

A multi-methodological view for the collaborative design of virtual environments

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Abstract

This paper describes the methodological research deliberations that take place during the course of a collaborative project related to the design of Virtual Environments (VEs). This work describes the analysis of empirical and methodological views, found in the related literature, for the design of VEs while the paper's main purpose is to provide an up to date reflexive multi-methodological view that combines previous methodologies related to the project at hand and speculates on its use. This multi-methodological view identifies the different dimensions of an interactive collaboration among the variety of participants' roles during the design process as well as the recurrent reconsiderations of resources that emerge during the design process. From a consideration of these factors the paper attempts to provide a range of decision guidelines for VE designers.

Keywords: virtual environment design, multi-methodologies, collaborative design

1 Introduction

Virtual Environment Design (VED) is a diverse and complex process similar to any design activity. We argue that in order to deal with this heterogeneity, pluralistic multi-methodological approaches are needed rather than singular highly structured methods that constrain our practice (Mingers and Gill, 1997; Taket and White, 2000; Jackson, 2003). This work provides a brief history of empirical VED techniques and methodologies and draws particular attention to similarities with systemic methodologies as described by a number of researchers in the areas of Systems Design and Systems Thinking, Operation Research and Human Computer Interaction (Newman and Lamming, 1995; Sutcliffe, 1995; Wilson and Eastgate, 2002; Avison and Fitzgerald, 2003; Molina et al, 2005). The contrast of VED with the aforementioned approaches highlights an important gap in the methodological development of VED. While Systems Design history involves a diverse use of several multi-methodological approaches, VED lacks reflexive design methodologies and usually relies on empirical techniques and structured methods by identifying part of the design process. These usually involve systematic use of isolated views of software and/or hardware development techniques, user and/or task analysis, usability evaluation, user performance etc. (Smith and Duke, 2001; Wilson and Eastgate, 2002).

The second section of the paper outlines our theoretical standpoint and provides definitions for concepts related to VED. These include VEs and VED, iterative and collaborative design process, the VE designer and his/her related organisational context. We also provide an analysis of the historical categorisations and the research methods and methodologies that primarily assisted us for the construction of our dialectics. The third section provides a taxonomic view of

previous approaches in VED methodological practice according to the research literature of the last few years. In the last section we offer an example of a reflexive multi-methodological view of interactive collaborative design for VED.

2 Theoretical Issues and Virtual Environment Design Methodologies

Our theoretical standpoint for the understanding of methodologies exercised for VED is supported by the idea that “every theory must have an object of explanation an explanatory form, a method to relate evidence to claim, characteristic explanations within a scope of performance and a consequence value” (Anderson, 1996). To direct this belief for the examination of VED methodological conceptualisation, we opted to use the traditional, encompassing set of *ontology*: identify the objects of our analysis, *epistemology*: identify the nature of our knowledge regarding our ontological assumptions, *praxeology*: identify the ways we obtain that knowledge and *axiology*: identify what is the value of obtaining that knowledge (Anderson, 1996).

This theoretical position, outlined throughout the course of the paper, combines a set of epistemological ideas and makes evident the intention to achieve an explanatory form for VED methodological thinking and practice. These include, definitions for concepts related to VED (design, design thinking, VE) and methodology concepts, the historical categorisation given by Avison and Fitzgerald for the systems development methodologies (Avison and Fitzgerald, 2003), the multi-paradigm multi-methodological and critical pluralism of (Mingers and Gill, 1997) for intergrading a range of methodologies from different paradigms in the course of a particular intervention, the pragmatic pluralism of (Taket and White, 2000) to deal with variety at the praxeological level and to provide a postmodern critique on privileged methodological narratives that might emerge during the design process. This set of research positions provides us with a plural reflexive theoretical background for the elicitation of the methodological context for VED.

2.1 Virtual Environments and Virtual Environment Design

Virtual Environments in the domain of Virtual Reality are considered the designed, real-time computer generated, interactive, immersive and three-dimensional environments that try to produce to their participant users a synthetic sense of presence (from existence to symbiosis) in an alternative, simulated environment (real-like or fictional) with spatial characteristics, often by the use of specialised hardware (Steuer, 1992) (Heim, 1993) (Stanney, 2002) (Burdea and Coiffet, 2003).

The notion of VED is a twofold concept and in our understanding refers both to the design of VEs, and also to the underlying tenets and systems of beliefs that justify the methodological practices that support the processes of designing such environments (design and design thinking). Similarly to systems design and development, VED is a human activity where designers collaboratively learn and then adopt their plans in order to reflect upon their findings and previous experience (Stavrakis et al, 2007). As a result, methodologies may be adapted in response to the appreciation of a “specific task” and its defining characteristics. More generally, VED can be viewed as a situated perpetual and emergent activity the contingencies of which are always in a state of *différance* (differentiated and deferred) (Derrida, 1974). In this sense, the activity of VED is seen to take place within a socio-cultural environment of an emergent design team/organisation. It is defined as an iterative and collaborative design process where participants continually strive to redefine its form through reflexive redefinitions of their own activity representations (methodologies and practices).

2.2 The Designer in Emergent Virtual Environment Design Teams/Organisations

The VE designer is not to be considered as a singular entity, but a pluralistic heterogeneous participant acting within the aforementioned socio-cultural environment (Lacan and Fink,

2002). When we refer to VED teams as emergent organisations we are considering them, regarding their features, as continually emergent, following no predefined pattern. These organisational features are the products of a perpetual social negotiation and consent, rather than “consensus”, building. The organisation itself or any of its features may phenomenologically exhibit temporal regularities, but these are recognisable only by hindsight, because they are always in “a process of becoming” (Truex et al, 1999).

2.3 Paradigm, Methodology, Multi-methodology, Pragmatic and Critical Pluralism

According to (Mingers and Gill, 1997) “the term *methodology* means a structured set of guidelines for activities to undertake to improve the effectiveness of an intervention”... “...methodologies are based implicitly or explicitly on particular philosophical assumptions concerning the nature of the organisational world and the appropriateness of various forms of actions. These sets of assumptions form a particular view of the world that is sometimes called *paradigm*”. In the postmodernist camp (Taket and White, 2000) support that “The will to methodology is a moral obligation to acquire “reliable” knowledge and act to achieve practical ends in some defensible manner, the will to methodology thus implies a will to act.” Here they adopt the Nietzschean “perspectivism” where the external world is to be interpreted through different concepts and alternative systems of beliefs that there is no authoritative independent criterion for determining that one system is more valid than another (Nietzsche and Faber, 1994). This necessarily involves the problem of reflexivity and leads us to the argument that “anything goes”; a “will” which provides different possibilities of different truths (Mingers and Gill, 1997). But instead of accepting any methodology, this idea gives access to the formation of two interpretations for transfer to multi-methodology (Taket and White 2000): 1) Multi-methodology as another meta-narrative which serves as another version of “will to methodology” and 2) a strategic action of mix and match, a practice where we seek for guidelines, examples, stories, metaphors etc., for use in our intervention.

In pragmatic pluralism the use of methodologies is founded on the grounds of postmodernist and poststructuralist thinking where we “move away from prescription and seek to maintain an open flexible stance, capable of responding creatively to the characteristics of a particular moment, continually disrupting the comfort of identification with a fixed theory or view and seeking instead to mix different perspectives” (Taket and White, 2000). What they propose is the recognition of the following features: the use of triangulation (in terms of data sources, methods, analysis team), combining parts of different methods (or methodologies), being reflexive and adaptive, being critically reflective. In critical pluralism the vantage point is located at the dichotomy of 1) actual action within a problem situation and 2) critical reflection about the intervention determining the particular combinations of actions and methodologies that are employed (Mingers and Gill, 1997). Both Taket and Mingers identify that this intervention, or in our case “design and design thinking”, is a double concept involving action and reflection upon action by acting methodologically and reflecting upon produced meta-methodological narratives. This suggests that we design and we reflect upon our designs by “design thinking”, and we reflect upon our thoughts by combining knowledge from different, practices, methods, methodologies, disciplines.

In the following chapter we will review the practices of VED from empiricism to methodology use and post-methodology.

3 Four Eras of Virtual Environment Design Methodologies

The categorisation of (Avison and Fitzgerald, 2003) identifies four major eras of systems development methodologies, Pre-methodology Era, Early Methodology Era, Methodology Era, and Post-Methodology Era. In our view (influenced also by the categorisation of Information Technology that (Coyne, 1995) outlined as: conservative, pragmatic, critical, radical), these eras do not necessarily provide an evident historical viewpoint that is only justified in a sequentially

chronological order. These eras are not mutually exclusive, but are only used in this way to provide the central tendencies in systems development. Today, many of the VE designers blend various beliefs and practices from these periods.

In this section and for each era we also provide a limited number of examples that are considered representative.

3.1 Pre-methodology Era

The ontological assumptions of this era are concerned with the design of VEs deprived of any explicit or formalised development methodologies. The epistemological considerations are based on foundational ends of true knowledge from mere belief and singular reductionist understanding of the design process. Knowledge is assumed to have an end point from linear understanding and explanation of all known design issues. In this era of VED, knowledge is at the same time individuated, located at the mind of the expert designer, and transcendently authentic. Knowledge related to the design of VED is gained through assumptions of instrumental use of empirical and scientific ideas. This foundational knowledge is often subjectively driven and does not emerge from a collaborative design activity among members of a VED community. The designers are mostly programmers that specialise in solving practical problems and experimenting with a variety of technical issues. The axiological arguments give emphasis in evaluating the techniques and procedures used for solving technical problems.

Examples: Because the nature of building VEs in this era is highly empirical not many documented practices are available. The first documented examples of VED in this era appear in the works of (Kim et al, 1998; Smith and Duke, 2001). In these first attempts to design VEs the design process was empirically concentrated around the following issues: 1) Identify the Design requirements and then 2) focus in producing and evaluating software tools. Emphasis was given to the development of the software tools rather than the design process and in most cases it was considered equivalent to the VE itself. In both cases, the researchers focused in dealing with technical issues related to VR applications and their development. It is also true that the notion of VED was at its infancy so most of the “designers” were programmers experimenting mostly with technical challenges.

3.2 Early-methodology Era

The ontological assumptions of this era are concerned with the design of VEs but also identify the need to manage the way of designing because of the complexity of the VED projects. The epistemology is focusing on controlling design processes in terms of design methods and is driven by the need to manage the increasingly intricate design requirements. The effort in this era is concentrating in developing structured design methodologies by identifying phases in VED that will lead to better management of the development process. Commonly known as the “waterfall model”, these methods consisted of a number of development stages that had to be followed in sequential order. These included feasibility study, system investigation, analysis, design, development, implementation and maintenance. The axiology in this era considered the reduction of complexity as the primary aim and ignored the evaluation of the structured method that was used. Because of this practice serious problems emerged that were observable in the highly conservative designed VE. These included similar traps to the ones mentioned in (Avison and Fitzgerald, 2003) regarding systems design; failure to meet the needs of the client (purpose), conservative VEs due to reuse of previous versions, instability, inflexibility, user dissatisfaction, problems with documentation etc.

Examples: Creating VEs in this era is primarily a process of using well known practices and considering them as highly structured methods that will fulfill the designers’ needs. Typical examples of these practices can be found in the works of (Ellis, 1991; Thalmann, 1994) regarding environment design and in the works of (Bordegoni, 1993; Herndon et al, 1994)

regarding interaction design. Both outlined the steps that they followed in their works. For environment design they suggested: the background space or geometry, the user avatar, virtual agents or virtual actors and objects that populate the background space. In terms of interaction design: navigation and viewpoint control, object interactions (picking, grabbing, rotating and moving objects), manipulating objects to change their state and querying to find out the content of an object. Another source of early methodological VED is evident in the manuals of software for VED. For example, according to (Molina et al, 2005), EON Reality (Eonreality, 2005) suggested that building virtual worlds with EON Studio is as easy as performing three steps: 3D modelling in a third party modelling software, exporting geometry to VR authoring tool, program interaction. Our experience with that tool and other similar ones confirms that this is not enough.

3.3 Methodology Era

The ontological assumptions of this era are concerned with the design of VEs and also identify the need to manage the way of designing, but primarily focus to analyse the restrictions posed by structured methods. Knowledge in this era is related to a better understanding of methodology conceptualisation and use, and assumes that structured methodologies that are constraining the design process should be replaced by reflexive ones. The praxeological interest in this era is focused in developing and evaluating methodologies. The belief that one methodology is ever able to provide the means of reducing complexity is dismissed and replaced by the idea of holistic design where methodologies are continuously refined. Methodology is a collection of scientific concepts imported from different disciplines and for the first time in VED history, user involvement is considered necessary for the continuous evaluation and development of the VE. The axiological arguments give emphasis in evaluating new concepts for inclusion or exclusion from the specific methodology and what is considered important is the enrichment of the methodology. This often led to inoperative complex methodologies that became unusable because of information overload and unrealistic appreciation or inability to follow of their guidelines.

Examples: The methodology era is the most prolific era in terms of epistemological thinking for the design of VEs. A large number of researchers and VE designers focused in analysing both empirical design practices and design thinking. Kaur was one of the first researchers that focused in developing a holistic methodological view of VED (Kaur, 1998). In her PhD thesis, she outlines three main areas that VED should look at in terms of usability: *Development Activities* (requirements specification, system design, interface design, implementation, evaluation), *Classes of VE* (single-user, multi-user, real-world model, desktop, abstract, immersive, augmented, projected), *Design Considerations* (usability, cost, ergonomics, reliability, utility, health & safety, motivation). Based on this idea, Kaur provides a reflexive theoretical model that VE designers can employ to effectively produce and mainly evaluate VE for usability. Another example is VEDEF (Wilson and Eastgate, 2002) which provides a structured systematic framework for the design of VEs. Its main focus is to aid designers by “defining what issues are relevant, what data and information are needed and what decisions must be made at what stages, and how these stages interconnect, including feedback loops”. Fencott introduces a methodological view that stresses two important factors for the design of virtual environments, the aesthetic notion of designing VEs to create the desired perceptual responses and the engineering notion of design as the creation of plans and models from which to build and test the desired outcome (Fencott, 1999). Based on Kaur’s introductory observations, Fencott develops an equivalent circular nonlinear methodological viewpoint outlined in the following steps: requirements modelling, conceptual modelling, perceptual modelling, structural modelling and building. The VRID methodology (Tanriverdi and Jacob, 2001) supported by the VRID model proposes two levels/phases for designing VEs according to

the observation that the methodological challenges for designing VEs are a) thinking comprehensively about the overall design, b) decomposing the design task into smaller conceptual distinct tasks and c) communicating the structure of the design to software developers. The first level (High-level) consists of three major steps: identifying data elements, identifying objects, modelling objects (i.e. graphics, behaviours, interactions, internal communications, external communications). The second level (Low-level) retrieves data from the previous level and builds/models the specifications of the sub-components of the modelling objects. The TRES-D methodology (Molina et al, 2005) is an iterative and incremental development approach that focuses to be adapted in a variety of different VE developments. TRES-D relies on iterative activities that try to define the variety of designers' roles that are involved in the design process, the tools to carry out the activities and the principles and guidelines to help developers complete these activities. They distribute these activities around a set of stages: initial requirements, understanding requirements, concept design, iterative design building and implementation and deploy and maintenance. Gabbard presents a structured iterative methodology for user-centred design and evaluation of VE user interaction (Gabbard et al, 1999). This methodology is based on sequential performing of 1) user task analysis, 2) expert guidelines-based evaluation, 3) formative user centred evaluation and 4) summative comparative evaluation.

3.4 Post-Methodology Era

The ontological assumptions of this era are concerned with the design of VEs, but primarily focus on the appropriateness and usefulness of the adoption of methodologies (as described in the previous eras) altogether. The epistemological position of this era supports that knowledge (based on hermeneutics and phenomenology) is addressed through the acceptance of the idea that "one methodology is not enough". By adopting a single methodology, knowledge is restricted and as a result the design of VE is considered inflexible in the presence of underlying issues that emerge during the design process. The praxeological argument is mainly directed towards a critical stance and against unitary methodological positions, supports pluralism and critical thinking and favours multi-paradigm multi-methodological practice within any intervention. The axiological arguments of this era hold that methodologies and knowledge construction are only useful at particular situations and try to diminish their superfluous rationality.

The post-methodology era is characterised by diversity in the methods employed. Many researchers and VE designers abandon methodologies altogether and return to a different version of a "pre-methodology era". They perceive VED as a fragmented domain where specific sub-domains emerge and produce new tasks of accomplishment (user interface design in VEs, context design, artificial life in VEs etc.). A method for the successful VED is considered a messianic "promise" that can never be known objectively. An example that tries to combine multiple methodologies and worldviews in the specific area of user interface 3D design for VEs, is the work of (Bowman et al, 2001). In their work they collect information from a multidisciplinary context and then they propose a philosophy for designing part of a VE; in their case the interface of VEs. Their philosophy is twofold, "artistic" -in the sense of guideline documents, user interface software tools, expert review and usability testing- and "systematic" - a methodical approach by a study of user tasks, existing interaction techniques, and characteristics of the user, environment or system.

Another example that provides evidence for the fragmentation of the VED community in the post-methodology era can be found in the various review books that try to provide a "complete" picture of the situation in the domain. For instance in (Stanney, 2002) we see that attention is paid to a wide range of areas related to VED. Stanney, following (Durlach and Mavor, 1995) supports that a number of areas are considered to play an important role in the design of VEs;

these include human factors, technological, psychological and evaluation issues. In the course of the book we identify that a number of other design issues emerge relatively to the project at hand (especially in the area of VE application description) that motivate designers to involve paradigms from other cultural domains in the VED process. Although that the above fragmentation provides a plural picture relatively to the state of affairs in the VED community, we argue that there is no “holistic” methodological view that tries to re-establish a way that designers should act in order to think and organise their work in terms of VED. We have found no research work on developing reflexive, multi-paradigm, multi-methodologies that try to inform an interventionist approach that will focus to assist the emergence of autonomous design organisations that deal with VED. We conclude by illustrating a pluralistic and pragmatic viewpoint related to VED.

4 A Multi-methodological Approach for Virtual Environment Design

Our aim is to present a framework for intervening which is inspired by critical and pragmatic pluralism (Mingers and Gill, 1997) (Taket and White, 2000). The situation of intervention in VED is envisaged as follows. A designer or a team of designers (namely an organisation) will commit themselves in trying to deal with the diversity and heterogeneity that abound in the multiagency setting of VED. The focus is concerned with the exploration of three overlapping questions (what is to be done? how shall we decide what to do? what can guide our actions?). The use of multi-methodology lays on the designers, the methodologies and techniques available. Thus the multi-methodological context can be described according to three notional systems and their relations:

- Design system: designers, facilitators, participants
- Intellectual resources systems: techniques, methodologies, theories
- Situation representation system: situation, “problems space”, purpose / objectives

The relations of these three domains constitute the context at the point of engagement in an intervention of VED. Here we provide an example of relevant questions for each relationship that can inform designers for the development of their own multi-methodological view (Mingers and Gill, 1997):

1. Relations between designers and intellectual resources:
 - a. What is the designer’s level of critical awareness and understanding of the potential resources?
 - b. What is the designer’s experience and skill in employing those resources?
 - c. What is the designer’s personality / cognitive style comfortable with?
 - d. To what extend can the designer perform in different paradigms?
 - e. To what extend the designer fills comfortable with the values implicit in particular methodologies?
2. Relations between designers and situational representation:
 - a. What has initiated this engagement?
 - b. What is the designer’s history of interactions in regard to this situation?
 - c. What are the designer’s commitments to other participants in the situation?
 - d. What are the characteristics of the situations owners? Who are they?
 - e. What are the designer’s expectations about his own role?
 - f. What resources are available?
 - g. From where the designer gains his influence?
3. Relations between intellectual resources and situation representation:
 - a. What is the culture of the organisation / situation with regard to methodology use?
 - b. What methodologies have been used?
 - c. Which methodologies seem useful for the current situation?

d. How suitable are the methodologies for this situation?

Most important are the questions that relate among the aforementioned relations. These include:

- (1)-(2): e.g. what the designer might be able in this situation?
- (1)-(3): e.g. what methodologies might be relevant to this situation?
- (2)-(1): e.g. what well known methodologies might be useful? What the designer might have to learn?
- (2)-(3): e.g. what methodologies may or may not be seen as legitimate here? What methodologies have they experienced?
- (3)-(1): e.g. will the designer's experience allow the use of a particular methodology here?
- (3)-(2): e.g. does the designer's history with this situation suggest particular methodologies?

This example can lead the VE designer to the creation of a more formalised version of a VED methodology. In conjunction with structured methodologies the above example can provide information at various levels, components or processes. For instance, it can work complementarily and describe the preparation phase (i.e. application goals, domain needs, VR attributes, alternative technologies and constraints), analysis phase (i.e. functional location, application task analysis, user needs and characteristics), specification phase (i.e. VE goals, concept design, resource acquisition and virtual task analysis), building phase (i.e. VR system configuration, VE appearance, cues and feedback, VE building and testing), implementation phase (i.e. VE use, tasks in the VE, circumstances of views, user performance) and evaluation phase (i.e. user experience, usability, attitudes and side effects) described in (Wilson and Eastgate, 2002).

5 Conclusion

The work presented in this paper is a framework of reflexive multi-methodological search. This framework does not provide a final solution or a methodological metanarrative, but encourages an iterative participant discourse towards the improved understanding of design thinking for VED. In this work, we have shown one example of multi-methodology in practice without profound formalisation. Our future plans include the illustration of case studies that we currently undertake, in the area of VED.

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