2 Geography in VR

Context

Ken Brodlie, Jason Dykes, Mark Gillings, Mordechay E. Haklay, Rob Kitchin and Menno-Jan Kraak

VR in geography

Given its ubiquity, researchers could be forgiven for believing that a concise and coherent definition of virtual reality (VR) exists, bolstered by a carefully-charted developmental history, a comprehensive list of the ways in which VR can be most profitably applied, and, perhaps most fundamentally of all, an encompassing critique of the technology.

As noted in our editors' Introduction (Chapter 1), reading the chapters in this book will show quite clearly that such a consensus doesn't exist even in the restricted field of academic geography. The diversity of technologies and approaches employed by the authors of this first section demonstrates this point clearly. It would appear that there are as many 'virtual realities' as there are researchers actively involved with VR. This has not prevented these authors from offering definitions or frameworks derived from a bewilderingly wide range of fields (including computational mathematics, education, cartography and aesthetics), based on technologies, or by using purely pragmatic approaches. The latter are the most commonly encountered and are founded upon the assertion that if you are engaged with a representation to the point where your body is responding involuntarily to it as though it were the real world, then you are probably dealing with VR! In such a scheme the definition of VR is reduced to the creation of representations that are so convincing that were a virtual glass to fall from a virtual hand, the user would involuntarily reach out to catch it (Brodlie and El-Khalili, Chapter 4).

Defining VR

Without wanting to anticipate these more detailed discussions, by way of introduction to this section we offer a very broad definition of the technology that emphasises the common elements in our work. We agree that VR is a form of human–computer interface (HCI). More specifically, in each case the process of using VR, or producing a VR simulation, involves the creation of a construct on the basis of a source reality, in our case the

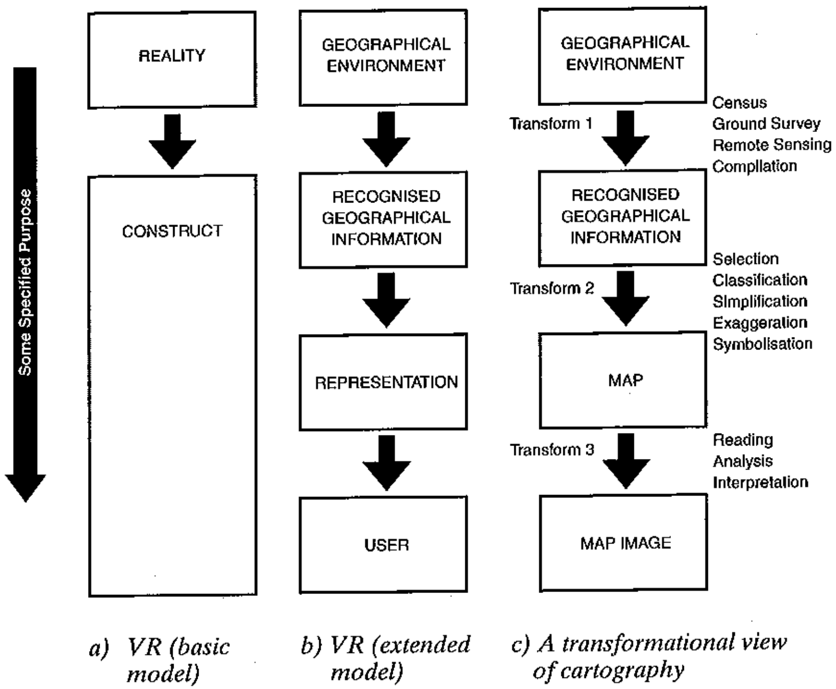


Figure 2.1 Schematic representations of VR and cartography.

a) VR identified as creation of construct from reality; b) An expansion of the schematic shows the series of information transformations involved in producing VR; c) A transformational view of cartography (after Tobler, 1979; Robinson *et al.*, 1996).

geographical environment (Figure 2.1a). This simple model can be expanded to include two other critical factors common to each of our applications. These are the geographical information derived from the environment and the users themselves (Figure 2.1b). To readers who have a background in cartography, it will be apparent that if we replace the terms 'representation' and 'user' with 'map' and 'map image' respectively, our framework for VR corresponds to the traditional cartographic process viewed as a series of transformations (Robinson *et al.*, 1996, after Tobler, 1979; Figure 2.1c).

So far our attempt to create a framework for our VR applications has got us little further than mere semantics. Are we to define VR simply as a subset of cartography? Is there anything that serves to distinguish approaches such as VR from traditional and more established means of representing the world?

We argue that VR is distinct from traditional cartographic transformations. What makes it different is the nature of the relationship between the representation (map) and user (map image). In such a formulation the emphasis of VR, as a form of HCI, is on the process linking the representation and its user. This transformation involves high levels of interaction between user and representation. In our schematic this feature of VR is represented by a bi-directional arrow flowing between the map and the user rather than the single, unidirectional arrow of cartography. This relationship is also stressed by our alternative terminology in the constructs used in the transformational view of cartography. In our VR applications the emphasis is on a 'representation' defined more broadly than the traditional 'map', and the physical user, rather than their 'map image'. This is because the real world affordances that we provide in VR to facilitate the transformation between representation and map image (involving the processes of reading, analysis and interpretation) form the crux of our applications. What is more, unlike any other mode of cartographic representation, in VR the level of engagement between map and user can be varied. In our schematic this is indicated graphically by the length of the arrow relating the two. If a single feature can be said to characterise VR, it is the ability to embed the user fully within the representation, permitting the kind of real world representation desired by, but unavailable to, Tobler when he noted that

> Any given set of data can be converted to many possible pictures. Each such transformation may be said to represent some facet of the data, which one really wants to examine as if it were a geological specimen, turning it over in the hand, looking from many points of view, touching and scratching.
>
> (Tobler, 1979: 105)

Ways in which VR can achieve this interactive, real-world interface between recognised geographical information, representation and user are shown schematically in Figure 2.2.

The degree to which the user and representation are collapsed is dictated by the precise use to which a given application of VR is oriented. As this volume shows, the breadth of applications of VR even within a single discipline such as geography are enormous. They cover the whole spectrum of approaches and users from the initial exploration of a complex data set by an individual expert in an attempt to find patterns, through to the final graphical presentation of results to a wider audience lacking in the same level of expertise. For example, if a VR model is constructed to test the effects of alcohol intake on drivers or to train surgeons in delicate techniques, the level of user immersion in the virtual representation (i.e. the degree of collapse) must be high (Brodlie and El-Khalili, Chapter 4). In contrast, for the purposes of creating a gallery space in which to deploy

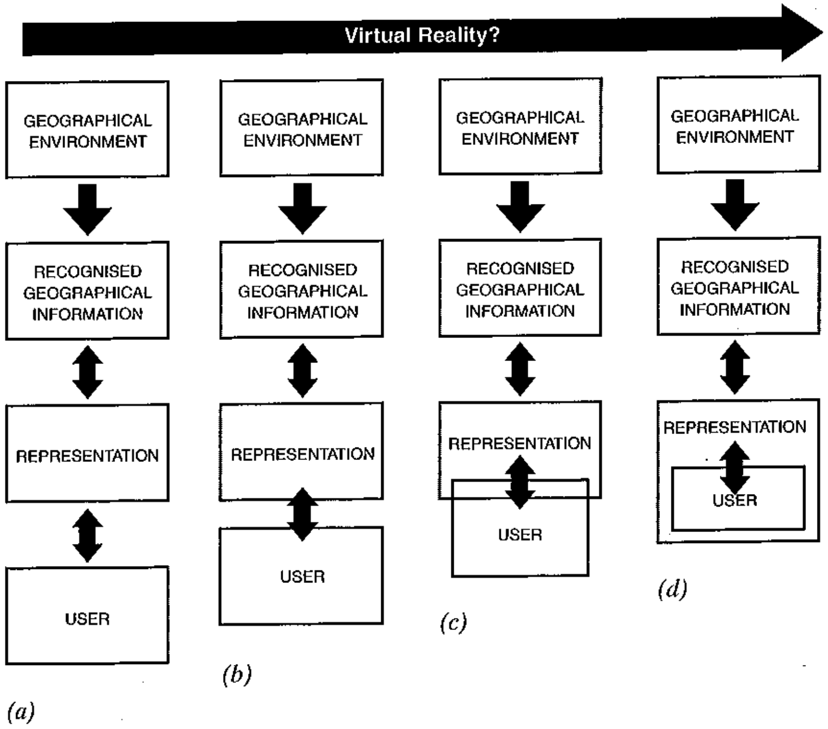


Figure 2.2 VR can be regarded as a continuum based upon levels of interaction and the real-world affordances used to support and facilitate the third transformation.
a) VR takes advantage of interactive visualization techniques where the user can interact with the data to vary transform 2; b) The interface uses some real-world spatial affordances – e.g. Chapter 7; c) The interface relies upon real-world spatial affordances and takes advantage of a strong sense of immersion – e.g. Chapter 12; d) The user is fully and physically immersed in the model and responds as if operating in the real world – e.g. Chapter 4.

virtual agents, the level of collapse can be negligible (Batty and Smith, Chapter 19).

The nature of the geographical information used to generate a given virtual construct can also vary enormously. In many instances this will reflect some aspect of the physical world, as shown by our schema that use 'tangible' data obtained by survey. A good example is the work of Lovett *et al.* (Chapter 9) who model sustainable landscapes. Other applications may rely on survey for their data, but record and thus visualize less tangible phenomena such as annual precipitation levels, social conditions or urban land use (Moore, Chapter 18). Equally, a given construct can be based on 'non-tangible' information that does not derive from the

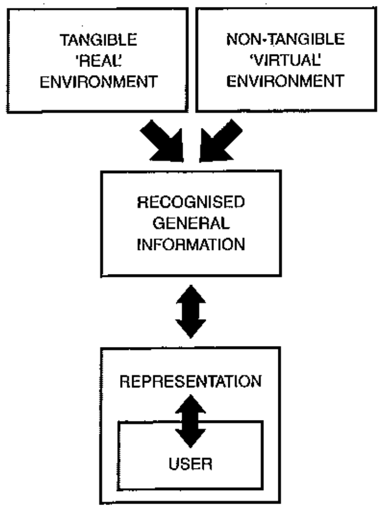


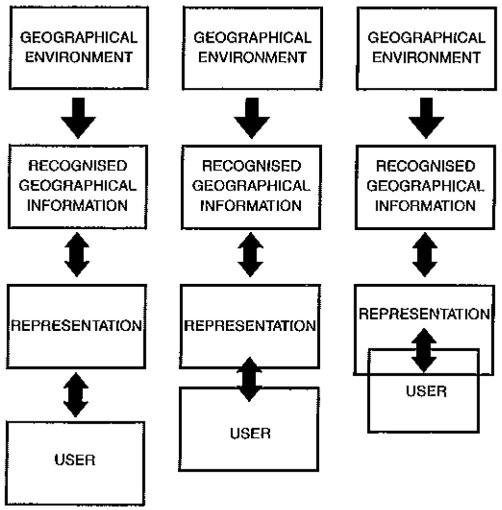
Figure 2.3 Applications can take advantage of a VR interface to present information that does not describe the physical environment of a real location.

physical world. In much the same way as a cartographer may seek to map out the fictional world of a novel, there are many instances where the virtual construct derives from the imagination, speculation or the realisation of abstract data spaces (e.g. Harvey, Chapter 22) as shown in Figure 2.3.

Taken together these factors go a long way towards explaining the diversity of definitions of VR the reader will encounter in this book. The framework outlined here allows a given VR representation to be defined and assessed not by any external criteria or pragmatic guidelines, but by its fitness for purpose. In this sense consider the following simple examples: the placement of a solid block in a simplified urban landscape; a series of geo-referenced images and linked data sets; and a simple series of coloured spheres that show rock types at different depths and locations. Each is as much an example of VR as a sophisticated reconstruction of a structure on a virtual brick-by-brick basis if it utilises spatial, real-world metaphors to enable the user to interpret the information by effectively engaging them with the representation. These examples might well enable residents visually to assess the impact of a proposed structure, students to learn about the geography of a region, and experts to identify geological structures from borehole samples.

As a result, rather than offering a single definition of VR, instead we propose a loose framework within which a series of task-specific

Gillings – Chapter 3



Transform 1

- Measurement and recording fragmentary material remains of the past using spades, trowels, total stations and cameras

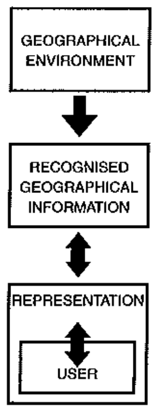
Transform 2

- Empiricist measurements are blended with dominant disciplinary views on topic enriched through informed speculation and opened to peer discussion

Transform 3

- Degree to which user collapsed with representation dictated by guiding purpose of simulation

Brodlie – Chapter 4



Transform 1

- CT Scan

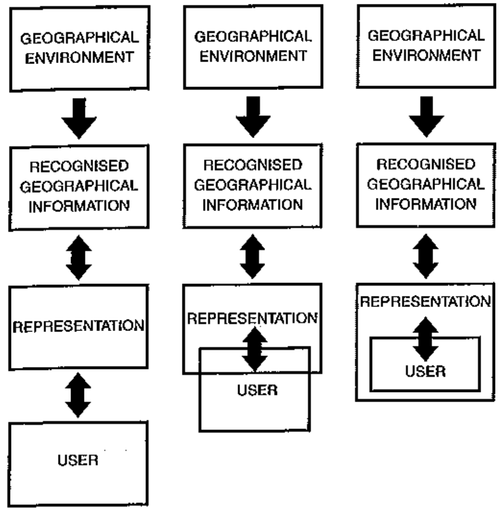
Transform 2

- Lagrangian Dynamics

Transform 3

- High and realistic levels of VR interaction with haptic feedback

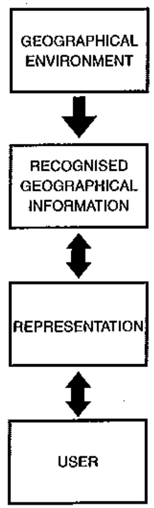
Kraak – Chapter 6



Transforms 2 & 3

- Development and use of tools for visual exploration to further understanding
- Schemas shown here represent plan, model and world views of data set
- Use of World Wide Web can increase accessibility and facilitate collaboration

Dykes – Chapter 7



Transform 1

- Survey
- Secondary data
- Camera
- Image stitching

Transform 2

- Photorealism
- Spatial affordances

Transform 3

- Low-level 'VR'

Figure 2.4 Task-specific trajectories through our framework for selected contributions.

trajectories can be identified. Although the basic framework remains the same in each case, the processes involved in negotiating the various stages, and the degree to which user and representation are effectively collapsed, vary. To illustrate this we have sketched out a number of trajectories linked closely to the case studies and discussions presented in the following section. In Chapter 3, Gillings assesses the development of VR models to help the interpretation of archaeological information from the perspective of process. In Chapter 4, Brodlie and El-Khalili introduce a series of scenarios requiring highly-realistic rendering, high levels of engagement and sophisticated forms of interaction between representation and user. Chapter 5 presents the results of a survey by Haklay of applications in geography that further emphasises the diversity of work in the field. Kraak's consideration of the use of VR for the visual exploration of geographic data in Chapter 6 identifies the plan, model and world views which relate to distinct trajectories within the framework. Finally in this section, in Chapter 7, Jason Dykes introduces a 'low-level' VR application that combines photographic imagery and spatial information to produce a photorealistic virtual environment with spatial affordances for use in supporting student fieldwork.

These are summarised in Figure 2.4, where in each case the processes involved in traversing the stages and the desired/required degree of collapse between user and representation are clearly indicated.

Issues in VR

It should be appreciated that the creation and use of virtual constructs raises a number of important issues. Some are negotiable, some intractable, but all should be considered explicitly when creating and using virtual constructs. The first is that of accessibility. Are VR simulations to be created on egalitarian principles and made as accessible as possible, using perhaps an open standard, such as VRML or Java, rather than limited through the use of proprietary software? Linked to this are a number of commercial issues and technological considerations ranging from the restraints inherent in current hardware and delivery strategies through to the thorny issue of technological determinism which levels the accusation that we generate VR models largely because we can, only then deciding what we can actually do with them. This is an issue that is tackled head-on by Gillings (Chapter 3) and is noted by Haklay (Chapter 5).

Looking at the VR models and environments themselves, we have a number of issues relating to the precise relationship that is claimed between a given simulation and the source reality it purports to represent. In effect this poses the question: what is the virtual component of any given virtual reality and what is the real? Despite considerable rhetoric to the contrary, the answer to this basic question is often far from self-evident. A number of navigational issues persist in multidimensional, complex spaces. Which users and which applications might benefit from limiting users in a virtual landscape to real-world navigation and movement? For example, this might be appropriate in the mountain navigation exercises described by Purves *et al.* (Chapter 13), whereas the ability to teleport and float around the virtual world might be appropriate in other circumstances (e.g. Dodge, Chapter 21). What is clear is that the increased complexity of our virtual simulations requires ever more elegant solutions to the problems of interactivity, sometimes incorporating projected presence. The final issue that needs to be highlighted is the lack of people in our often highly-sophisticated virtual simulations. Navigating a virtual construct can often be a ghostly and unsettling experience, yet the introduction of avatars and virtual inhabitants poses considerable technical and representational challenges.

Geography in VR

Up to this point we have been discussing VR as a tool, or approach, that can be used by geographers to undertake investigations or present information in new and often challenging ways. The discussion has been centred upon the explicit role of VR in geography. However, such an emphasis neglects a whole field of study opened up by the combined collapse of user and representation, and the gentle blend of tangible and non-tangible data sources. We can undertake geography in VR, with virtual constructs becoming the objects of study rather than mere heuristics. Such a re-orientation can already be seen in the work that has generated satellite images and demographic trend maps for virtual worlds such as AlphaWorld (Chapter 21). Sociologies, histories and archaeologies will no doubt follow!

Influencing reality?

The relationship between reality and a given construct and the resultant 'reality' or 'authenticity' of any virtual simulation is a topic that has generated much heated discussion. 'Virtual reality is as real as a picture of a toothache' (Penny, 1993: 19). It is discussed at length in a number of the chapters in this book. What has prompted less discussion is the impact VR constructs can have upon the reality from which they are derived. From discussions of the hyper-real, whereby the only reality at stake is that generated by the construct (Gillings, Chapter 3), through to the augmented reality applications (Cheesman and Perkins, Chapter 24; Jacobson *et al.*, Chapter 25), there are a growing number of applications where the virtual construct serves to enhance, if not define, the world traditionally thought of as 'real'. The developing fields of robotic and telepresence will undoubtedly serve to further develop this theme.

Conclusion

In seeking to introduce and associate the contributions to this section we have highlighted diversity as one of the defining features of the technology. Instead of a prescriptive straitjacket we outline a flexible framework within which applications of VR can be developed and identified in their contexts. What VR is has as much to do with what we do with it as it has with sterile computational or theoretical definitions. In saying this, a number of critical issues and limitations exist which researchers must acknowledge and address if VR is to have the impact on the discipline it deserves. The chapters in this opening section seek to highlight and explore precisely these issues.

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3 Virtual archaeologies and the hyper-real

Or, what does it mean to describe something as *virtually*-real?

Mark Gillings

Introduction

> At the time of writing, virtual reality in the civilian domain is a rudimentary technology, as anyone who has worn a pair of eyephones will attest. That the technology is advancing rapidly is perhaps less interesting than the fact that nearly all commentators discuss it as if it was a fully realised technology. There is a desire for virtual reality in our culture that one can quite fairly characterise as a yearning.
>
> (Penny, 1993: 18)

Over the last five years, the term 'virtual reality' (VR) has become ubiquitous within all aspects of contemporary western society, synonymous with a developing generation of photo-realistic and fully interactive computer-generated environments. VR models are being used in a bewildering variety of contexts: from analysing the effects of alcohol intake on the drivers of automobiles to training surgeons and astronauts; from calming nervous dental patients to creating utopian worlds within which individuals can socialise and gather (Brodlie and El-Khalili, Chapter 4; Kitchin and Dodge, Chapter 23). In this chapter I argue that despite this widespread and growing interest in VR, researchers and commentators have not yet begun to grapple adequately with the question: What does it actually mean to describe something as *virtually* real? It is my contention that until they do the unique potential VR has to change the way we approach, study and think about the physical world will not be fully exploited.

Academic disciplines have been quick to register an interest in these innovative new approaches. For example, my own discipline, archaeology, has been actively exploring the potential of VR since the late 1980s through a number of expensive and highly-sophisticated collaborative projects. These include IBM's work on Winchester Cathedral and Roman Bath and more recently English Heritage's much-publicised Virtual-Stonehenge (Burton *et al.*, in press). As early as 1991, a clear blueprint was laid down for the future realisation of what was grandly termed a 'virtual archaeology' (Reilly, 1991). In 1996 the first popular text on virtual