1 Introduction

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The present volume differs from the earlier volumes in this series about virtual inhabited 3D worlds in two respects: as the title says, it is focused on applications (trains, ships, toys, urban planning, brain surgery, design and production, and educational material); but it also took an unexpected turn, partly because half of the chapters are about augmented reality and partly because the concept of a *habitat*, originally proposed by Daniel May, turned out to be useful in a number of chapters.

In addition to this, the focus on applications raised the issue of evaluation criteria: what is a "good" virtual reality application? Is a "realistic" application (i.e. an application that looks like reality) better than an application that does not look like the real world? Not necessarily. For instance, the animals in the virtual environment for small children analyzed by Madsen don't look like real animals, but the application still works. So what are the criteria for good VR applications?

1.1 Virtual and Augmented Reality

That augmented reality is closely related to virtual reality should come as no surprise: both technologies are based on a mapping between two coordinate systems. In virtual reality, the user's view point is mapped into the coordinate system of a virtual world, so that he sees what he would have seen had he been located at a certain position in the virtual world. In augmented reality, the mapping works the other way around: the user's position and orientation is now the point of departure, and the virtual world is presented in such a way that the user sees what he would have seen had the virtual object been located at a certain position in the real world.

Therefore, augmented versus virtual reality is a matter of balance: is the real world strong enough to make the virtual one adapt, or does the virtual world succeed in forcing the user to see and hear according to its logic?

The chapters in Section 1 of this book are about the world in the computer that users can enter, i.e. about virtual reality applications. In Section 2, the chapters deal with computer applications that are placed in the real world. In both cases, the problem reminds one of Chinese boxes: one box must fit into another box. In some cases, pieces of the real world, including real users, are put into the computer application's virtual world. Here the application provides real-world simulations in which users can act and navigate. In other cases, the computer application's virtual world is put into the real world in order to help users to navigate in the real world. However, in both situations, of course, the final aim is to help people perform better in the real world. For instance, a 3D brain model (cf. Chapter 3) is a virtual reality application that users can enter in order to practice their surgery skills, or simultaneously to navigate better in a real brain. The user goes from the real world into the virtual world in order to perform better in the real world. In the interface designs for mobile augmented reality analyzed by Kjeldskov in Chapter 8, the application "enters" the user's real world. The application's virtual world is being merged into a physical space supporting the real-world users' collaborative behaviour.

1.2 The Habitat Concept

The proliferation of the concept of habitat is at bit more surprising. It was tentatively suggested as a common framework at a meeting in spring 2002, and a number of authors, more or less reluctantly, tried it out in their work. As might be expected, the result was a number of variants, but still sharing the same kernel.

One constant feature is the idea of a *boundary* with an inside and an outside (Brown, 1971). The conditions inside are markedly different from those outside, so what can be said or done inside cannot necessarily be said or done outside, and conversely. For very good reasons this notion is heavily stressed in Chapter 3, which deals with various kinds of surgery: macroscopic surgery in an operating theatre, micro-surgery and endoscopic surgery. It is also a major idea in the Chapter 9, which looks at information needs in railways.

When one is inside the boundary, certain things can be done according to this particular habitat's conditions and rules of behaviour. But when one crosses the boundary (i.e. makes a transition from one habitat to another), new rules apply. It is important for a well-functioning virtual reality or augmented reality computer application to support the user in understanding and managing these changes.

Another recurrent feature is the idea of *simplification*, i.e. reduction of complexity. Once inside a habitat, one can ignore many choices and complications that are dealt with outside. This simplification may be a necessity in order to survive, but can also be counter-productive – even lethal. The former is stressed in Chapter 6, which discusses organizational habitats, characterized by specialized languages and modes of thinking, as an obstacle for developing efficient design and production processes; the latter is important in Chapter 10 on wayfinding on ships during maritime accidents. In such cases, passengers really live in small chunks of space and have difficulty in getting the overview that might help them to escape to the muster stations.

Nevertheless, a useful "overview" is not necessarily a grand model of everything. On the contrary: overviews are often too complex and provide too much information; that is, information that is not relevant in a specific situation. Thus what is needed is support to get from one habitat to another. In the wayfinding example, one set of wayfinding signs should lead the user into a new set of signs, and the "virtual" signs on signboards should not contradict the implicit directional signs of staircases etc.

A third idea is the notion of something moving in and out of a habitat. In this case, the habitat is seen as a *context*. This was probably the original motivation for using it in connection with mobile technology, which is exemplified in Chapters 7 and 8. In both cases, habitats are seen as a context that can cause movable devices to adapt their information to the needs associated to particular places and times.

Finally, there is the notion of *evolution*, stressed in Chapter 7 and hinted at in Chapter 9. Many existing habitats need a historical account in order to be understandable, since they have evolved piecemeal: they are altered to support certain activities, but in their altered shape they give rise to other activities that in their turn motivate the next change, etc.

Whether or not the habitat concept will survive this book is difficult to judge; however, it does stress the importance of *context*, which is indisputably an important feature of the new types of technology.

A discussion that has caused several heated arguments among the editors is the relation of (real) space and time to the other aspects of the habitat concept, which includes the notion of a *social system* – the way people interact – and the notion of a *restricted language* – the way people communicate. If the boundary of the habitat *must* be physical, the Internet is not a habitat; in fact, it is quite the opposite! A dialect can be said to be part of a habitat, whereas a sociolect cannot. If we do not require a physical anchoring, then ideologies are conceptual habitats, since they provide the necessary conceptual infrastructure for some thoughts and convictions while excluding others. If one wants to speak about conceptual habitats in general, the spatial restrictions must be abandoned, but then the concept may tend to become synonymous with the notion of a social system.

1.3 Application Quality Criteria

The of editors also discussed how a virtual reality or augmented reality application qualifies as a good application. How do we measure quality?

In the chapters on urban planning (Chapter 2) and brain surgery (Chapter 3) the VR model must allow the users to navigate and act within a realistic virtual world. When supporting urban planning the users must know what happens if a new house is built within a certain location. When supporting brain surgery it is a matter of life and death for the user to know what will happen if she makes a cut one millimetre to the left of the present position. These models should look like reality.

In the chapters on virtual environments for small children (Chapters 4 and 5) a fictional world is presented that is not realistic in any naturalistic sense. The animals, buildings and landscapes provided for the child users are not aimed at making them believe that they are in a real world. Nevertheless the VR application functions because it supports an understanding of emotional conflicts and dramaturgic choices.

Finally, in Chapter 6 on 3D applications in design and production the aim is at least partly to support social and organizational behaviour in an enterprise. How can a VR application support communication between people from different parts of an organization? How can it support processes such as organizational change and learning? Here, neither physical realism nor dramaturgic conflicts are asked for. Here, in order to function, the VR application should represent a social habitat.

1.4 Kant in Virtual Reality

Among the editors we found a solution to the discussion of application quality criteria by turning to the German philosopher Immanuel Kant. He made a distinction between three forms of reason: pure, practical and aesthetic. In the 20th century the German sociologist Jürgen Habermas elaborated the characteristics of these three forms of reason in a linguistic direction. Inspired by the American language philosopher John Searle he identified three types of speech acts: constatives, regulatives and expressives. Constatives are about the way in which the world is according to truth criteria. Regulatives are about the way in which the social world is or should be according to practical criteria. Expressives are about the way in which the world is or should be according to aesthetic criteria.

It is our suggestion that the quality of 3D applications can be evaluated according to similar criteria. Thus, three classes of applications can be identified. One class of applications works in so far as these applications look like the phenomenon represented by the application. These models are constatives. Another class of applications works in so far as these applications have a practical relevance for the social or organizational world that they represent. These models are regulatives. Finally, a third class of applications works in so far as these applications are beautiful or sublime. The landscape of a computer game should not necessarily be naturalistic, but it should create exciting situations or express particular emotions. These models are expressives. The point is that the evaluation criteria for identifying good or bad applications are different within these three application types.

A further point, however, is that although one form of reason dominates a particular application, all three are present in and relevant for every single application. A computer game should be aesthetically attractive, but of course it should also function. An application aimed at physical planning should also be beautiful.

1.5 Good Theories Are Practical

In our editorial work with virtual and augmented reality applications we have been through lots of different theories: the philosophy of Kant, Spencer Brown's laws of form, Searle's speech acts, biological theories of habitats etc. We do hope that our readers also agree that in such practical realms as VR and AR applications there is nothing as practical as good theories.

Actually, this has been the general ambition of the four volumes on virtual interaction, virtual space, virtual reality methodologies and, finally, virtual reality applications: to bring together theoreticians and practitioners, analytical and construction-oriented approaches, media theory and computer science, dramaturgy and engineering, in order to demonstrate not only that interdisciplinarity is requested, but that it must be developed into new paradigms with shared basic concepts. One such concept, suggested in the present volume, is the habitat concept, which has a computer scientific, a humanistic and a sociological significance. Another is Spencer Brown's concept of form. These concepts are, in other words, two of many bridge-building concepts that may support the ongoing construction of a common computer science paradigm crossing the gap between those two cultures that were introduced by C. P. Snow in 1956, but which should not be kept apart in multimedia: science and arts. Returning to Kant, any virtual reality application has a pure, a practical and an aesthetic dimension. Any such application must be constructed and analyzed according to constative as well as regulative and expressive criteria. For some years in academia this has been taking place through the meeting of colleagues from different realms. The next step is the building of common paradigms. These four books on virtual reality have aimed at bringing this process one small step forward.

Acknowledgement

This book could not have been written without the support of the Danish Research Councils, which through their Centre for Multimedia research funded major parts of the work on which it is based.

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