing that work, as a resource in the

71 Twidale, M., Chaplin, D., Crabtree, A., O'Brien J., Nichols, D.M., Rouncefield, M. (1997) *Collaboration in Physical and Digital Libraries*, British Library Research and Innovation Centre, Report No. 64.

ongoing collaborative formulation of enquiries and the production of candidate solutions. This use is an improvised use in which staff and users order their interactions around the OPAC terminal as they work up increasingly more specific information requirement categories. The innovative cooperative work-practices in which OPAC use is actually embedded raised interesting issues for the design of an extension which would ground blue-sky technologies in real-world work-practice. Developing an appreciation of these work-practices enabled the *configuration* of blue-sky research concepts to 'fit' and support everyday activities. Before turning to technical configurations, we would like to stress three important characteristics of the work observed in the library with regard to our primary concern here: accessing and identifying 'information' of potential relevance from large collections of 'data'.

1. In accomplishing "searching's" work users and staff share the OPAC interface in the course of shoulder-to-shoulder cooperation. Sharing the interface is central to the cooperative work taking place.
2. Cooperative work at the interface consists of categorisation work directed towards the production of search descriptions that are used to guide the search.
3. The historical details of previous search activities are routinely invoked and used as a cooperative resource for narrowing down the search.

Insofar as we were concerned to instantiate an abstract eSCAPE in practice, it should be said that we did not consider that the development of a system supporting such work would replace the existing OPAC interface. To reiterate the point, when users have well defined goals, or have managed to fit their query into the catalogue's organisation (as they often do), the OPAC system works well. Instead, we envisaged alternative support as *augmenting* existing catalogue facilities to provide an alternative 'topic-based' method of issuing and visualising queries. We are not trying to support current search activities here, then, but using our understanding of the social organisation of those activities to configure novel technological support for "searching's" work. In order to demonstrate this 'configuration', in the following section we consider the development of a novel interface to the library catalogue that allows library users to search the library through the use topical categories driving a host of previous searches. The use of topical categories used in previous searches exploits the activities of other users to guide current users through the catalogue, supporting and promoting social navigation through the information space.

Chapter 6: Configuring “Blue-Sky” Research Concepts

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In the previous two chapters we have outlined how the artistic works within eSCAPE provided a source of radical "Blue Sky" research concepts. We described the notion of a generative grammar as a means of characterising the relationship between multimedia art installations and the developed concept demonstrators. We also described in the previous chapter how the "Blue Sky" research concepts that were "harvested" from the Multimedia art pieces were grounded in practice and the way in which ethnographic studies of work were used to ground these concepts in everyday practice.

In this chapter we consider in more depth how these research concepts selected from the art works and grounded by a consideration of a real world activity are realised and configured to meet the demands of an actual population of everyday citizens. In particular, we will focus on the abstract electronic landscape demonstrator which exploited concepts drawn from both the Web Planetarium and 10dencies.

In this chapter we show how we employ the studies of real world work-practice as a resource for configuring innovative future technologies for deployment in everyday situations and the continued development of general mechanisms of interaction. Below we provide a concrete example that shows how the artists' ‘creative concepts’ described in chapter 4 were configured through observations of help deskwork in the library described in chapter 5.

In this chapter we outline an extension to the existing OPAC system that is motivated by the cooperative work of “searching” identified at the help desk. The extended OPAC system provides a novel means of accessing data in utilising the visual affordances of a 3D environment and exploits an awareness of previous search activities to support users’ exploration of an electronic environment supporting searching’s work. To do so the system embodies the notion of *data clouds* as a means of facilitating categorisation work and *search trails* as a means of representing the previous activities of users. Rather than present search trails directly they are instead used to drive an *aggregated activity* display representing the previous search activities of *other* users. The focus for design has been the development of interfaces that exploit real world data in the library catalogue for real world purposes.

Within eSCAPE the development of this environment extends our traditional approach of bringing social science studies to bear on design by incorporating artistic explorations of a user interface for searching. In particular we exploit the previous work of multimedia artists described in chapter 5 in the form of an interface that offers users search suggestions based on the aggregation of previous search activities.[72]

Configuring for real world activities

In developing a shared search system to extend to the existing library catalogue we would like to provide a system that tries to present a representation of the library catalogue that is not based upon any existing categorisation. As others have found, supporting the sharing of information categories is a problematic feature in cooperative systems[73] and solutions have been developed that allow the cooperative *construction* of shared categories.[74] Rather than replace existing computer-based search methods - which work well for the initiated and technically proficient - we seek instead to provide complementary means of searching which support the activities of less adept users. We want to allow the emergence of new classification structures that satisfy the needs of ordinary users. Rather than emulating OPAC, then, the demonstrator builds upon previous work on shared information visualisations[75] to provide a 3D information space which contains a collection of information objects and media.

The configured prototype connects to the library's WebOPAC, which allows remote access to the library catalogue. The system draws upon both the catalogue and a collection OPAC searches issued from all users of the system. These two information sources are used to produce two distinct yet interrelated and coupled displays.

1. **The category display.** This display presents the information in the catalogue as a series of interconnected or linked data clouds allowing users to undertake the categorisation work outlined in the previous section.
2. **The activity display.** This display exploits the previous searches by other users to present a selection of the related keywords that are dynamically reorganised with more significant keywords brought closer to the user.

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72 Schiffler, A. & Schwabe, D. (1998) The 10_dencies System: Design and Visualisation Techniques, eSCAPE Deliverable 3.1 *Visualisation of Structure and Population within Electronic Landscapes*, Esprit Long Term Research Project 25377, Lancaster University: Computing Department. ISBN 1 86220 053 X

73 Simone, C., Mark, G. Giubbilei , D. , Interoperability as a means of articulation work; Proceedings of the international joint conference on Work activities coordination and collaboration , 1999, Pages 39 - 48

74 Dourish, P., Lamping, J., Rodden T., Building bridges: customisation and mutual intelligibility in shared category management; Proceedings of Group'99: the international ACM SIGGROUP conference on Supporting group work , pp 11 - 20

75 Benford, S., Mariani, J. Virtual environments for data sharing and visualisation - populated information terrains, in `Proceedings of the 2nd International Workshop on User Interfaces to Databases', Ambleside, 1994, Springer-Verlag

These two displays are designed to visualise two distinct but related aspects of the OPAC data. The displays share a common repository of information (held as a MySQL database) and are linked to one another, allowing effects in one display to be reflected in the other. The general architecture of the developed system is shown in (Figure 1.).

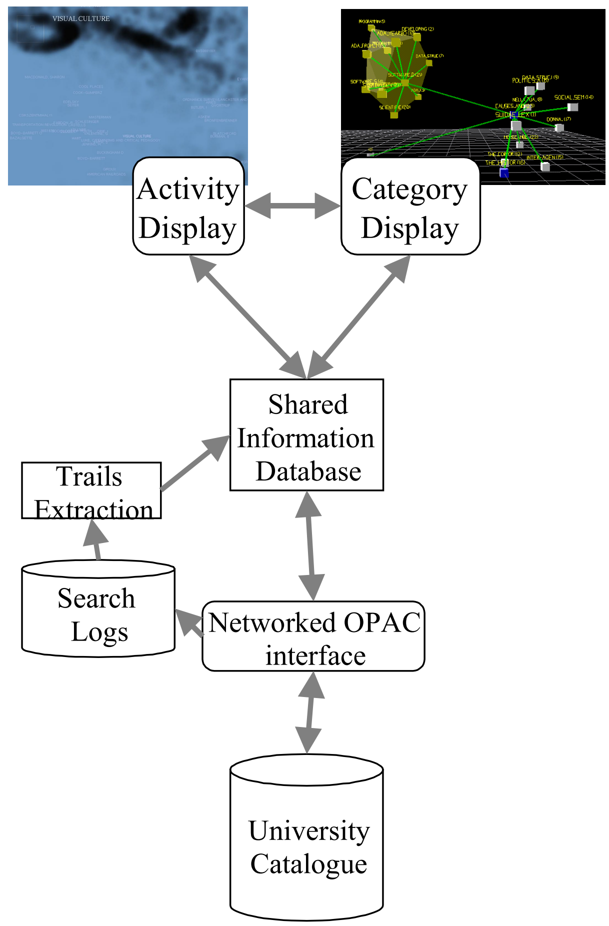

Figure 1. The overall architecture of the system

The network OPAC interface and the trails extractor transforms the information available in the OPAC system and places it within a shared information database. This shared repository is then used to present the information to two display components. In the following sections we provide a brief overview of each of the two displays and outline how each presents different aspects of the information furnished by OPAC to users.

The category display

The central interface for our extended OPAC is the category display. This presents a 3D information landscape constructed from an analysis of the contents of the OPAC database. Users initiate an exploration of the search space by entering a keyword into a single keyword entry window (Figure 2.). This is analogous to the specifically vague classification used as a starting point by users approaching the help desk.

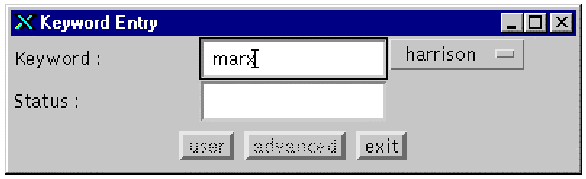

Figure 2. The keyword window

The items that match the keyword input by the user form the basis for the generation of new category display. The OPAC is searched using the keyword query and the returned objects are then used to populate the electronic landscape making up the category display (Figure 3.).

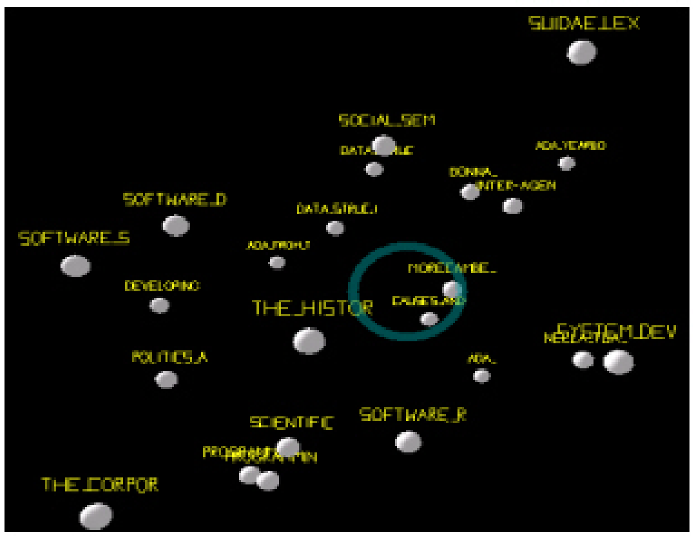

Figure 3. Populating the electronic landscape

Population of the landscape is animated both in terms of a series of progress bars and stage indicators providing an awareness of just what is happening in terms of the population of the space. In forming the similarity matrix, retrieved objects are first ‘spat out’ into the space, giving the users a feel for how many objects have been returned as part of the search. Regions of similarity are then identified and a regional colour associated with each item accordingly. A force-directed placement algorithm is then applied and the coloured objects begin to ‘swarm’ together into coherent, coloured groups. The final stage in the process consists of the formation of data clouds and links in the space. The clouds display an at-a-glance groupings of similar objects. The links point out inter-connections between clouds and objects therein (Figure 4.).

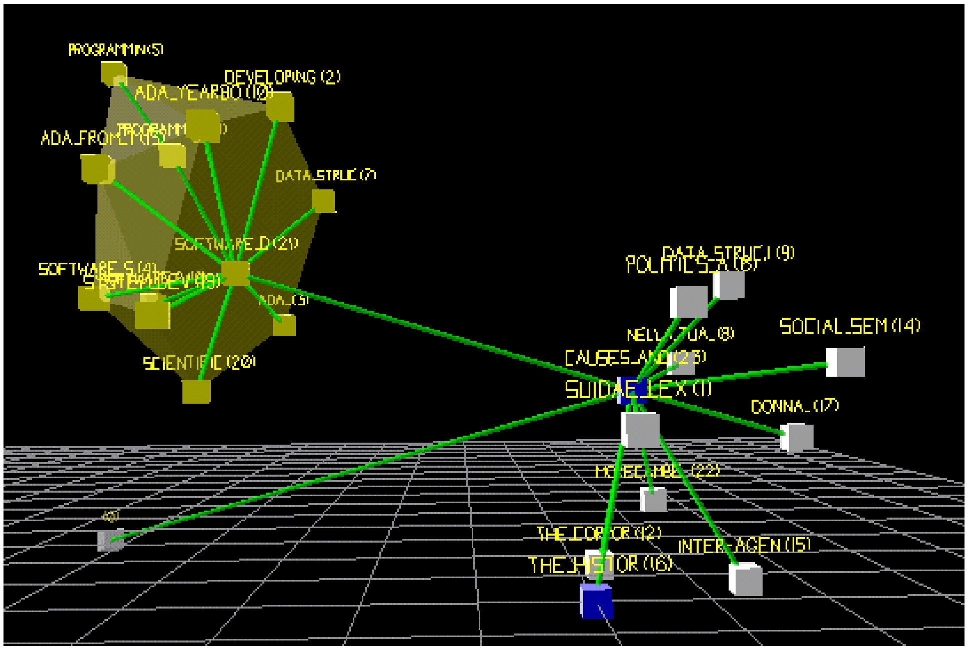

Figure 4. The results of a library query for 'Ada'

Users can see at-a-glance just what each data cloud contains as a topical space in reading the displayed titles of objects. In issuing a keyword search on 'Ada', for example, the user can see that the cloud on the left (of Figure 4.) contains items on the programming language and software engineering. This is linked to a cluster of objects focusing on people called 'Ada' including Ada Lovelace who the programming language is named after. This visualisation of the grouping provided by the category display provides users with an emergent sense of categorisation and allows them to explore the space in a manner more akin to the approach identified at the library help desk. The category display represents an exploration of a radically different interface than the text-based OPAC display currently provided to users. The formation of the space is informed in significant respects by the cooperation observed at the help desk where staff guided users' explorations through the catalogue by exploiting emergent categories and groupings of information. The category display seeks to provide a similar form of support by allowing users to enter keywords that are similar in effect to the specifically vague descriptions used at the help desk, and the through clustering of topically-related information returned to the user in the effort to refine the search.

Interacting with the category display

To enable users to interact with the category display in a quick and easy fashion, an object centric vehicle was developed for the space. Users select an object in the category display by using a simple point-and-click approach. Selecting an object causes its visual appearance to alter slightly (Figure 5.) and prompts a window to open up displaying more detailed information about the object (Figure 6.).

Figure 5. A selected object

Users are free to point and click on any visible object in the display. Doing so centres the selected object within the display. Users can then use the mouse to explore the space surrounding the selected object. Under this 'browse' mode the mouse pointer disappears and all mouse movements allow the user to orbit around the selected object while maintaining the users view on the object. This means it is impossible for users to get lost and look away from the data because the view is always fixed on the central selected object.

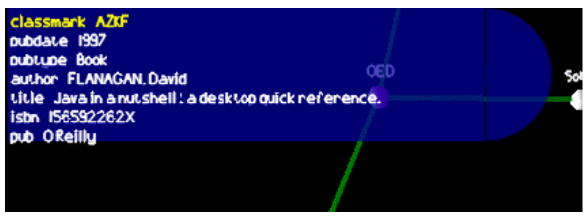

Figure 6. Part of the HUD display

Users of the OPAC observed during previous ethnographic studies routinely wrote down the details of successful hits before going to the particular items on the library shelves to scan and read the books.[76] In order to support this, the category display allows users to build a shopping list of books in which they are interested. This list (Figure 7.) can persist across different searches and is, as such, session-oriented and linked with particular users and may, as such, support the identification of previous individual search activities in its cooperative use.

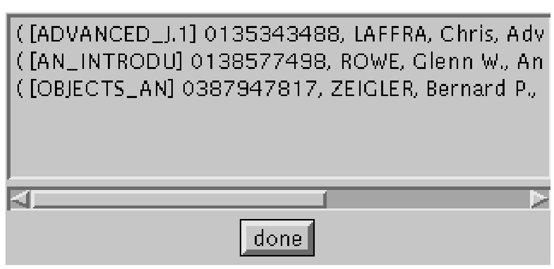

Figure 7. The shopping list of books

76 eSCAPE D4.1 (1999) Understanding Searching as a Socially Organised Achievement in the Library, *The Library Abstract eSCAPE Demonstrator*, Esprit Long Term Research Project 25377, Lancaster University: computing Department. ISBN 1 86220 079 3

The activity display

The category display reflects the focus on the production and use of emerging information categories at the help desk and aims to support cooperation between users sharing a public access point to the catalogue. We are also interested in the situation where users may not be co-located and where users are not simultaneously engaged in searches. As we saw in the studies of the library, helping users search the catalogue often relied upon the history of search activities previously undertaken. To support such approaches to finding information in the library, we complement the category display with a display that makes available to the entire community of library users the activities of community members in the library. The aim here is to allow searching to be supported by providing a sense of cumulative and aggregated social interaction with the environment. Our aim in undertaking design is not to provide an exhaustive topography of user activities but rather to provide an awareness of the cumulative sense of social activity in searching. This approach mirrors that of Babble[77] where an aggregated display is employed to convey some sense of the activities of others. The activity display highlights and suggests areas of the library catalogue of potential interest to users by drawing their attention to areas that have been investigated by other users issuing similar searches. Essentially, in a manner akin to recommender systems, we seek to exploit the search activities of previous users as a means of suggesting items of potential interest to current users.

Exploiting well-trodden paths or ‘search trails’

Ethnographic studies of help desk work point out that an understanding of the history of search activities plays a key role in the discovery of information in the library. Although confined to specific user-staff interactions at the help desk, we seek to *explore the premiss* in extending it to other users. The starting point for our consideration of the wider use of search histories focused on the explicit identification of search trails as a means of representing previous activities. Our use of search trails builds on a growing body of research work considering sequences of search activities as paths through an information space.[78] Essentially, we can consider people forming a trail through the information repository as they uncover objects and that this trail provides a resource for other users to make sense of the overall information landscape.

We define a *search trail* to be a sequence of search type/term statements and successful match selections. The trail is ordered according to time – in the sequence the user performed *these* operations. So for example the trail:

Keyword: ‘d*ada*’->Sel:*ISBN ‘abc’*->Classmark: *‘XN123’*->Author: *‘smith’*->`Sel:`*`ISBN 'def'`*

[77] Erickson, T., Smith, D. M., Kellogg, W. A.. Laff, M., Richards, J.T., Bradner, E., Socially translucent systems: social proxies, persistent conversation, and the design of babble; Proceeding of the CHI 99 conference on Human factors in computing systems, 1999, Pages 72 - 79

[78] Chalmers, M., Rodden, K., Brodbeck., D. , The Order of Things: Activity-Centred Information Access, Proceedings of WWW7, Brisbane, April 1998, pp. 359-367.

is understood to mean that the user first performed a keyword search on ‘dada’ and from the resulting list selected the book identified by ‘abc’ as a match. The user then proceeded to search by classmark on ‘XN123’, and subsequently by author ‘smith’ before finding another match on the object ‘def’. It is worth noting that search trails are constructed from the execution of searches to explore new parts of the catalogue. Other browsing operations at search clients such as scrolling backwards and forwards through the results list, and browsing the details of certain books which turn out to be unsuitable according to specified search criteria are not recorded in the trail. Rather, trails represent an ordering of the sets of books found by users in the catalogue as they searched particular objects of potential relevance.

Identifying and remembering search trails promotes cooperation *through* the aggregate effect of user activities. For example, consider a second user who now enters the same keyword search on ‘dada’ as the user above. The system now has a search trail that it can provide as a resource. This second user then explores a number of catalogue entries including object (B) that is also on the first user’s search trail. This arrangement is shown diagrammatically in (Figure 8.). This use can be informed using the contents of the search. The user continues and finds a different suitable book using a different sequence of searches from the first user.

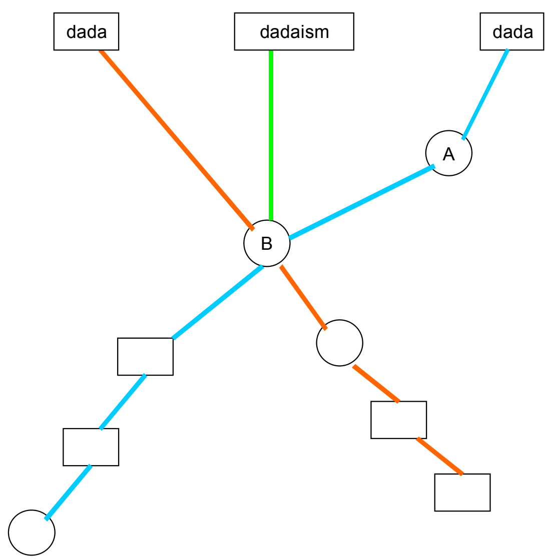

Figure 8. A diagrammatic representation of search trails

A third user enters a different search, this time a search on ‘dadaism’. In this instance, object B matches the search and consequently the search trails associated with the other two users become a resource to be used by the system in making recommendations to the third user. As with the previous two users, the third user navigates down to the individual object level from the initial search. The user selects this object as being a match for their search but wants to see what other objects and search topics are related. The identification of search trails allows the system to suggest that the objects on the other topical search trails may be of relevance to the user.

Trails provide a way of recording and remembering the activities of users in searching the catalogue and allow the previous search paths of users to become a resource for future users. However, two distinct problems exist in exploiting trails in this manner. The first problem concerns the initial identification of the trails from user searches and the second concerns the presentation of the trail information to users in a manner that does not cause confusion. In the following sections we consider each of these issues in turn.

Identifying search trails

One of the largest problems for this application is in capturing a user's search trail. Ideally this would be done implicitly. That is, through the user's normal interaction with the existing OPAC system the information can be extracted. Given the real world nature of the system being developed, however, our opportunity for logging searches is limited. We accomplish some portion of this through the WebOPAC's interface. A user's interaction is recorded by capturing the HTTP requests sent to the OPAC server, via a special proxy server which the user's browser is configured to use and by looking at the servers web logs.

Unfortunately, two main problems need to be considered with this approach. First, the current system doesn't provide any easy mechanism for users to 'mark' successful matches for a given search. Users observed during the study normally jot this information down on a piece of paper and continue searching. Secondly, the system has no mechanism to identify the start of a search or its completion. For example, when a second query is issued at the OPAC interface, is it still part of the original search or a new one? Is it even by the same user? Whether it is or it isn't, we have no way of knowing for certain.

One solution to this problem may be to extend the existing interface to provide such information. For example, with an initial log in screen (or 'topic' start/stop buttons) and by allowing users to mark a book as useful within the context of the current topical search. However, our early prototyping investigations suggested that this was a heavy-handed approach that most users felt uncomfortable with. Consequently, our solution to the problem is to apply some simple heuristics over the OPAC web logs in order to try and extract trails of the form defined at the start of the section. This is certainly not an ideal solution but is simply most appropriate for the data at hand. Thus, we determine that a book was 'selected' if the user had the information about it on their screen for a given amount of time, which could equate to them writing the details down. We also identify 'selection' when a user adds a book to their personal bibliography. The start and end of individual trails are identified based on the amount of time that has elapsed between the last search term or selection being performed and the next keyword being entered.

This use of approximate search trails allows us to use the community of users activities to evolve the display based upon information implicitly gained from internet based searches of the OPAC system. The core resource we exploit for this purpose is the OPAC log that maintains an anonymous list of previous searches. This log provides the basis for the generation of trails underpinning the activity display.

The OPAC Log

Every line in the log-file created by the web-based OPAC interface consists of seven fields, separated by the special character '#' and represents an answer of the OPAC database to the query of a user – (Figure 9) shows an excerpt from an OPAC log file. The first field shows the ISBN of a found book, followed by date, time, IP number of the originating host and search type of the query. The last field shows the search term.

```
0485113457#02/03/99#10:03:43#148.88.246.106#H#D#DELEUZE#
0485114216#02/03/99#10:03:46#148.88.246.106#H#D#DELEUZE#
0412234106#02/03/99#10:03:48#148.88.12.201#H#D#BARRETT, G#
0942299515#02/03/99#10:03:51#148.88.246.106#H#D#DELEUZE#
0X60174765#02/03/99#10:03:52#148.88.128.34#T#D#YOGA#
0855227931#02/03/99#10:03:52#148.88.12.201#H#D#BARRETT, G#
0X08003904#02/03/99#10:03:54#148.88.246.106#H#D#DELEUZE#
0X50396293#02/03/99#10:03:59#148.88.12.201#H#D#BARRETT, G#
0X50262335#02/03/99#10:04:02#148.88.128.34#T#D#YOGA#
0X07029829#02/03/99#10:04:04#148.88.12.201#H#D#BARRETT, G#
0231068123#02/03/99#10:04:08#148.88.246.106#H#D#DELEUZE#
0941664937#02/03/99#10:04:09#148.88.12.201#H#D#BARRETT, G#
0X50497200#02/03/99#10:04:10#148.88.128.34#T#D#YOGA#
```

Figure 9. An excerpt from an OPAC log

Given that many users can use the system in parallel, the lines related to one user are usually interleaved with the outputs related to other users queries in the log file. Fortunately, one of the logged fields is the IP address of the host on which the query was issued, hence it is possible to extract just the output produced by the sessions on one host (possibly held by many users). Of course, all queries logged for one host during the day are usually not produced by the same user. To distinguish between one session and the next, a certain period of time is assumed to lie between consecutive sessions.

A Java application does the conversion and filtering of the OPAC log files and places trail data within the database shared by the category and activity displays of the system. The converter tries to filter entries from the log file which do not make much sense with respect to the intended user interaction. Thus, entries with an empty search term or an empty ISBN (i.e. a number of 0000000000) are skipped during the conversion process.

Presenting activity information

The search trails stored in the database provide a means of suggesting alternative resources worth considering based on the activities of others. However, a problem emerges with respect to presenting this information to users. Two key issues dominate the presentation of this information.

Complexity: The number of trails grows quickly with a large number of search trails crossing. Explicitly presenting these trails to users would almost certainly provide spaghetti like confusion.

Uncertainty: The trails generated from the log files are approximate and based on simple heuristics and it would be unwise to present them as exact entities. Consequently, we wish for a more approximate

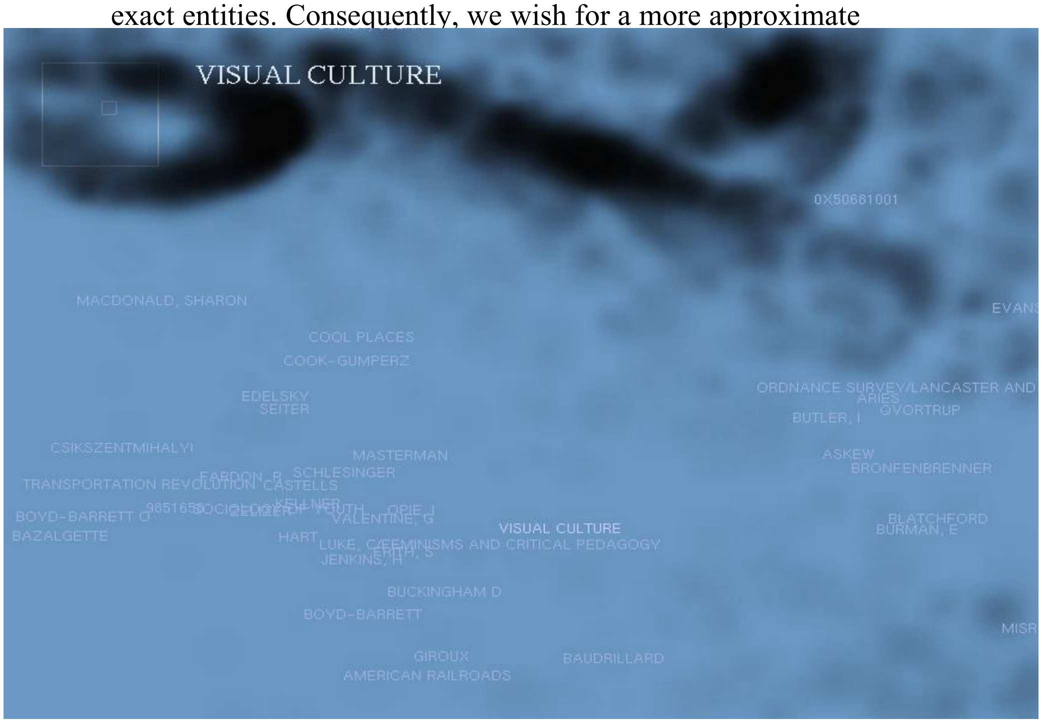

Figure 10. A snapshot of the visual client showing some of the search terms in the database

Knowbotics visual design of the activity display seeks as an art piece to convey an "organic" look to the activity showing the aggregate and under specified nature of the activities. These are reflected in an aesthetically pleasing manner as a series of animated “clouds” of activity. The involvement of the artists in the design of this display has resulted in an interface that contrasts with the precision of the category display and conveys a much more derived and aggregate sense of activity and uncertainty both in its visual display and how users interact with the display.

Once the keyword has been centred on in activity display, users are free to interact and navigate with either display. The Activity Display presents a two dimensional space where navigation and selection is entirely done through a two buttoned mouse (Figure 11.). There are two types of navigation in the activity display – moving and zooming. Moving consists of moving the users “window” of view on the flat to a new position and is performed by pressing and holding the left mouse button. While the button is depressed an indicator appears around the last position of the mouse which “points” in a given direction (see Figure 12). By moving the mouse the user can rotate this directional indicator around the original mouse cursor position. When the left button is finally released the system moves the users’ view in the direction indicated by approximately one screen. The portion of the activity display been seen by the user is shown in the top left hand of the display. When more than one user is using the display their view is also shown as a square.

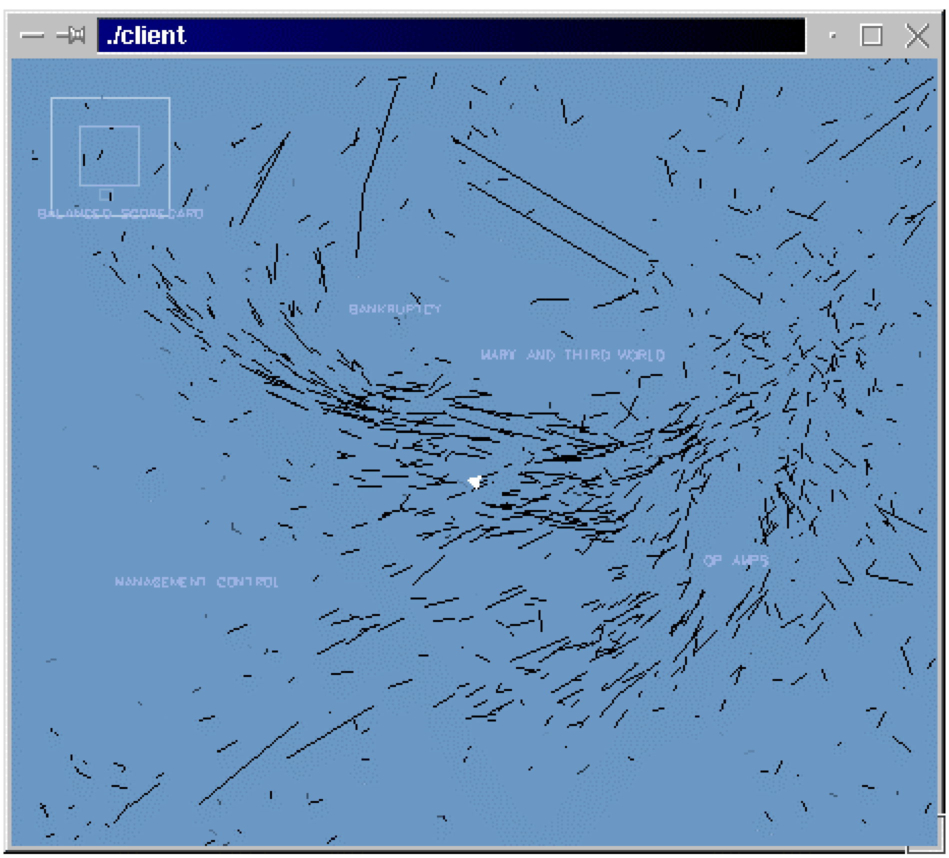

Figure 11. The activity display

Movement in the space is achieved by pressing the left button mouse and dragging in the direction of the display you wish to see. The direction of movement is shown by a series of concentric arcs indication the general direction and of movement (figure 12).

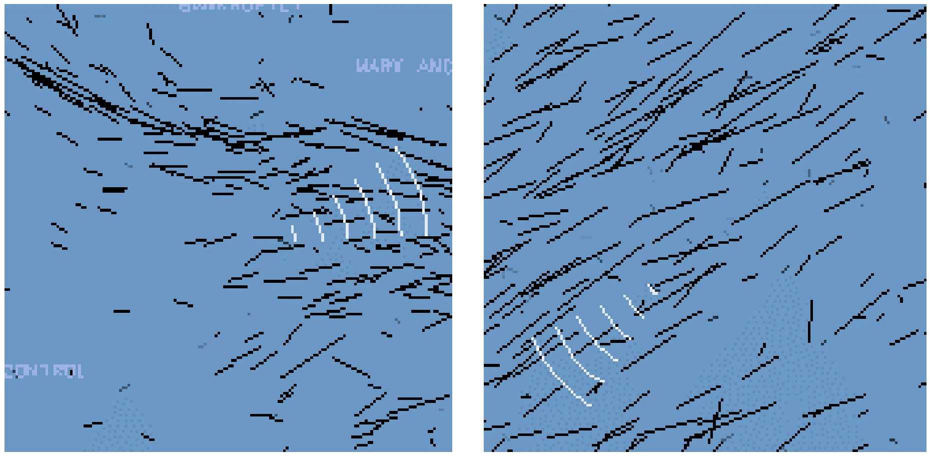

Figure12. Choosing a direction to move in

Zooming allows the user to zoom into or out of particular regions of the space and is performed by pressing and holding the right mouse button. While the button is depressed the user can select “zoom in” (Figure 13.) by moving the mouse in the X-axis, and “zoom out” in the Y-axis. The amount of zoom is pre-set (it does not depend on “how far” the user moves the mouse) and when the user releases the right button the system updates the view with the new zoom factor.

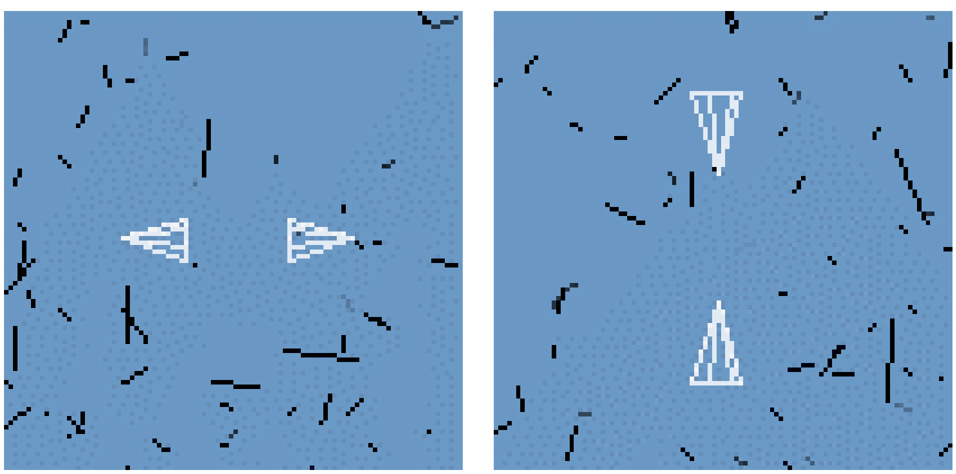

Figure 13. Choosing to zoom in or out

Once the user has reached a certain level of zoom he can choose to select objects in view by moving mouse over the text label and left clicking on it (Figure 14.). Selecting an object in the activity display essentially allows a user to initiate a new enquiry to the OPAC. The new search then updates the category display and redraws it based on this keyword.

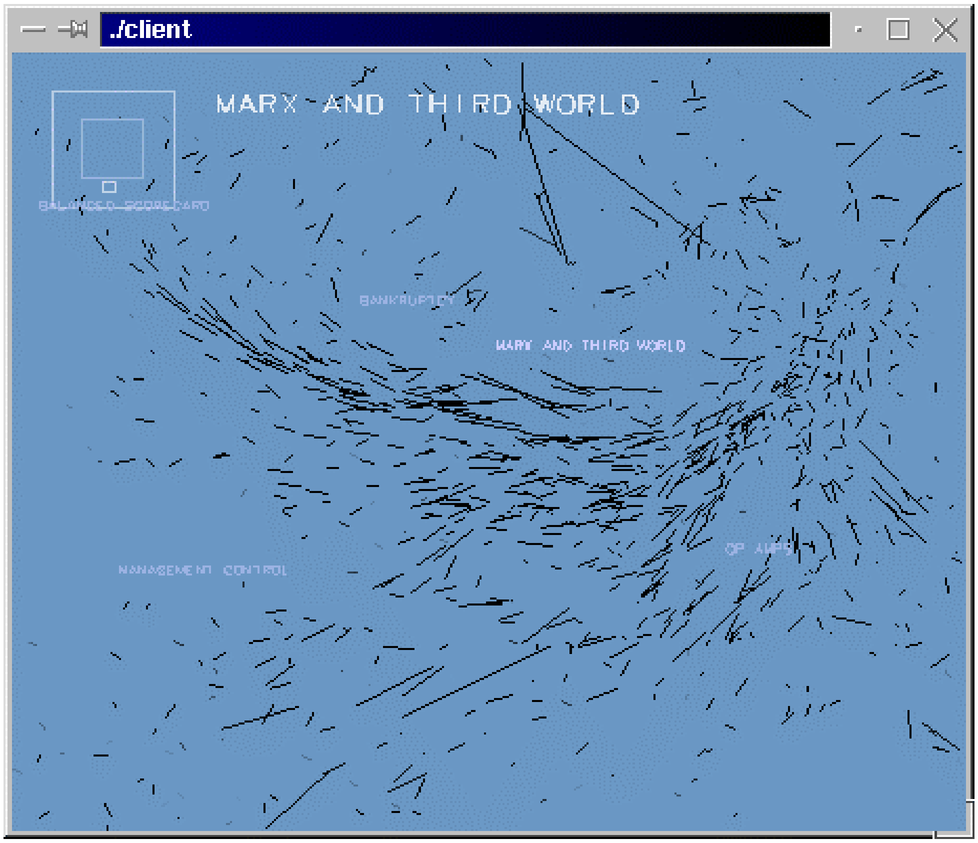

Figure 14. Selecting an entry

In this chapter we presented the development of an electronic landscape that builds upon some of the "blue sky" concepts originally generated by the initial artistic explorations in chapter 4. These initial concepts where grounded by considering them alongside the demands of the particular community of users to emerge from the sorts of studies reported in chapter 5. This grounding of these concepts allowed us to develop and configure the electronic landscape to support the work of users. The final part of the common experience in moving from artistic concepts to demonstrator application focuses on how we calibrate the effects of this work and assess its applicability. In the following chapter we review this issue by considering our experiences of assessing aspects of the demonstrator reported in this chapter.

Chapter 7: Calibrating blue-sky configurations: situated evaluation

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In the previous chapter we considered the means by which we developed a system to be placed in front of users that allowed grounded versions of "blue sky" research concepts to be placed in front of users. Having designed what to us seemed like a coherent artefact that exploited blue-sky technology to support the accomplishment of searching's work, the next question to be addressed was whether the demonstrator would be experienced as coherent by users? Working on the assumption that users are the real experts in the accomplishment of searching's work, the demonstrator was subject to *situated evaluation* involving academics, tutors, students, and administrative staff who needed to search the library catalogue in order to find particular resources.[79] The point and purpose of situated evaluation is to establish whether or not the demonstrator 'fits' and (thus) supports real world work-practice, and to elicit a tangible sense of 'what more' may be done in terms of designing for future work-practice. Situated evaluation is predicated on the doing by users of the activities the artefact is designed to support in contrast, for example, to the doing of abstract tests to establish the validity of the system or certain aspects thereof. Situated evaluation is a 'hands-on' prototyping activity, then, which *situates* the blue-sky technology *in everyday activities*. In doing this, embodied (current) work-practice is treated as a baseline for establishing the 'fit' of the developed technology and, at the same time, 'hands-on' prototyping are treated as a means of exploring and elaborating 'what more' (future) work-practice might well consist of concretely. The meeting point of current and future provides for the calibration of the configured technology to meet the needs of an evolving family of work-practices.

Calibration: where the current and future meet

Situating virtual environments within real world work-practice stands somewhat in contrast to the perception of many collaborative virtual environments that reason about the environment from within. What was clear from our evaluation was that the environment was seen as an alternative representation of the

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[79] eSCAPE Deliverable 4.0 (1999) Inventing New Technologies: The Economics of Information and Situated Evaluation, *Towards a Common Methodology*, Esprit Long Term Research Project 25377, Lancaster University: Computing Department. ISBN 1 86220 078 5

eSCAPE Deliverable 4.1 (1999) Situated Evaluation of the Library Demonstrator, *The Library Abstract eSCAPE Demonstrator*, Esprit Long Term Research Project 25377, Lancaster University: Computing Department. ISBN 1 86220 079 3 catalogue and understood as such by users. Users worked together around the screen as they did in using the OPAC system and engaged in the everyday activities they were familiar with in coming to understand and use the environment. It should come as little surprise, then, that the shared environment is one that is strongly situated within the real world and that the cooperation promoted by the environment takes place within the context of the accomplishment of searching's work-practices rather than within the context of the virtual world. As Bowers *et al.* point out, everyday work is achieved by a combination of activities within the virtual environment *and* within the real world. Thus,

> when it is claimed that CVEs can in principle support cooperative work in ways difficult to achieve with alternative technologies, we take this as a claim most appropriately assessed in light of *all* the work *both within and without* the virtual environment narrowly considered. CVEs should not be criticised (nor prematurely celebrated) on the basis of *only* what can be designed into the virtual environments or occurs within them. This argument, then, suggests that there is an opportunity to rethink the design challenges in CVE research: *one should be designing for two worlds not just one*.[80]

The marriage of the everyday nature of the work being supported and the advantages of the shared environment represent a considerable success for the eSCAPE project in terms of putting a virtual environment to real work. That the virtual environment was readily accepted, understood, and used as a practical instrument for practical purposes does not mean that a 'perfect' piece of technology had been developed. On the contrary, users identified a number of shortcomings in their efforts to accomplish searching's work-practices. By way of elaborating what we mean by 'calibration' we briefly review some these shortcomings.

In the course of the evaluation a number of practical troubles emerged which place various constraints on the development of the demonstrator. That is, troubles which shape design in specifying concretely just what the demonstrator should support from the practical perspective of users. Such troubles serve to calibrate the technology for use in practice in their resolution through design.

Spatial Distribution of Objects. Perceptual troubles were experienced in *densely packed* data clouds. Users found it difficult to discern particular objects, as they overlapped and obscured one another. Similarly, difficulty was experienced in discerning which side of a data cloud an object was situated. Although the problems here appear to be navigational ones, they are not ones concerning the object based navigation vehicle but the *spatial distribution* of objects. The dense grouping of objects was not efficacious from a users' point of view and required rebalancing.

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80 Bowers, J., O'Brien, J., Pycock, J. (1996) Practically Accomplishing Immersion: Cooperation in and for Virtual Environments, *Proceedings of the 1996 ACM Conference on Computer Supported Cooperative Work*, Boston: ACM Press.

Selecting Objects. As noted above, in the course of browsing the space, difficulties were experienced in clicking on objects on the far side of data clouds. Users also found that they could not click on objects in clouds - although they could use the 'cross-hairs' to view objects within a cloud. The point to note here is that users preferred, and indeed displayed something of a natural propensity, to use the mouse and cursor as the primary means of navigation and object selection rather than separate selection and navigation as two different acts.

At the same time as users identified a number of mundane practical troubles that would constrain and shape subsequent development, a number of possibilities for design also emerged. These were not related to particular problems as such, but concerned functionality that users felt would be 'good to have'. Users articulated these as they worked with the developed environment to undertake real world searches of the online library catalogue.

Browsing Classmark Relations. Having located an object of potential relevance through searches not based on classmark, users nevertheless thought it relevant to be able to browse the other objects within the same classmark without regenerating the space.

Support for Elimination. In the course of the evaluation it transpired that users were not only 'narrowing down' the search by interrogating objects that might satisfy their information requirements but also by interrogating objects that obviously did not satisfy those requirements. Searching proceeded by negation as much as confirmation. This suggested the implementation of functionality enabling users to remove objects from any current search, thus supporting searching through "a process of elimination".

The practical 'possibilities' and 'constraints' identified in the course of the situated evaluation of the virtual environment (and there were, quite obviously, more than are cited here by way of example) elaborated requirements for the current prototype *and* future avenues of development which were subsequently pursued.[81] In due course, the demonstrator was subject to situated evaluation again and the future not only worked up concretely in collaboration between ethnographers and designers but through the active participation of the real experts in searching's work: library users. It is worth observing at this point that in developing a real world virtual environment for a real world purpose that users understood and appreciated the blue-sky vision and indeed, in interacting with that environment, articulated positive suggestions to support this vision. However, the *mundane everyday troubles* experienced in the course of "getting the technology to work" dominated users interaction with, and evaluation of, the

[81] ESCAPE Deliverable D4.4.

virtual environment. That troubles of use are ‘mundane’ does not mean they are trivial. On the contrary, such problems need to be attended to and resolved if design visions are to be realised and novel technologies situated in actual circumstances of everyday use. Situated, that is, within real world work-practices. Accomplishing the situating of blue-sky technology in everyday activities in attending to those activities and the troubles the technology brings to their performance through ‘hands on’ user-centred development is what mean by ‘calibration’.

The practical affordances of 3D environments

We have presented a real world application using an electronic landscape. In constructing an environment that has a particular purpose – namely, supporting searching’s work in the library - we have moved from a blue-sky vision of these environments to a practical tool for everyday use. Recognising that online public access catalogues work reasonably well for a great many purposes, we have used a study of the cooperative work at the library help desk to ground the development of an extended interface to the library catalogue in the sociality of information searching. In particular we have developed a search facility that provides two displays of the information and activities in the underlying OPAC system. Each of these displays is constructed from a search issued from a display that prompts the user for the topic they are interested in. The first of these displays draws upon cooperative activities in help desk work to support a cluster-based environment interfacing to the OPAC system. An associated display exploits the recording of previous search activities as search trails to reflect the cumulative activities of the community of users. In developing these displays, one of the major points of undertaking the project is to involve users in the design of future technologies. By developing a future environment with a real world purpose and content we can place a demonstrator in front of users to allow them to experiment with the demonstrator and to further inform the development of a usable system. Specifically, over the course of ongoing evaluations end-users continue to challenge design in bringing mundane practicalities of work to bear on configured prototypes. Through ‘hands on’ experience end-users identify important avenues of development not considered by the designers and in so doing enable the developed environment to be calibrated for practical situations of everyday use.

At the same time as we have focused on the development of an electronic landscape for a particular library we have nevertheless tried to maintain the generality of the system. This means that the mechanisms developed for the production and use of evolving information categories and search trails can be applied to other bodies of data. Thus, in principle and for example, the use of search trails may be generalised to embrace unstructured repositories such as the World Wide Web. Developing an Internet search environment is not unproblematic, however, as the category display needs to group and organise objects according to similarity. This lends itself to objects with many different properties such as books but it is unclear how this display could be used to represent things like web searches which have very few external properties. Nonetheless, searching other web-based corpuses of information, like the books available on Amazon.com for example, is clearly attractive and we have started to develop interfaces that link with common web sites containing such data. Immediate future work will see the current system extended to allow it to be 'pointed' at different resources, including Amazon.com, and libraries supporting the standard Z39.50 protocol.[82] We also seek to develop the system to allow the integration of multiple searches to allow a collection of searches from different sources to be displayed together. Simply put, work is ongoing and directed towards grounding and extending blue-sky visions in and across practical circumstances of use to be found in the accomplishment of information search activities in a various of settings.

The potential widespread application of electronic landscapes suggests that 3D environments offer some significant practical affordances from the point of view of real world work-practice. In other words, 3D environments seem to 'add value' to real-world practice. Naturally, we can only speak of one case – searching in the library, although the ubiquity of "searching" particularly via electronic media allows us some degree of generalisation. Consequently, we feel there are some important issues to be addressed here, particularly in light of the fact that environment is currently being scaled up to support searching of other large databases and possibly even the Internet. How, then, might we assess the affordances of the library demonstrator as a real world application? The natural approach would be in contrast or comparison to existing access environments (OPACs) as these are just what users currently employ in the accomplishment of searching's work.

In investigating a perspicuous setting occupied with the daily accomplishment of searching's work we identified two distinct but related real world activities currently accomplished in and through OPAC use. In the first instance OPAC is used to do categorisation work in the course of articulating information requirements in ways that 'fit' the catalogue's organisation. That work currently trades on the use of a fixed number of options provided by the OPAC that place very finite constraints on the formulation of search queries. The environment, by way of contrast, allows for a much wider range of search formulations and focuses on managing their presentation through shared visual structures. The affordances of *shared visual structures* are central to the developed virtual environment. OPAC visualises search results in terms of lists. Sometimes the lists provided mediate between the search query and, quite literally, hundreds of search items in furnishing the users with an alphabetically ordered sequence of topical groups to choose from. On selecting a topical group users are then presented with a list of individual items. Alternatively, no topically grouped list is displayed and users go

[82] Z39.50, Library of Congress Maintenance Agency for International Standard Z39.50 http://lcweb.loc.gov/z3950/agency

straight to a list of individual items. At this level, just what constitutes topically grouped or topically related is broad to say the least. On issuing a search on ‘java’, for example, the user is presented with a vast array of topics ranging from software engineering to island life. The only way to establish the potential suitability of any item on the list is to browse it - a time consuming activity that requires the user to move back and forth between the list and bibliographic displays.[83]

The virtual environment supports searching’s work in visualising spatial structures in contrast to lists. Data clouds group similar items together and display similarity through the use of colour. Visible links connect different but related topics – Java engineering and Java testing, say. Users do not have to spend a great deal of time browsing lists to see what topics are available but can see the range of topics at-a-glance and quickly establish a concrete sense of each topic by selecting an item within a cloud. From that point the cloud and its contents may be investigated or passed by. There is, then, not only a distinct *economy* to doing searching’s work through the use of spatial structures but as a feature of that economy, *added information* supporting the accomplishment of searching’s work Clouds and links group and relate individual items in ways not provided by OPAC. In visualising those groups and relationships users are provided with new resources of practical utility.

The virtual environment clearly ‘adds value’ to the accomplishment of searching’s work, and it does so from a users’ perspective, but does it support ‘cooperative work’? Without engaging in philosophical and theoretical disputes as to the meaning of the word ‘cooperation’, the virtual environment certainly supports the social organisation of searching’s work. That is, it supports the real world work-practices in and through which searching ‘gets done’ by users working alone or together in various arrangements of shoulder-to-shoulder cooperation within the library. On the one hand we provide support both for individual and cooperative work in providing mechanisms for the articulation of information requirement. On the other hand, we provide new resources promoting the sociality of searching through the aggregation of previous user activities. In providing these mechanisms and resources we have developed an electronic landscape that satisfies, indeed goes beyond, social requirements of use (see chapter 2 "Social science perspectives on eSCAPE".). The developed environment satisfies background expectancies insofar as it is intelligibly organised for the accomplishment of searching’s work in providing mechanisms for the articulation of information requirements and practically efficient interrogation of results. These mechanisms provide users with a novel but readily intelligible scheme of interpretation for making sense of the environment: data clouds group similar objects together and links connect related data clouds, for example. This scheme of interpretation consists of material arrangements which may used in methodical

83 See eSCAPE D4.1 (1999) *Understanding Searching as a Socially Organised Achievement in the Library* for details.

ways: data clouds provide at-a-glance groupings of objects which may be quickly interrogated and connections followed through visible links. Furthermore, the environment supports ordinary interaction methods enabling elucidation of previous user activities in being session-based and, more innovatively, in enabling appeal to previous search activities of the community of users to be drawn upon as resources for interacting with the environment in the course of accomplishing searching's work. In such ways, the abstract e-scape described here provides a learnable environment meeting the practical criteria implicated in the social construction of space making it a publicly intelligible place for action. Accomplishing the situating of this electronic landscape in real world work-practice is not only a considerable achievement but, as such, suggests that the *marriage* between the virtual and the real world is the essential factor for consideration in ongoing research into and development of electronic landscapes supporting real world activities.

Concluding Remarks

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This deliverable has considered a common methodological perspective of the work of the eSCAPE project during the last three years. It has presented a series of different disciplinary perspectives on the work of value to those who wish to orient themselves to this form of work. These different disciplinary perspectives have been complemented by the articulation of the common multidisciplinary experiences of eSCAPE in the development of novel interactive environments.

Underpinning the presentation of a common method in this deliverable is the suggestion that the marriage between the virtual and the real world is the essential factor for consideration in ongoing research into and development of electronic landscapes supporting real world activities. The eSCAPE project has provided the site of a course of research between multimedia artists, social scientists, and computer scientists which has seen the emergence of a ‘common methodology’ for effecting that ‘marriage’.

The project has adopted a constructional philosophy with a focus on the user centred development of electronic landscapes that serve a purpose for real-world communities. In order to do this the project has developed two demonstrators that represent different styles of electronic landscape. Each of these demonstrators have followed a common development methodology in terms of combining the different disciplines involved in the project

The development of each demonstrator has focused on harvesting novel and often radical "blue sky" concepts from multimedia art pieces and then focusing on putting these to work in partnership with real-world user communities engaged in practical applications. This convergence of the adventurous and exploratory nature of interactive media art and the pragmatic nature of everyday environments has resulted in the outlining of a simple iterative approach to development.

As we have said in the introduction to this deliverable it would be unwise to think that a single "silver bullet" exists that can address the host of pragmatic and practical concerns that need to be addressed in the development of an electronic landscape that can support the needs of real users and address the problems of an everyday cooperative application. The work of the project has focused on recording our actual experiences and reporting these as a set of illustrative arrangements of work rather than proposing an abstract method. The point here is that it is unlikely that a prescriptive set of guidelines should be articulated for the development of electronic landscapes. Rather the issue is how we might arrange radically different working styles and traditions to promote communication across and between the disciplines involved and to promote the development of future novel cooperative environments.

The common method in a nutshell

The common method suggested in this deliverable represents a reflection of the work of the eSCAPE project and as such it has a user centred and practical orientation. We have presented an essentially iterative process with a number of distinct stages. Although presented here in a linear manner these stages represent particular emphases at moments in time as an concept matures from its initial conception to eventual deployment. These stages should not be seen as a prescriptive set of instructions but as a statement of the process we went through within eSCAPE on a number of occasions. However, we do feel fairly confident that these stages will routinely occur within the development of this class of system and that the orientation of the different working traditions inherent in this presentation is of general utility.

Stage One: Generating Blue-Sky Concepts: Interactive Artworks

An initial role of the interactive artworks within eSCAPE was to promote and support open-ended development of "blue sky" concepts. The development of interactive artworks, by their very nature, explored the scope and bounds of new technologies and the possibilities they presented for radical forms of interaction. These radical concepts could be initially explored within these interactive art pieces before selected concepts were chosen for incorporation within electronic landscapes that aimed to meet the demands of a particular application.

Stage Two: Grounding Blue-Sky Concepts: Investigating Everyday Settings

The open-ended explorations of the interactive art works were complemented by a consideration of the practical and pragmatic nature of the everyday world. The use of ethnographic studies of settings provided rich descriptions of the mundane nature of everyday interaction that contrasted with the more visionary view of the interactive art pieces. This contrast allowed the "blue sky" concepts to be selected and grounded within the world of an actual user community.

Stage Three: Configuring Blue-Sky Concepts: Evolutionary Prototyping

The initial generation of visionary concept, the selection from the different possibilities within the interactive art pieces, and the grounding of these within a real world setting provide the starting point for development. The agreed concepts need to be developed in close involvement with users. Essentially, this means concepts need to be worked up in a user centered manner with an on-going process of summative assessment allowing the development of new applications to be informed from their use in practice.

Stage Four: Calibrating Blue-Sky configurations: Situated Evaluation

Once you are confident about the developed electronic landscape and that you have migrated the initial "blue sky" concepts from interactive art to actual use it is worth calibrating the concepts against a user community more generally. In order to do this some form of situated evaluation should be undertaken that will inform both the further refinement of the particular application and new potential areas of investigation for future blue sky research.

Inventing future technologies for everyday use

In this deliverable we have presented a methodological view of the work of the project by presenting a set of views of the project from different disciplinary perspectives. This was complemented by a description of the main stages involved in the formation of an electronic landscape that has its roots in the inspiration provided by Interactive Media arts.

The work presented here and the general approach it embodies seeks to marry two main perspectives that are often seen as being in conflict

> **Understanding the Present**. In the case of eSCAPE this was achieved through a series of ethnographic studies that sought to uncover the everyday practices of a user community

> **Inventing the Future**. In the case of eSCAPE this took the form of a series of exploratory interactive art installations that were used by the wide population.

Rather than see these two drivers of innovation as in direct opposition we have sought to exploit the tension inherent in combining "blue skies" envisionments of the future with the mundane demands of current work. We would suggest that by undertaking artistic works alongside user oriented development it is possible to exploit the innovative nature of the artistic investigation to generate radical concepts that can then be migrated to everyday work settings. The aim here is not to remove the tension inherent in inventing the future but rather to recognise it and manage it as an everyday aspect of research.