# Is a Picture Worth a Thousand Words? An Investigation into the Validity of 3D Computer Landscape Visualizations in Urban Planning

by

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## Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

## Abstract

This study examined the use of computer visualizations in urban planning and whether they facilitate effective decision-making and communication within community engagement. The objective was to determine the potential for the human element in the visualization process to impact the public's evaluations of a future landscape. A response equivalence experiment was performed that compared evaluations based on actual urban landscapes to those based on accurately prepared, as well as intentionally persuasive, visualizations of the same landscapes. To ensure the persuasive visualizations assessed were akin to those used in practice an investigation of procedures and professional attitudes regarding visualization use was carried out, including surveys of municipal planning departments and key-informant interviews with visualization preparers. Results from the response equivalence analysis show that a visualization preparer can positively influence preferences for an urban park or mixed use streetscape by using subtle techniques that enhance the aesthetic appearance of the virtual environment. These same techniques also have a considerable impact on aspects of landscape perception such as maintenance, safety, social inclusiveness and place identity. Findings indicate that qualitative instruments are necessary for measuring response equivalence as social aspects of landscape perception are important to the validity of simulations. Finally, it is argued that the current context of visualization use in planning practice is a threat to legitimate public engagement and the health of stakeholder relationships. A two pronged approach to effective visualization use is proposed, suggesting equal emphasis on changing professional attitudes toward the technology and creating a public with a deeper understanding of the visualization process.

# Acknowledgements

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# CHAPTER 1: INTRODUCTION

## 1.1 Information and Urban Landscapes

The urban environments that house the majority of the world's population are a complex fabric of information waiting to be perceived and interpreted, yet the wealth of information contained by the average city is now so rich and diverse that comprehending discrete messages in the landscape is no longer possible using innate perceptual mechanisms alone. This problem of information overload has become so pervasive in contemporary cities that some have even suggested our ability to function in an urban setting now requires not only the full operating capacity of our five senses, but also a suite of behavioral adaptations that can reduce the stress of navigating these elaborate systems (Milgram, 1970). Given the complexity of contemporary cities it is not surprising then that planners are perpetually searching for new tools to communicate and analyze urban issues more effectively and comprehensibility. Moreover, in the context of Canadian planning practice the need for efficient communication methods is intensified by legislation that mandates public engagement across a range of scenarios; including everything from municipally driven community visioning exercises to development applications put forward by the private sector (Ministry of Municipal Affairs and Housing, 1990). The rapid proliferation of three dimensional (3D) computer landscape visualizations (heron referred to as CLVs or simulations) in planning practice has thus been hastened by the discipline's desire for a communication strategy that presents complex issues in an understandable format that is more akin to the daily experience of the average urban dweller (Paar, 2006).

## 1.2 Current Research on Computer Landscape Visualizations

Findings from nearly three decades of landscape visualization research agree that the computerization of visualization methods has produced a suite of tools and techniques that are better suited to increasing comprehension, participation, and consensus within a decision making process (Al-Kodmany, 1999; Al-Kodmany, 2002; Hamilton, Trodd, Zhang, Fernando, & Watson, 2001; Pietsch, 2000). This breadth of research has also generated numerous attempts to classify the many forms of CLVs used in planning today, with aspects of realism, interactivity, immersion and abstraction consistently arising as the most important variables used to structure such frameworks. Interestingly enough, while academic research has been obsessively focused on the progression of the technology, seeking the perfect combination of the elements just mentioned, the transition of simulation software from early photo-manipulation (Orland, 1988; Schroder & Orland, 1994; Sheppard, 1989; Vining & Orland, 1989) to true 3D vector based modeling (Lafortezza, Corry, Sanesi, & Brown, 2008; Laing et al., 2009; Lewis, 2008) has been attributed to advancements made by the military and entertainment industry, rather than the academy (Sheppard, 2001). As a consequence of this technical thrust research on CLVs over the past three decades can be broadly grouped into two distinct themes. The first theme has emphasized the need for more realistic, immersive and interactive CLVs, and champions the development of new tools or techniques (Bergen, McGaughey, & Fridley, 1998; Brown et al., 2006; Crawford, 2006; Danahy, 2001; Donaldson-Selby, Hill, & Korrubel, 2007; Ghadirian & Bishop, 2008; Hamilton et al., 2001; Hanzl, 2007; Huang & Claramunt, 2004; Muhar, 2001; Paar, Rohricht, & Schuler, 2008; Stock & Bishop, 2006; Von-Haaren & Warren-Kretzschmar, 2006; Williams, Ford, Bishop, Loiterton, & Hickey, 2007; Zhou, Tan, Cen, & Li, 2006). Conversely, the second theme has sought to illustrate the breadth of benefits that can be realized by applying existing tools to communication and decision-making situations (Dockerty, Lovett, Appleton, Bone, & Sunnenberg, 2006; Dockerty, Lovett, Sunnenberg, Appleton, & Parry, 2005; El-Araby & Okeil, 2004; Jude, Jones, Watkinson, Brown, & Gill, 2007; Lafortezza et al., 2008; Lange & Hehl-Lange, 2005; Lange, Hehl-Lange, & Brewer, 2008; Lewis & Sheppard, 2006; Pullar & Tidey, 2001; Sheppard, 2005a; B. Tress & G. Tress, 2003; Wang, Li, Sun, & Meng, 2008).

Although the themes discussed above have formed the primary research agenda of CLVs to date there has also existed a small but consistent voice in the literature that has cautioned against the unfettered use of CLVs in decision-making processes. The most common concern voiced is that simulations may evoke different perceptions from the public than the actual landscapes they are trying to represent, rendering opinions formed in response to them invalid and damaging to attempts at genuine public engagement (Appleton & Lovett, 2005; Ervin, 2001; Orland, Budthimedhee, & Uusitalo, 2001; Neto, 2001; Sheppard, 1989; Sheppard, 2001). To clarify, when used in this context the term invalid refers to a very specific concept from the field of environmental psychology, wherein 'representational validity' (or response equivalence) is "the extent to which landscape perceptions, preferences and/or judgments based on photographs o*r simulations* correspond to responses elicited by direct experience with the landscapes nominally represented” [*italics added*] (Daniel & Meitner, 2001, p. 62). In addition to being an important consideration in the study of human-environment relationships, this concept is also crucial to the current use of CLVs in planning practice as a decision based on a simulation may be illegitimate if the simulation does not elicit valid emotional and cognitive responses from the decision maker (e.g. member of council). The consequences of using invalid CLVs to make important decisions about a future landscape can thus be quite serious, although practice has arguably failed to recognize this fact. Alternatively, in the academic world the representational validity of various computer-based visualizations has already been the subject of a small number of studies that have examined the phenomena in a variety of environmental settings. Interestingly, while levels of reported response equivalence have varied across these studies the general attitude toward the use of simulations with the public has been largely supportive of the tools application (Appleton & Lovett, 2005; Bishop & Leahy, 1989; Bishop & Rohrmann, 2003; Bergen, Ulbricht, Fridley, & Ganter, 1995; Oh, 1994; Stamps, 1993; Wergles & Muhar, 2009).

## 1.3 Thesis Context

The need for a constant critical review of CLV use in decision-making processes becomes most apparent when one considers the highly influential nature and rapid evolution of contemporary computer visualization technology, which has undergone a drastic transformation since the early 1980s. As applications like Google Sketchup and Artlantis have made the creation of photorealistic CLVs more technically and financially viable a wider range of planning professionals have been able to tap these powerful tools, producing a new legion of self purported visualization experts. The unfortunate reality, however, is that computer based techniques have been adopted within the discipline in such an informal fashion that these same practitioners often lack any recognized training in visualization preparation, and posses little understanding of a simulation’s impact on the public’s perceptions of a landscape (Sheppard, 2001). The importance of this as far as the discipline is concerned is that proposed projects are now visualized and communicated not only by skilled, neutral third parties, but also by ‘inexperienced, slipshod or crooked’ individuals who are financially and emotionally invested in the success of a project (MacFarlane, Stagg, Turner, and Lievesley, 2005; Sheppard, 2001). What is worrisome is that these types of preparers are likely to develop simulations based on improper data or careless procedures, yielding inaccurate results. Worse still, the direct financial or emotional motivation to see a project succeed can prompt the use of persuasive visualization tactics that unjustifiably enhance the appearance of a future landscape by using flattering viewing perspectives, exaggerated vegetation, or overly entertaining media such as animations; to name only a few. Moreover, while such tactics are often a marketing based attempt at quelling public opposition, their use is usually justified on the basis of an artistic license that is apparently bestowed when one purchases CLV software. Ultimately the ability of these individuals to have complete control over the representation of their projects will damage the long term credibility of computer based visualization (Bosselmann, 1998), as they possess the motivation to sell a product to the public but not the skill or desire to represent it accurately and ethically.

It is likely becoming evident that this research deals with the impact of persuasive visualization techniques on the public's ability to validly assess a proposed project or landscape. However, amid the theoretical discussion that follows it is important to remember that when attempts to undermine public opinion enter the arena of planning practice the stakes are anything but theoretical. For instance, contrary to the claim that CLVs are a conduit to consensus in public engagement (Hamilton et al., 2001), implying an unforced search for the public good (Healy, 1997; Innes, 1996; Innes, 2004), when misinformation is employed simulations can obscure contentious elements of a project and unjustifiably sway individual and group attitudes toward a planning initiative (Neto, 2001; Neto, 2006; Wergles & Muhar, 2009). When used in this manner it is questionable whether CLVs really support the goals of public engagement as outlined in the planning literature or the disciplines code of practice (Arnstein, 1969; Canadian Institute of Planners, 2004; Innes & Booher, 2004), or whether decisions made in such an atmosphere are merely a predetermined result arrived at through coercion.

Since computer based visualization is still relatively new within public engagement processes deliberate attempts at persuasion or unintentional inaccuracies can often go unnoticed within a single public meeting, or even the course of a longer public engagement program. Still, as time goes on a development that was sold on misinformation will begin to take concrete form, and the public will likely take exception if the physical and social impacts of a project fail to meet the expectations that developed through exposure to a utopian vision that was never attainable as a reality. While this outcome is clearly unacceptable from an ethical standpoint, in a practical sense a continued string of similar events could create a public that is skeptical of CLVs in general, negating any communicative benefits that could have otherwise been realized through their use. Furthermore, there is no guarantee that this skepticism will not transfer from the technique itself to the preparers of the simulation, fostering mistrust between local stakeholders and further damaging the already tentative relationship between the public and planning professionals (Forester, 2006). Finally, there also exists a very real potential that discrepancies between simulations and reality could lead to litigation if misinformation is deemed to have been taken too far and practitioners are found to be in breech of professional conduct (Chenoweth, 1991; Lange, 2005). Indeed this very situation has already arisen in Spain, where Greenpeace was sued by local landowners in response to inaccurate simulations of rising sea levels that were argued to have reduced local property values (Shaw et al., 2009).

In addition to potential distortions within individual public engagement exercises, there also exist broader disciplinary implications to the expansion of CLV use in planning practice. Even though many of the financial and technical barriers to producing CLVs have been lowered due to the introduction of programs like Google Sketchup, visualization tools are still beyond the reach of many members of the public. This means that those with access to the necessary knowledge and software (usually planners or developers) have an informational advantage in the planning process (Sager, 1994). In essence this provides these stakeholders the ability to discredit the public's claims about a future project not because their analysis is more certain, but simply because they are the only parties who can present their argument in a highly influential manner (Luymes, 2001). In this sense access to visualization skills and technology may even provide certain groups the power to unilaterally define what information is legitimate to a given decision, further entrenching the power imbalances that are the legacy of comprehensive planning and its instrumental rationality (Forester, 1989; Forester, 1999; Hudson, 1979; Sager, 2006).

Thankfully many adept and ethical visualization preparers do exist, and hopefully these practitioners will set industry standards for CLV use in the future. That said it is safe to assume that the public will be unlikely to remember these individuals, but rather those who promised perfection, but delivered mediocrity. It is therefore based on the slipshod preparers that the public will judge CLV use in the future, potentially placing the benefits of simulation use at the mercy of distrust triggered through experiences with only a few poorly prepared products. This author thus suggests that while CLVs may offer many short-term benefits to public engagement, a deeper understanding of their influence on preferences and perceptions is a pre-requisite for their long-term employment in real world contexts. Since planning does not operate in a vacuum that is free from sources of bias like accidental mistakes or intentional persuasion, it is also fair to assert that this understanding will require an explicit focus on the role of the simulation preparer (Sheppard, 2001). Unfortunately while this fact was also noted over 20 years ago when Sheppard (1989) provided five principles for the unbiased preparation for CLVs, no attempt to date has been made to quantify the impact that biased simulations can have on the public's evaluations of a landscape.

## 1.4 Research Objective and Research Questions

Given the current state of knowledge there are two reasons the proposed research is necessary. First, the few representational validity studies that have assessed CLVs have focused mainly on natural areas, leaving the urban context largely unaddressed. Second, existing representational validity studies have compared visualized and real landscapes under conditions where the CLVs being assessed were *calibrated* by expert preparers to represent the actual landscape as accurately as possible. As such research to date has primarily evaluated the technical limitations of various CLV tools, rather than the preparer or the visualization process. An exhaustive literature review was unable to find any study that has investigated the alternative, where the focus is directly on a comparison of the CLV development process. Adopting this focus not only shifts the assessment from the technology to the human element (i.e. the CLV preparer), but also addresses surrogates that are more akin to those used in professional practice where tactics are often used to *bias* public opinion (Lange, 2001; Sheppard, 2001; Sheppard, 2005).

The objective of this study is therefore to explore whether the process used to develop CLVs can influence the public's preferences and perceptions of an urban landscape. More specifically, this research compares two sets of simulations that were created following two distinct processes common to urban planning practice: simulations developed paying careful attention to accuracy and representativeness (i.e. *calibrated*), and simulations developed with an intentional attempt to positively persuade the public's opinion of a project (i.e. *biased*). Using a mixed methods response equivalence design the public's preferences for three types of visual representations (photos, calibrated CLVs, and biased CLVs) are compared for twelve scenes representing two separate urban environments. Similarly, perceptions of the scenes are compared for the three representation types using semi-structured depth interviews that probe into the reasons for participant's preference choices. The specific research questions that address this research objective are:

1. Do *calibrated* 3D computer landscape visualizations of urban environments elicit similar landscape **preferences** from the public as views of the actual landscape?
2. Do *calibrated* 3D computer landscape visualizations of urban environments elicit similar landscape **perceptions** from the public as views of the actual landscape?
3. Do *biased* 3D computer landscape visualizations of urban environments elicit similar landscape **preferences** from the public as views of the actual landscape?
4. Do *biased* 3D computer landscape visualizations of urban environments elicit similar landscape **perceptions** from the public as views of the actual landscape?

## 1.5 Thesis Organization

The remainder of this thesis is organized into four chapters. Chapter 2 provides a literature review that briefly discusses the history of landscape visualization, the technical structure of the most common form of CLV used in planning practice today, as well as current research on the application of CLVs in planning and decision-making processes. Because Daniel and Meitner's (2001) definition identifies both perceptions and preferences as key indicators of response equivalence, Chapter 2 also outlines theoretical perspectives of landscape perception, as well as research on landscape preference. Chapter 3 discusses the methodological approach that was followed to create the CLVs used in this study, as well as the process that was followed to assess their validity. Chapter 4 begins by presenting a diagram that uses the in-depth interview data to illustrate how the visualization techniques used in this research impacted landscape preference. Chapter 4 then presents results from the quantitative response equivalence analyses of each environment and discusses these results in light of the qualitative data and body of existing research. This chapter concludes by revisiting the qualitative data in a discussion of how certain visualization techniques impacted specific aspects of landscape perception. The thesis concludes with Chapter 5, which outlines the implications of the study's findings given the current context of CLV use in planning practice.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Landscape Visualization in Retrospect

The visualization of our lived environments has been a preoccupation of the human species for millennia, and in its purest sense visualization dates back over 30 000 years to the first charcoal drawings etched onto stone walls by our ancient ancestors. More practically, the concept and practice of contemporary visualization in landscape design is largely a product of advancements in the artistic and scientific representation of places that occurred throughout the 15th and 16th century. For instance, Filippo Brunelleschi's (1377-1466) perspective 'peephole' experiment allowed him to execute a portrayal of the Baptistery San Giovanni di Firenze in perfect linear perspective and was the first introduction of a vanishing point to perspective representation, although the exact method he used is still speculated amongst art historians (Bosselmann, 1998). Following Brunelleschi's experiment Albrecht Durer developed an introductory manual of geometric theory that included the first integration of perspective and scientific method by a Northern European Artist (Lange & Bishop, 2005). Together these advances set the ground work for contemporary photography, cinematography and the visualization of landscapes using familiar perspective views.

Another important development of the 16th century was the production of the first highly accurate plan view of a city landscape. In this innovative representation Leonardo de Vinci visualized the small Italian town of Imola in a fashion that is considered to be one of the earliest attempts at a modern city plan. In subsequent work Leonardo was tasked with design repairs to the city's fortifications, producing the need for plans that were not only based on a landscape that did not exist, but that also required an accurate geometric representation of space. Leonardo's fortification plans blended true conditions with proposed changes in a geometrically precise manner and were a significant departure from the iconographic representation of city form that was prevalent at the time (Bosselmann, 1998). Although the representations were still abstract in nature, this break in tradition signifies an important advancement in visualization preparation, as it is one of the first instances where accuracy was explicitly incorporated in a visualization process.

Throughout the 18th century Humphry Repton honed these early visualization techniques by applying them to design issues at both the site and landscape scale. In his Red Books Repton meticulously presented design changes using highly relatable perspective views, and by using these views to create a 'flip book' of existing and proposed conditions he was able to communicate his designs in a more interactive manner that is not entirely unlike the effect of using animations today (Lange & Bishop, 2005). The body of Repton's work laid the way for 19th century English landscape architecture, essentially setting the foundation for much of the experience based design of cities that is common in North America today (Bosselmann, 1998).

As one of the most significant events in landscape design to occur in the 20th century, the passage of the 1969 Environmental Policy Act made funding available for basic environmental assessment research, with the focus being a deeper understanding of the visual qualities of cities and the country side. By the early 1970s this funding was already being put to broad scale use, affording Donald Appleyard and Kenneth Craik the opportunity to build the Environmental Simulation Laboratory at the University of California Berkeley. The research team built scale models of streets, neighbourhoods and cities, and used a computer controlled camera on a gantry system to capture videos of the simulated landscapes. While the models themselves where physical in nature, the use of a computer to control the camera system was one of the earliest integrations of computer technology and visualization techniques, arguably making it the origin of contemporary computer based visualization (Bosselmann, 1998). The video capture technique was innovative for the time, but because it required numerous cinematographic experts and was exceedingly expensive, this early CLV system was not put to practical use until 1979; a full five years after research established it as a reasonably valid representation of reality (Ibid.).

Shortly after Appleyard and Craik's pioneering work significant increases in computing power negated the need for expensive physical models and cumbersome gantry based camera systems, with the early 1980s marking the full computerization of simulation techniques. Throughout this period physical models began to give way to digital relief models draped with orthophotography, as well as digital photomontage techniques which were actually more prevalent at the time (Pietsch, 2000). As the military and the gaming industry continued to drive the development of CLV technology, vector based models textured with photographic or fractal textures became the industry standard (Sheppard, 2001), and by the mid 1990s vector based techniques had gained enough prominence to elicit the first study of their validity as environmental surrogates (Oh, 1994). Since that time similar vector based simulations have dominated research on place representation, although their actual structure has undergone a drastic evolution. Increasingly powerful graphics platforms have provided the ability to visualize hypothetical landscapes with incredible levels of realism, in some instances to the point where they are nearly indiscernible from the real world. The seemingly unrestrained growth of computing power has also allowed the introduction of a fourth dimension (i.e. time) to CLVs, wherein thousands of rendered images are sequenced together to produce an animation of a completely synthetic landscape. By introducing this fourth dimension to simulation techniques animations have produced a medium that is much more interactive, as the viewer's dynamic visual experience is more akin to that of the real world (Bishop & Rohrmann, 2003).

Most recently the attention of CLV research has turned to the investigation of highly interactive virtual (VE) and augmented (AE) environments, which fully immerse an individual in a synthetic landscape, or hybrid synthetic/real landscape in the case of AEs. These burgeoning visualization systems use display devices that can be traced back to Ivan Sutherland's early work on immersive environments and in combination with a number of peripheral devices they allow an individual to perceive a synthetic environment with all five senses, although the visual, auditory and tactile senses are the most common targets (Bishop & Lange, 2005). By coupling immersive visual displays with other means of environmental perception, AE and VE systems are truly blurring the line between experiences in real and synthetic environments.

Starting with early photo manipulation tools, Figure 2.1 presents a recent history of research on computer based visualization and contrasts the level of interactivity and realism that various systems are capable of. It is important to note that throughout this history the practical application of visualization techniques in the field of planning has lagged behind their research, which is interesting since the evolution of landscape visualization has been driven by the private market and the government, not academia (Sheppard, 2001). As a brief example, while the current research focus is quickly shifting towards more interactive and immersive technologies (i.e. VEs and AEs) the use of CLVs in practice is for the most part just beginning to bridge the gap between static and dynamic (i.e. animations) vector models.

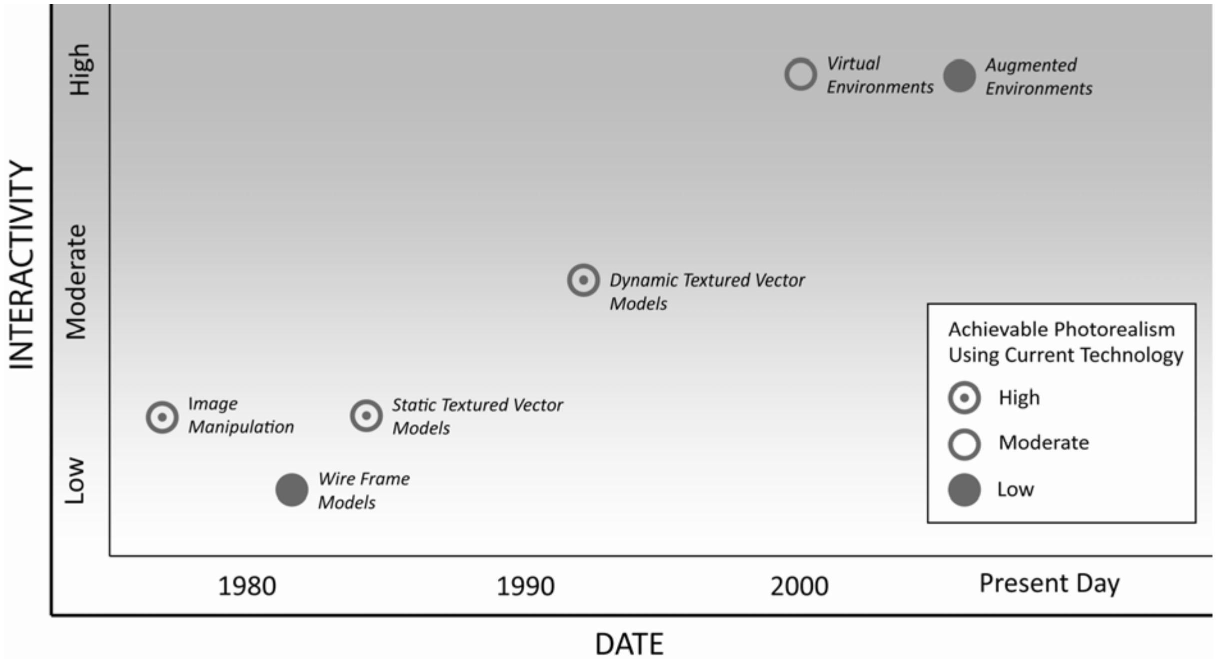


**Figure 2.1 A history of computer based visualization research.**

## 2.2 Definition of a Computer Landscape Visualization

It is important to reiterate that the term 'visualization' refers to many forms of visual representation, ranging from mapping and sketching to advanced computer based methods. That said it is generally recognized that CLV techniques are becoming more common to planning practice and are conceptually distinct from more traditional analogue representations (Al-Kodmany, 1999, 2002; Bishop & Rohrmann, 2003; Sheppard, 2001). In addition to being distinct from analogue techniques, CLVs themselves can also be sub-categorized based on internal factors such as their level of realism, immersion, interactivity and abstraction (Bishop & Lange, 2005). Because of this wide range of intrinsic variables the specific definition of a CLV can vary greatly depending on how the tool is being used. For example, Tyrvainen, Gustavsson, Konnijnendijk, and Ode (2006) define CLVs in very general terms; "visualizations are defined as computer generated images of the landscape" (p. 813), whereas others are more specific, defining them as an "attempt to represent actual places and on-the-ground conditions in three-dimensional perspective views, with varying degrees of realism" (Lewis & Sheppard, 2006, p. 293). As varied as the contemporary definitions might be, one important aspect that does not seem to be explicitly communicated in most descriptions is that the modern process of producing a CLV typically involves the creation of an image from a virtual model. In fact, software has become so advanced that creating a CLV is much like taking a photograph, only the camera and the environment exist in a virtual space. While this analogy may make the creation of a CLV easier to conceptualize, it does not aid in the provision of a precise definition, which is further complicated by the fact that a simulation's form changes throughout its creation and application within the planning process. For this research one necessary distinction in form is between a CLV as an image and a CLV as a virtual model, although it is recognized that no hard boundary between these concepts exists (i.e. even viewing the virtual model on a computer screen can blur the distinction). To make this distinction more clear it is thus necessary to look beyond aspects of the technology itself by identifying a CLV's intention within a given situation. As an example we might consider the distinct purposes of a virtual model *(to act as a tool for testing and combining various landscape designs)* and an image of that model *(to communicate these designs to individuals that are external to the design process*). Based on this reasoning this research uses a modified version of Lewis and Sheppard`s (2006) definition, defining a CLV as 'an image captured from a virtual model that attempts to represent actual places and on-the-ground conditions in three-dimensional (3D) perspective views, with varying degrees of realism, possessing the primary intention of communicating potential landscape changes to the public.'

## 2.3 Structure of a Three Dimensional Virtual Model

The virtual model that a CLV is captured from generally consists of four main elements; the digital terrain model (DTM), the surface texture model, vegetation models, and models of built structures (Appleton & Lovett, 2003; Bergen et al., 1998). The DTM forms the base of the virtual landscape and is typically constructed using either a digital elevation model (DEM) or triangulated irregular network (TIN). A surface texture model is applied to the DTM to represent the landscape's ground cover, and can be specific to the landscape being modeled (Geospecific), such as aerial photography or site photographs of ground textures, or more general (Geotypical), such as simple colours or fractal textures created within the software (Discoe, 2005). Vegetation models range in complexity from simple blades of grass to complex trees and normally take the form of billboards, which are photographs of particular elements that use an alpha channel to create a transparent background. Although other methods can be used to represent vegetation, such as particle generators or 3D tree models based on computer algorithms, these techniques are less common due to the high processing demand they place on computer hardware (Muhar, 2001). Built structures are typically represented in a virtual landscape using volumetric vector models that have been textured with photographic or fractal techniques (Appleton & Lovett, 2003; Bergen et al., 1998; Bishop & Lange, 2005; Lange, 2001; Neto, 2006). In addition to these four main components other elements have become increasingly important in the creation of CLVs, including algorithms for controlling lighting, water and atmospheric conditions, as well as the incorporation of billboards or 3D models to represent animals (including people) (Appleton & Lovett, 2003; Ervin, 2001; Laing et al., 2009). Figure 2.2 illustrates the basic workflow followed to create a virtual model.

## 2.4 Why a Computer Based Visualization is Unlike Traditional Visualizations

Within the daily practice of planning there is a strong temptation to simply accept computer based visualization as a mere extension of the visualization techniques that have been used in the profession's past (Appleton & Lovett, 2005). That said, this acceptance fails to recognize the fact that computer technology has fundamentally changed the nature of visualization over the past three decades. It is suggested here that computer based visualization is fundamentally different from traditional techniques in aspects of information accessibility, persuasiveness, and the degree of certainty that is communicated.

The use of computer based visualization techniques in the planning process produces two primary outcomes related to the accessibility of information. They are: the increased physical access to information (e.g. coupling of interactive virtual models with the internet); and the increased potential for the public to produce information by creating CLVs themselves (e.g. user friendly CLV tools such as Google Sketchup) (Appleton & Lovett, 2005; Lewis & Sheppard, 2006; Sheppard & Cizek, 2009; Von Haaren & Warren-Kretzschmar, 2006). It is not difficult to envision possible benefits that could be realized through these outcomes, such as increased participation or innovative new avenues for the delivery of local knowledge, and there may even be similarities between these benefits and the theoretical goals of communicative planning theory (Wissen, Schroth, Lange, & Schmid, 2008). Still, the drawbacks to increasing information access in these manners must also be considered. By placing interactive virtual models on the Internet we can certainly broaden access to planning information, allowing an individual to explore a proposed landscape much like one explores a video game. However, doing this also greatly amplifies the cognitive load that is placed on members of the public, and if supplementary data is absent in such a situation this broad access to information could cause confusion and misinterpretation, instead of fostering understanding (Sheppard, 1989).

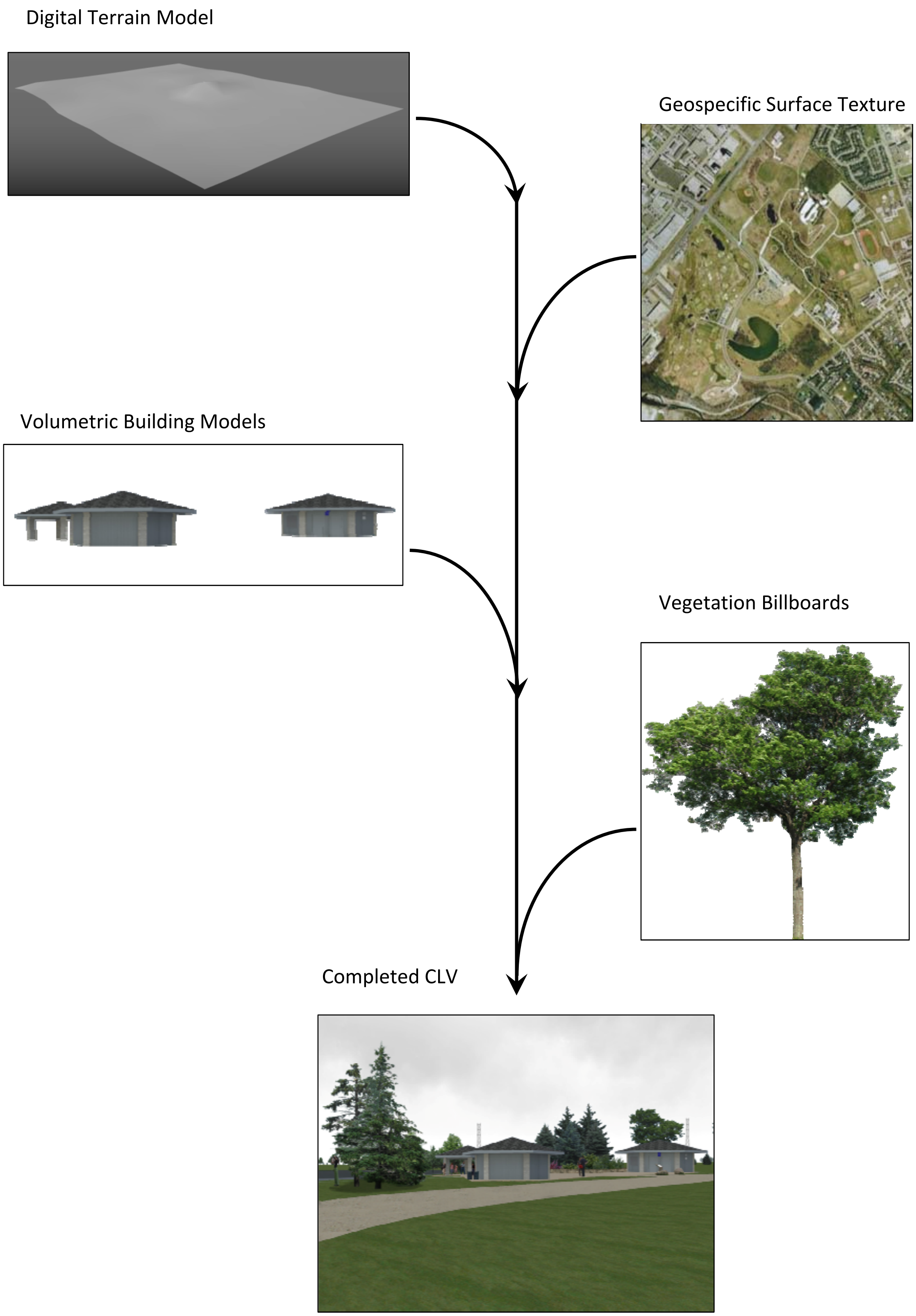


**Figure 2.2 Composition of the four main elements in a vector based virtual model.**

Delivering information that is only accessible via computer would also engage only particular segments of society, effectively excluding all individuals who lack computer access or computer literacy (Wherrett, 1999). Finally, while the use of CLV software by the public could provide an innovative means for communicating local concerns, there are potential issues that must be considered when these tools are put in the hands of inexperienced users. It is entirely possible that CLVs produced by untrained individuals could gain legitimacy within a planning process and detrimentally effect decisions if they contain errors in accuracy or representativeness. Moreover the continued discrediting of such CLVs in a public forum could lead to a more general discrediting of a particular software package or even the technique itself (Meitner et al., 2005; Sheppard & Cizek, 2009).

The highly persuasive nature of CLVs is another aspect differentiating them from traditional visualizations. High levels of immersion and interactivity create a media that is more akin to experiencing the real world and thus more compelling to the public than analogue representations (Danahy, 2001; Howard & Gaborit, 2007; Pettit, Cartwright, & Berry, 2007). While this capability can be used to increase participation and comprehension, it must be recognized that these properties are also highly influential as they elicit potent emotional responses that are unlike reactions to traditional media (Sheppard, 2005; Wissen et al., 2008). Appleton and Lovett (2005) point out that the persuasive nature of realistic CLVs is well recognized in the development industry, where such representations are commonly used to communicate with the public even though they are not a requirement of the planning process. This fact is also documented by Neto (2001), who used a variety of media to examine the perceptions of a streetscape design among architects and non-architects. When responses between the groups were compared Neto attributed a positive overall evaluation of the project by the two groups, who differed greatly in their detailed perceptions of the design, largely to the influential nature of the 3D animations and not the design itself. In subsequent research Neto (2006) has reiterated that when simulations are used to communicate new designs to the public there is a strong tendency for the focus to be on the impressiveness of the virtual model and not more salient issues of the project.

Another aspect that can contribute to persuasiveness is the degree of realism that a CLV possesses (Orland et al., 2001). Appleton and Lovett (2003) used photorealistic images with the public and found that the general acceptance of a simulation can be negatively influenced by even seemingly inconsequential elements if they are poorly simulated, or positively influenced if foreground vegetation and ground cover are realistically depicted. A similar effect is also noted by Bishop and Rohrmann (2002). In addition to preference for a particular scene, extreme levels realism can also have an impact on the certainty that a CLV purports. Due to their high level of detail and perceived continuity with the real world photo-realistic images tend to be associated by the public with a high likelihood of a project turning out exactly as it is shown (Appleton & Lovett, 2005). This can be a considerable problem in cases where CLVs achieve only apparent realism (the degree to which the simulation appears to look like the real world when judged on the basis of the image alone) rather than actual realism (response equivalence or lack of bias in responses between simulated and real environments) as reactions to the built project may fall short of expectations that were developed in response to the simulations (Sheppard & Cizek, 2009, p. 2107).

On a deeper level the association between realism and certainty is specifically linked to the lack of apparent artistic license and the authoritative stature that is inherent in photorealistic simulations (Appleton & Lovett, 2005; Luymes, 2001). As noted earlier this can be a significant concern as the creation of these images often does in fact involve considerable subjectivity on the part of the preparer. Another issue is that while the public is familiar with analogue drawings and knows how they are produced, CLVs are novel and their development is poorly understood (Bosselmann, 1998). Similarly, because they are created using sophisticated computer techniques CLVs tend to imply a data driven process that is associated with unquestionable accuracy and precision, even though this is not always the case. This failure to recognize the assumptions that are inherent in the creation of CLVs, combined with high levels of apparent realism, can lead to innate trust of simulations, although as Neto (2006) points out this trust may be vastly misplaced. Unfortunately the issue of certainty will only be exaggerated in the future as CLV software shifts further toward GIS based platforms, which are even more foreign to the public and seemingly more infallible (Appleton, Lovett, Sunnenberg, & Dockerty, 2002; Paar, 2006; B. Tress & G. Tress, 2003). The problem of perceived certainty is so substantial that several authors have even alluded to the likelihood of future litigation over completed projects that appear significantly different from the images they were marketed with, and as is apparent from the case in Spain that was discussed earlier these assertions appear to be accurate (Chenoweth, 1991; Decker, 1994; Lange, 2005).

## 2.5 Applications of Computer Landscape Visualizations in Urban Planning

The discipline of planning has a long and complex relationship with theory and throughout its history models seeking to guide the profession have waxed and waned continuously. Despite the consequences of these purported paradigm shifts however, the landscape of planning practice has never truly strayed from its positivist roots, meaning that rational information has traditionally been, and remains to be, the foundation of the planning system. Methods and tools for managing and communicating information are therefore key to the planning process, with varying forms of visualization (i.e. maps, plans, photographs etc.) having a long history of use. Although most research has indeed emphasized this communicative function for simulations, it has recently been suggested that contemporary CLV use actually fills two roles in planning practice; the analysis and exploration of data by experts, and the communication of this data to non-experts (Sheppard & Cizek, 2009). Recent examples of the analytical role of CLVs in the planning process are less common, but include research on the quantification of visual impacts from landscape change, as well as the analysis of soil erosion potential due to large scale construction projects (Schofield & Cox, 2005; Wang et al., 2008). In addition to these applications within planning research, virtual models have also become a popular tool in planning practice for studying the potential shadow impacts of proposed developments. In contrast to this analytical function, research examples illustrating the communicative role of CLVs include the exploration of acceptable forest management alternatives in British Columbia, as well as the investigation of brownfield revitalization alternatives and their influence on perceived landscape preference and ecological quality (Lafortezza et al., 2008; Lewis, 2008).

While Sheppard and Cizek (2009) have outlined the dual roles of CLVs, the impetus for their increased use in practice has been attributed in the literature primarily to their ability to improve communication and engagement with the public (Appleton & Lovett, 2005; Orland et al., 2001; B. Tress & G. Tress, 2003). Likewise, planning practitioners report that the improved capacity for communicating with the public is the primary motivation for adopting CLV tools (Donaldson-Selby et al., 2007; Neto, 2006; Paar, 2006). More specifically, it is believed that the 3D nature of simulations improves the public’s ability to comprehend complex spatial information, especially compared to verbal descriptions or traditional 2D visual representations (i.e. maps) (Appleton & Lovett, 2005; Bucolo, Impey, & Hayes, 2001; Lewis & Sheppard, 2006; Pettit et al., 2007). One proposed explanation for this is that CLVs enhance aspects of cognitive understanding, such as recognition and retention, because they communicate information in a manner that is more akin to how humans perceive their actual environment (Sheppard, 2005). This capacity has been realized in numerous contexts including research from Lange and Hehl-Lange (2005) who used an interactive virtual model to improve the public's comprehension of spatial issues related to the placement of wind turbines, as well as Donaldson-Selby, et al. (2007) who used static CLVs to successfully communicate the organization of possible urban greening scenarios to the public in the city of Durban, South Africa.

Benefits to using CLVs have also been recognized in decision-making processes, where it is argued that they facilitate discussion and consensus building (Hamilton et al., 2001). Even before communication amongst participants begins it is believed that the intrigue of seeing a familiar landscape under future conditions can increase public participation, legitimizing community engagement exercises (Appleton & Lovett, 2005; Forester, 1989). Pettit, et al. (2007) claim that this power to engage is derived not only from intrigue, but also the interactive nature of CLVs, which can be infused into all stages of the engagement process to more intimately involve members of the public. Once communication begins simulations provide a means to make the abstract tangible, focusing discussion on content rather than misunderstanding (Appleton & Lovett, 2005; Lange & Hehl-Lange, 2005; Pettit et al., 2007). Finally, as noted above it is argued that CLVs provide a common language that facilitates a shared comprehension of complex spatial problems, thereby reducing misunderstandings and the time it takes to make a decision (Al-Kodmany, 2002; Nicholson-Cole, 2005; Orland et al., 2001; B. Tress & G. Tress, 2003).

## 2.6 Visualization Ethics

Although potential ethical dilemmas regarding the use of simulations with the public have been identified by Orland, et al. (2001) and Appleton and Lovett (2005), the discussion of this issue has largely been dominated by the voice of Stephen Sheppard. In his earlier work Sheppard (1989) identified three primary objectives for CLVs and stated that the most important goal for an ethical simulation is to be unbiased; wherein bias is considered to be a factor intrinsic to a simulation that might influence the decision of a viewer. In this sense bias can come from many sources that include both intentional attempts at persuasion, as well as unintentional mistakes in the visualization process (Sheppard, 2001). Macfarlane, et al. (2005) present a similar argument in a discussion of simulation *positionality*, which is a concept that has traditionally been associated with cartographic representation. They argue that because the visualization preparer is theoretically positioned between a visualization product and the viewer, there is potential for his or her values to influence the final composition and look of the image, and ultimately the viewers' perceptions of what is being depicted. As mentioned in a previous section this issue can be exceptionally problematic when using photorealistic CLVs because the final product often appears to be accurate and data driven, but in reality is nothing more than the preparer's interpretation of the world.

To help guide the unbiased and ethical production of CLVs Sheppard (1989) has proposed a set of five general principles that should be the foundation of the visualization process. Although these principles may now be difficult to apply due to the incredible diversity of contexts in which simulations are used, certain aspects like the documentation of the CLV process can unquestionably be followed in any discipline to improve transparency in communication among stakeholders. The five principles are summarized as follows:

> **Representative:** visualizations show important views of a project under typical viewing conditions. Ensuring that a visualization is representative reduces the possibility that the visual impact is underestimated and prevents the exclusion of views that may be important only to more disenfranchised participants.
>
> **Interesting:** visualizations are those that are engaging enough to hold a viewers interest and get them involved in the issue being discussed. Creation of interesting visualizations ensures that audiences do not "turn off" before information is delivered. This both improves communication and engages a wider number of participants within the process. That said, visualizations should not be so stimulating that they take focus away from the true issue.
>
> **Visually Clear:** visualizations are those where information is unambiguous and free from competing or distracting elements. Ensuring visual clarity reduces the risk of misinformation and the potential for information to be interpreted incorrectly. This reduces the possibility for confusion and bias, and can prevent situations in which participants become frustrated.
>
> **Accurate:** visualizations are not significantly different in appearance from the 'real view' from the same viewpoint. Accuracy is related both to subject matter shown and the elements that are presented in the visualization. Thus, visualizations can only be as accurate as the information on which they are based. Careful attention must be paid in data collection as well as in the decision of what elements will make an accurate visualization.
>
> **Legitimate:** visualizations are those that can provide evidence proving that information used is accurate and views included are representative. By ensuring visualizations are legitimate, situations can be avoided in which distrust for the visualization translates into distrust for the creator.

In more recent work Sheppard (2005b) laments the fact that detailed case study research examining the influence of simulation bias on actual planning decisions is still lacking. He presents convincing arguments for the adoption of a specific code of conduct to aid the ethical production of visualizations, with the notion being that CLV use should be controlled in the absence of a complete understanding of its impact. Implicit in this reasoning is the suggestion:

that visualizations are a powerful tool that can influence decisions; that visualizations have a high potential for misuse; and that there is a current inability to identify, control and compensate for misuse (Sheppard, 2001). Of these threats the potential for misuse is perhaps the most compelling. Misuse in this sense is similar to the concept of positionality, but may in fact be more devious as it openly indentifies the fallible nature of the human element in the visualization process; namely the preparer's willingness to intentionally persuade the viewer. Although the technical thrust that has dominated CLV research has somewhat obscured this fact, it must be recognized that advances in computing power will offer little in the way of reducing simulation bias because the process will always be human centered, thus forcing the preparer to make innumerable subjective choices that shape the nature of the visualization and the landscape it depicts (Appleton & Lovett, 2005; Sheppard, 2001). A recognition of this fact is apparent in the content and wording of the interim code of ethics for landscape visualization development, which is presented in Figure 2.3.

The use of landscape visualizations should be appropriate to the stage of development of project under consideration, to the landscape being shown, to the types of decisions being made, to the audience observing the visualizations, to the setting in which the presentation is being made, and to the experience level of the preparer. Within this context, preparers and presenters of landscape visualization will:

-Demonstrate an appropriate level of qualifications and experience

-Use the appropriate visualization system(s) and media for the purpose

-Choose the appropriate level of realism

-Identify, collect, and document supporting visual data available for or used in the visualization process; conduct an on-site visual analysis to determine important issues and views

-Seek community input on viewpoints and landscape issues to address visualizations

-Estimate and disclose the expected degree of error and uncertainty

-Use more than one appropriate presentation mode and means of access for the affected public

-Provide the viewer with a reasonable choice of viewpoints, view angles, viewing conditions, and timeframes appropriate to the area being visualized

-Present important non-visual information at the same time as the visual presentation

-Avoid the use of appearance of "sales" techniques or special effects

-Avoid seeking a particular response from the audience

-Provide information describing how the visualization process was conducted and key assumptions/decisions taken

-Record responses to visualizations as feedback to future efforts

-Conduct post-construction evaluations to document accuracy of visualizations or changes in project design/construction/use

**Figure 2.3 Code of ethical conduct for landscape visualization (Source: Sheppard, 2005b).**

## 2.7 Paradigms in Landscape Assessment Research

Amid the surge of community growth that occurred in the post World War II era was a host of environmental issues that brought to light the importance of human behavior as an actor on the form of the built environment. Crystallizing during the peak of environmental awareness in the late 1960s, this consideration for the human/environment relationship formed a major impetus for the establishment of a discipline that was solely dedicated to the study of such phenomena (Proshansky, 1983). In the decades following the realization of the discipline of environmental psychology, which is marked by the formation of the journal of Environment and Behaviour in 1969, there was a rapid expansion in the volume and breadth of research examining the human/environment interface; including a myriad of landscape assessment studies (Ibid). While the earliest accounts of this pioneering research include classifications put forward by Daniel and Vining (1983) and Zube, Sell, & Taylor (1982), the latter has been the dominant standard in the field of landscape assessment over the past three decades and has quite literally dictated the focus of contemporary landscape research.

Through an exhaustive literature review Zube, et al. (1982) identified four paradigms of landscape assessment by contrasting the methodologies that studies in the field employed and the orientation they took toward describing the source of people's landscape perceptions. Bottom up orientations attributed landscape perceptions to our biological predisposition to specific information in the landscape that has developed through a common evolutionary history. Alternatively, top town explanations tended to accredit landscape perception to the influence of our individual past experiences or attained cultural values (Tveit, Ode, & Fry, 2006). The four paradigms put forth by Zube et al. (1982) include the expert, the psychophysical, the cognitive and the experiential.

The expert and psychophysical paradigms are considered to have a bottom up orientation and employ mainly positivist methodologies that emphasize the role of the researcher as a knowledge generator. Conversely, the cognitive and experiential paradigms adhere to methods that recognize the public as a source of knowledge, and as such they tend to emphasize the researcher as an interpreter of knowledge. While the cognitive paradigm is considered to have a top down orientation, the experiential paradigm can take either a top down or bottom up view on perception. Among the four paradigms the psychophysical and cognitive paradigms have been dominant in recent landscape assessment research, due mainly to the methodological rigor and validity that is provided by the use of public opinion as a metric for landscape quality (Real , Arce, & Sabucedo, 2000). Comparisons of these two dominant approaches have argued that the cognitive paradigm has a strong theoretical foundation that provides a means to explore the relationship between human evaluations and information in the landscape by using techniques such as semantic differential classification and multiple sorting tasks (Lange, 2001; Real et al., 2000; Zube et al., 1982). On the other hand it has been stated that the psychophysical paradigm does a better job of emphasizing problem related research as it seeks to establish quantifiable relationships between landscape elements and human evaluations using quantitative scaling techniques (Daniel, 1990, 2001; Daniel and Boster, 1976; Lothian, 1999; Real et al., 2000).

While the cognitive and psychophysical paradigms have flourished in recent years, expert assessments have been shown in the literature to be highly variable and imprecise, ultimately causing the popularity of the expert paradigm to wane significantly (Daniel and Vining, 1983; Lothian, 1999; Scott and Canter, 1997). Similarly, while the experiential paradigm has received much positive theoretical discussion to date, it has garnered considerably less empirical examination due to the expensive and onerous nature of the paradigms methods (Lothian, 1999). That said Bishop, Ye, & Karadaglis (2001) have noted that advances in interactive virtual environments offer a new, efficient means for the experiential investigation of the human/environment relationship, and thus the paradigm could see a surge in future landscape assessment research. Table 2.1 summarizes elements of the four paradigms.

**Table 2.1 Summary of landscape assessment paradigms (Source: Zube et al., 1982).**

| Paradigm | Orientation | Summary |
|---|---|---|
| Expert | Bottom up | -Focus is on specific landscape properties (i.e. form, line, unity)<br>-Landscape evaluated by trained experts<br>-Skills used come from arts, design, ecology, resource management |
| Psychophysical | Bottom up | -Focus is on specific landscape elements (i.e. water, vegetation)<br>-Landscape evaluated by testing the public<br>-Landscape elements are a trigger for human responses |
| Cognitive | Top down | -Focus is on human meaning associated with landscapes<br>-Perception involves the collection of information<br>-Human responses are mediated by past experiences, future expectations and socio-cultural factors |
| Experiential | Top down or bottom up | -Focus is on human-landscape interactions<br>-Assumes that perception changes the observer and the landscape |

## 2.8 Theories of Landscape Perception: The Informational Model

Developed as a response to a theoretical void in the field of cognitive psychology, the *informational model* has become an important theory in the explanation of environmental preference, although it originally sought to answer broader questions of environmental perception (S. Kaplan, 1987). This aptly named model attributes environmental preference to the exchange of information between the environment and observer, as well as the evolutionary importance of this exchange to human survival (S. Kaplan, 1975, 1987). The key focus from an evolutionary perspective is the arrangement of information within a landscape and whether its organization promotes understanding and exploration; that is to say does a landscape seem to make sense and does it seem to offer additional information (R. Kaplan, 1985). More specifically it is argued that understanding allows individuals to avoid undesirable and potentially dangerous environments, whereas exploration allows for the expansion of one's cognitive map, thus increasing access to important resources (Appleton, 1975). As previously mentioned the *informational model* is based heavily on the cognitive framework of landscape assessment. This is apparent not only in the emphasis on the organization and categorization of data, but also in the assertion that the 'ability to understand' and 'the desire to explore' stem from the cognitive processing of four predictor variables: coherence, complexity, legibility and mystery (S. Kaplan, 1987; Zube et al., 1982).

The predictor variables used in the *informational model* are organized into a matrix that relates the exploration and understanding metrics to the availability of information in the landscape. Coherence is defined as the degree to which a scene hangs together and it is influenced by the ability of a scene to be categorized into a manageable number of 'chunks'. As such, coherence is related to the understanding metric. Legibility is also related to understanding, however it is defined as the inferred ability for one to maintain orientation while navigating deeper into a scene. From a conceptual standpoint the legibility and coherence variables differ in the nature of the information they provide. For example, while coherence has an immediate impact on one's ability to process information, legibility only infers that future information will be useful for navigation and survival.

The mystery and complexity variables of the informational model are also distinct in terms of the availability of information that they offer, but are similar in the sense that they both relate to the evolutionary drive for exploration in the landscape. Like the coherence variable, complexity has an immediate impact on the amount of information that is available in a scene, as it is defined as the variety of elements within a landscape. In contrast to this, mystery only suggests the availability of information, inferring that useful information can be attained if one moves deeper into the landscape. (S. Kaplan, 1975, 1987). Table 2.2 summarizes the variables of the informational model and illustrates the links between the evolutionary driver and informational availability that is inferred by each variable.

| | | Evolutionary Driver | |
|---|---|---|---|
| | | Understanding | Exploration |
| Information Availability | Immediate | COHERENCE | COMPLEXITY |
| | Inferred | LEGIBILITY | MYSTERY |

**Table 2.2 Summary of Kaplans' informational model of landscape perception (Modified from: S. Kaplan, 1975)**

The *informational model* has received much empirical study over the years and an extensive meta-analysis of the model's ability to predict landscape preference has recently been completed (Stamps, 2004). This meta-analysis of 61 studies incorporated 12 452 participants and 3125 landscape scenes. The results of the meta-analysis suggest that there is indeed a statistical relationship between each of the four predictor variables and landscape preference, although in all four cases it is impossible to determine the direction of this relationship due to the variability of the individual studies. Among the most significant results of the meta analysis is the finding that expert judgments of the predictor variables are different than those of the general population. It is also reported that coherence and legibility correlate higher with preferences for built, as opposed to natural, scenes, whereas mystery and complexity do not correlate differently between the two environments.

## 2.9 Theories of Landscape Perception: The Ecological-Aesthetic

Most theories of environmental perception tend to delineate humans as outside observers of the landscape who perceive, transform and react to environmental stimuli (Zube et al., 1982). In contrast the *ecological-aesthetic* model of environmental perception, which has grown in depth and popularity since the reevaluation of Aldo Leopold's work, situates the human element at the center of a transactional interface (Gobster, 1995; Nassauer, 1995b). Because of this focus on human/environment interaction the ecological aesthetic can be categorized into the experiential paradigm of landscape assessment (Zube et al., 1982). In this theory human-landscape relationships are argued to exist at a range of scales occurring from the abstract (e.g. our relationship with climate change) to the concrete (e.g. our relationship with our neighborhood), although it is believed that humans can only perceive this relationship at the less abstract scales of interaction. This concept is termed the 'perceptible realm' (Gobster, Nassauer, Daniel, & Fry, 2007). Another important consideration in the *ecological-aesthetic* is the transformative nature of landscape perception, wherein humans become engaged with the landscape as opposed to simply observing it as a passive bystander. In this sense conventional perceptions become a powerful actor on landscape change and landscape change becomes an equally powerful actor on conventional perceptions. The relationship between culture and the landscape is thus viewed as a positive feedback loop, with the landscape being shaped by the aesthetic tastes of the time (Nassauer, 1995a).

In explaining landscape preference the *ecological-aesthetic* does more to prescribe an appropriate origin for preference than it does to explain existing aesthetic conventions. Three questions are of key importance in this respect. First, do conventional landscape preference and ecological quality conflict with one another? Second, if they do conflict, can conventional preferences and ecological quality be reconciled? Third, are there ethical and societal implications in suggesting the need to change existing aesthetic conventions to be more reflective of holistic ecological quality? (Gobster et al., 2007)

Although it does tend to be prescriptive in nature, the *ecological-aesthetic* does in fact outline certain specific predictors of landscape preference. Through the lens of the theory landscapes are viewed as enormous communication tools that posses information waiting to be perceived through experience. In this sense the *ecological-aesthetic* is similar to the *informational model*, although the types of information involved, mainly cultural, and the means of perception, via experience, are different (Nassauer, 1992). This overt focus on cultural information consequently makes the expression of human intention in the landscape an important element of preference. Landscapes that suggest a high level of stewardship or maintenance, interpreted as 'cues to care' such as mown strips or trimmed shrubs, are believed to be associated with positive perception of the land's caretaker and thus lead to a preference for the landscape. On the other hand landscapes that lack order or appear to be neglected or derelict paint a negative picture of the caretaker and lead to a distaste for the landscape (Nassauer, 1995b). A core question driving the *ecological-aesthetic* is how to develop positive public preferences for non-traditional aesthetic landscapes, recognizing the need to support ecological systems that may not be aesthetically pleasing, but are vital to ecological integrity and human health. As the model attributes preference to communication between humans and the landscape it follows that this goal can be achieved by altering the message that being is exchanged. This change can be made in two ways. First, the landscape itself can be designed differently, therefore shifting the content of the message to be more inline with cultural norms. This in fact has been the dominant approach used throughout the history of design and planning. An alternative approach, however, would be to use an information intervention that can change how the message is perceived by the public, actually changing cultural preferences to be more in tune with the aesthetic appearance of ecologically important landscapes. Not surprisingly this method has been considerably less common in planning and design as it involves the shifting of trenchant cultural conventions, thus requiring structural changes to society that are difficult to achieve on a broad scale (Gobster et al., 2007; Lewis, 2008).

## 2.10 Theories of Landscape Perception: Sense of Place

Similar to the ecological aesthetic, sense of place (SoP) theory is tightly rooted within the experiential paradigm, although it is a somewhat more nuanced concept. In fact, while the term SoP is borrowed for the purposes of this research, due mainly to its ubiquitous use in the discipline of planning, the concept it describes is compatible with many other phenomena that have been examined throughout the second half of the 20$^{th}$ century (i.e. genius loci, topophilia, place identity, and community sentiment) (Low & Altman, 1992). Because examinations of the experiential interaction between human and environment have subsumed many disciplines, including architecture, geography, urban planning and environmental psychology (Lynch 1960; Norberg-Schulz, 1980; Proshansky, Ittleson, & Rivlin, 1970; Relph, 1976; Steele, 1981; Tuan, 1974), the concept of SoP is best explained not as a synthesized theory, but as a number of theoretical tensions within a body of research that is actively developing an understanding of a complex phenomenon.

The concept of SoP can be broadly defined as the affective relationship between people and their environment that develops via experience; and it is the nature of this relationship that forms the impetus for the most pervasive tension in the SoP literature. More specifically, the dispute is whether SoP develops as a direct consequence of stimuli in the environment itself (i.e. bottom up), or out of a socially mediated understanding of what the environment has to offer (i.e. top down). On this subject some of the earliest holistic theories of SoP seem hesitant to prescribe the phenomena to one cause or the other. Tuan (1974) goes into great depth describing the biological basis of landscape perception, detailing the function and significance of the five senses. He notes that from an evolutionary perspective our primate vision developed out of the need to distinguish static food sources within our environment, thus leading to a visual system that is focused on the discrimination of shape, color and texture, as opposed to minute movements. Tuan also attributes our tactile abilities, which allow us to manipulate and examine the structure of our environment, to the need to form cognitive maps used in the visual discrimination of discrete objects. While such notions imply that SoP is a direct and somewhat ubiquitous consequence of important stimuli in the landscape, Tuan also places tremendous importance on the cultural aspects of SoP. He claims that while an infant engages in play out of a biological urge to attain information about his or her surroundings, the modes of exploration and the information that is sought will increasingly fall under the control of cultural forces as the infant ages. For example, Tuan notes that the culturally defined gender roles of men and women have traditionally predisposed them to different life patterns, impacting the type and range of environments that are experienced by each group. Ultimately Tuan's taxonomy of human experience and landscape perception involves the influence of three prominent forces; external cultural factors, hereditary dispositions, and yet more innate biological drivers. This view is illustrated when he states that;

> In our daily contacts with people we take for granted that eccentric attitudes exist and that they are not explained exhaustively by cultural factors such as family background, upbringing, and education. The examples given above are meant to suggest the existence of outlooks which, in their waywardness, invite us to postulate congenital influences – that is to attribute certain inclinations to temperament, that uncertain mixture of humours. But there is little hard evidence. We are on surer ground when we relate the range of human attitudes to the biological categories of sex and age. (Tuan, 1974, p. 53)

Not unlike Tuan, Steele (1981) attributes SoP to a contribution of both the physical and social contexts of a setting, specifically stating that "the environment is made up of a combination of physical and social features; the sense of place is an experience created by the setting combined with what a person brings to it" (p. 9). Similarly, while Relph's (1976) conception of SoP is admittedly more adherent to cultural explanations than that of Tuan or Steele, there is evidence of the biological/cultural dichotomy in his views. He suggests that the perception of a place depends largely on the prominence of its function, and as such it holds that certain places may be so clear in function that there is little room for differences in how the place is perceived between individuals. Interestingly this notion corresponds closely to the 'Spirit of Place' that is described by Steele (1981) as "the combination of characteristics that gives some locations a special feel or personality" (p. 11), and is highly reminiscent of innate biological accounts of landscape perception.

In more recent literature the distinction between the physical and social construction of SoP is still apparent, although the focus seems to have shifted to a more critical examination of the respective theories. Stedman (2003) presents three opposing models to describe the creation of SoP. The 'Direct Effects' model relies on the provision of desirable elements within the physical landscape that meet the needs of the perceiver. The assumption underlying the model is that because SoP is the essence of a place, it must reside within the place itself, not in cultural interpretations. The 'Meaning Mediated' model is viewed as an extension of the 'Direct Effects' concept, wherein SoP is proposed to develop not as a direct response to physical elements, but through the influence of these elements on the culturally derived meaning of a place. Last, the 'Experiential' model attributes SoP to the meanings that are ascribed to a place, and in its purest form this model would account for the development of such meanings entirely through the influence of individual and cultural experiences over an extended period of time. That said Stedman seems apprehensive to allow such a pure explanation of the 'Experiential' model, stating that "the analytical question becomes whether these patterns of interaction are driven by characteristics of the landscape itself, or whether human behaviours and landscape characteristics are largely independent factors" (p. 674). Clearly the answer is that if the model wishes to be appreciably different from that of the 'Meaning Mediated' model, behaviour would have to be independent from the direct control of landscape characteristics. Based on a predictive examination of the above models, using measures of place attachment and place satisfaction, results indicate that the 'Meaning Mediated' concept is the only model that produces an acceptable description of SoP. Stedman's investigation therefore supports the assertions of early theorists, suggesting a dualistic role of culture and the physical environment in the formation of SoP.

In a more theoretical examination, Riley (1992) presents the concept of SoP as a process that can operate at three hypothetical levels of human existence; the level of a hominid species, the level of a cultural group, or the level of an individual. That said he is sharply critical of evolutionary explanations of SoP, stating that "such explanations of biological, evolutionary-based human experience enrich our conceptual vocabulary of the environmental experience but are unlikely to produce proven explanations" (p. 15). As a result Riley describes the human-environment relationship as a transaction where the landscape serves as a symbolic repository for cultural traditions and values. At the cultural level SOP would thus shape the physical environment through a process of cultural determinism, where societal conventions carve out a landscape that fits the needs of the accepted norm. Alternatively, at the individual level SoP would have much less physical impact on the landscape, operating more as a mediator of the experiences that a person has with landscapes throughout their life.

The theoretical levels of human existence proposed by Riley (1992) highlight the second tension within the SoP literature, namely the appropriate unit of analysis for studying the concept. More specifically, this issue is concerned with both the scale of the physical landscape that SoP can occur at, as well as the level at which culture can influence SoP. On the later issue Relph (1976) notes that any landscape is experienced both individually and in a communal context, and further suggests that both communal and personal experiences lead to place attachment, which is the "familiarity that is part of knowing and being known here, in this particular place" (p. 37).

At the communal level Relph ascribes an 'authentic', uncontrived SoP to the unselfconscious translation of deep cultural values into physical design, and suggests that once this process is subverted by the infiltration of the 'popularized aesthetic', the SoP within a landscape begins to deteriorate. In describing the unfortunate effect of the dominant western culture on our landscapes, Relph goes as far as to say that;

> Indeed in North America the only instances of authentically, yet unselfconsciously created places are peripheral to the main thrust of the society, for instance the anachronistic and traditional societies of the Hutterites or Amish, and possibly the back to nature communes and some street markets (p. 68).

This is not to say that the current inauthentic landscapes will always be as such, as he also acknowledges the dynamic character of culture and the ability for authentic places to derive from authentic use by a particular culture over an extended period of time.

Similar to Relph's interpretation Tuan (1974) asserts that SoP is, to some degree, a product of a culturally derived meaning that ultimately shapes a physical landscape, as well as how that landscape is perceived. As such the SoP created by a downtown business district is viewed by Tuan not merely as a function of the exterior volumes and interior spaces created by a grouping of high rises, but as a result of a common symbolic understanding that the landscape is a source of dominance and economic power. Important as this symbolic understanding is, Tuan (1976) also recognizes the reciprocal manner in which communal culture and the physical environment shape one another, noting that "the life style of a people is the sum of their economic, social, and ultramundane activities. These generate spatial patterns; they require architectural forms and material settings which, upon completion, in turn influence the patterning of activities" (p.173).

At the individual level culture shapes SoP in a somewhat more discrete manner. Rather than communal values moulding the landscape, culture influences everyday personal experiences and the messages that people take from an environment. Steele (1981) suggests that individual expectations frame landscape perceptions, guiding the experiences that one has throughout their life course. Similarly, mood, an inconsistent and often uncontrollable variable, is viewed as a powerful filter of experience that has a circular influence on place experience. As an example we can all probably recall a bad mood making a particular place seem rather deplorable, regardless of what the physical space actually had to offer. Likewise, a particularly compelling place, containing a spectacular scenic view or a vibrant social atmosphere, may have been able to pull us out of an especially sour temperament. Through this intimate relationship with the landscape individuals are also able to reaffirm their personal identity as it provides a means to legitimize their role within the larger milieu of society. While this process of affirmation is generally positive, it must also be recognized that the expectations and conventions that culture impose on us can represent a barrier to authentic place experiences. For this reason if we are to achieve a true, uncontrived SoP that goes beyond mere evaluation of a landscape, we must first relinquish the control and structure of cultural norms (Tuan, 1974).

In more recent research Jorgensen and Stedman (2001) present SoP as a multidimensional concept that incorporates aspects of place attachment, place identity and place dependence; which are in turn influenced by individual affective, cognitive and conative attitudinal factors. When theorized in this way SoP can be explained based on the independent contributions of these tripartite factors to a person's more general disposition towards a place. Results from the empirical testing of five distinct explanatory models indicate that while SoP is best explained as a unidimensional concept, there is tentative evidence to support the tripartite attitudinal model. Given the contemporary understanding of attitudinal theory, which suggests that affective and cognitive systems generally act in concert to inform an individual's decision making process, but can under certain circumstances operate independently, these results seem valid (Damasio, 1994; Nabi, 2003; Peters & Slovic, 2000; Wilson, 2008). At the individual level SoP may therefore best be explained as a sensation that is influenced by three underlying attitudinal factors (i.e. emotional attachments, personal beliefs, and behavioural intentions) that are indivisible under general circumstances.

When considering the scale of the physical landscape that SoP can occur at, Tuan (1974) describes an ethnocentric means of perception, where cultural groups consider themselves to be at the centre of the perceived world. He notes that such ethnocentrism is apparent throughout history ranging from the existing indigenous people of the southern United States, who view their villages as the centre of a flat world, as well as the centre of the entire cosmos, to ancient Chinese empires that referred to themselves as the chung yuan, or the centre and source. As such Tuan seems to place few restrictions on the scale at which SoP can actually occur, going as far as to outline place attachments between humans and non-existent realms. On the other hand Relph (1976) focuses on SoP as a product of existential spaces, which he describes as "the inner structure of space as it appears to us in our concrete experiences of the world as members of a cultural group" (p. 12). Such a description implies that SoP occurs not via an attachment to abstract notions of a place, but at landscape scales that facilitate the direct and immediate experience of the perceiver. In an empirical investigation of the issue of scale Hidalgo and Hernandez (2001) measured SoP at three discrete spatial scales; the house, the neighbourhood, and the city. They indicate that while the neighbourhood scale has been among the most popular units of analysis in SoP studies, it actually elicits the lowest SoP rating of the three scales. Although this represents a novel finding, the result is not entirely unintuitive given that the concept of a neighbourhood is more abstract than that of a house or a city, which are easier to envision as a concrete, bounded entity. The fact that the neighbourhood scale produced the lowest level of attachment therefore corresponds with the assertion made by Relph; that SoP will dwindle as the concept of the place becomes more abstract and thus more difficult to perceive in a personally meaningful way.

## 2.11 Sources of Landscape Preference: Preference for Water

Even a cursory examination of human history reveals that water has been among the most important factors in our biological and cultural evolution. It is not surprising then that research is so unified in reporting water as a positive predictor of landscape preference. In the natural environment water evokes emotions such as tranquility and seems to be associated with restorative properties and perceived naturalness (Purcell, Peron, & Berto, 2001; Ryback & Yaw, 1976; Ulrich, 1986). Furthermore, water bodies such as lakes, streams and ponds are amongst the most preferred elements in urban parks (Bullock, 2008; Ozguner & Kendle, 2006; Wong & Domroes, 2005).

In an analysis of 70 natural scenes containing various forms of water Herzog (1985) finds that scenes depicting unclean or rushing water form distinct categories, with rushing water being highly preferred to all other contexts. Similar studies of urban water features find scenes depicting water jets or flowing water to be preferred over those containing still water, and also find reflective water to be more preferred than transparent water. (Nasar & Li, 2004; Nasar & Lin, 2003). Taken together, these studies suggest that preference will be highest for scenes that contain reflective or dynamic water, and lower for those that contain static, transparent, or dirty water. Lastly, in support of these findings Wilson, Robertson, Daly, & Walton (1995) show that assessments of preference for an urban lake are negatively influenced by the presence of a range of elements including garbage, surface foam, a posted health warning and natural aquatic vegetation. These findings suggest that not only do viewers value clarity and freshness in water scenes, as suggested by Herzog (1985), but that these values are sensitive to elements that are perceived as aesthetically unappealing as opposed ecologically damaging.

## 2.12 Sources of Landscape Preference: Preference for Vegetation

Much like the presence of water, the presence of vegetation in the landscape has a positive general influence on preference, with natural scenes that contain ample vegetation being consistently preferred over those that are less natural (R. Kaplan & Matsuoka, 2008; Smardon, 1988; Ulrich, 1986). Vegetation is not only linked to preference in both natural and urban landscapes, but it has been suggested that natural landscapes can actually contribute positively to an individual's psychological well-being (S. Kaplan, 1995; Purcell et al., 2001; Ulrich, 1979, 1981). More specifically, vegetation elements tend to be judged most favorably when they show obvious signs of maintenance, when they create moderate to high levels of complexity and mystery, and when they are structured to provide a moderately open landscape that is conducive to locomotion and the ability to see without being seen (Balling & Falk, 1982; Hagerhall, 2000; Herzog, Herbert, Kaplan, & Crooks, 2000; Kaltenborn & Bjerke, 2002; Kearney et al., 2008; Staats, Gatersleben, & Hartig, 1997; Tveit et al., 2006; Ulrich, 1986).

Within an urban setting the public's conception of 'natural' seems to interact with the presence of vegetation in various ways. For urban parks the public associates natural as a concept that is the opposite of formal, suggesting a specific link to the spatial arrangement of vegetation. On the contrary when 'natural' is used in the city-wide context the term tends to imply the opposite of man-made, suggesting a broader perceptual influence of vegetation (Ozguner & Kendle, 2006; Ulrich, 1986). As mentioned landscape research that focuses specifically on urban parks has often examined the spatial arrangement of vegetation as a potential predictor of preference. Using photo manipulation Jorgensen, Hitchmough, and Calvert (2002) tested the influence of tree arrangement on preference and perceptions of safety in a park environment. Their findings show that while preference is not significantly influenced by the spatial arrangement of trees, the removal of trees that block sightlines does improve perceptions of safety. In contrast Bjerke, Ostdahl, Thrane, & Strumse (2006) used vegetation density as a predictor for recreation preference and found that a moderate level of density is in fact significantly preferred amongst the public. This relationship between density and landscape preference is also suggested by other research. For instance, when Schroeder and Orland (1994) used image manipulation to vary the amount of trees, as well as the number and diameter of vegetative clumps, in a natural scene results indicated that configurations with more trees spread across the entire scene were preferred to those with a higher number of dense clumps. Likewise, in a comparison of a naturalized park to a park with a highly formal design, Ozgunder and Kendle (2006) found that participants viewed the structure of a formal park more suitable for peaceful, stress relieving activities, while the naturalized park was deemed more appropriate for social interaction. In addition to preference then, the spatial arrangement and the perceived tidiness of vegetation in a park setting also seems to be linked to SoP through perceptions of landscape function and social atmosphere.

Similar to park environments the influence of vegetation on preferences for streetscapes is highly positive. Herzog (1989) used factor analysis to analyze preference ratings for a wide range of city scenes and identified ‘tended nature’ as the most preferred of four explanatory dimensions. A subsequent regression model of the same data further revealed that vegetation was the most powerful predictor of preference for the urban scenes. This general positive influence of vegetation on preferences for urban areas is also noted in studies that investigate the influence of trees on neighbourhood and workplace satisfaction (R. Kaplan, 2007; Lee, Ellis, Kweon, & Hong, 2008; Thayer & Atwood, 1976; Ulrich, 1986). In research using similar satisfaction measures an assessment of preferences for trees in the inner city of Detroit indicated that the public not only has an aesthetic preference for urban scenes with trees, but that the provision of park and street trees is second only to education in perceived importance of municipal services. Responses in this study also suggested that residential streets, as opposed to urban parks, were the most important areas for the provision of new trees, which is not entirely surprising given that adding trees to a streetscape will have a more noticeable impact. (Getz, Karow, & Kielbaso, 1982). A similar valuation of trees amongst inner city residents is reported by Kuo, Magdalena, & Sullivan (1998), with a dense configuration of trees that allows visual penetration being the most preferred. Finally, in more recent studies Wolf (2005a, 2005b) utilized a photo survey to investigate responses to various retail streetscapes that possess and lack trees. Results indicated a considerably higher level of preference and perceived place character for streetscapes containing trees, as well as notable improvement in perceived atmospheric comfort. Individuals in these studies also reported a higher willingness to pay for products that were associated with the treed scenes.

While the studies discussed above have described the influence of vegetation on general landscape character, a small number of studies have also directly investigated preference for tree morphology. In a study of urban forests Buhyoff, Gauthier, & Wellman, (1984) used a regression model to analyze predictors of preference for scenes of suburban residential forests and found that of the variables analyzed the amount of the scene depicting sky, vegetation, deciduous crown and large trunks were the best predictors of preference. Taken together the results indicate that preference might be expected to be highest for scenes containing large trees with a dominant deciduous crown. Similar results are also found in a pair of related studies that used graphic depictions of trees to directly assess the public's preference for tree form. Subjects in these studies responded most positively to depictions of trees with large spreading canopies and relatively short trunks, and when scene context was changed (e.g. from urban to natural) a high preference for this tree form remained constant. In contrast other tree forms appeared to be less stable across scene context, with coniferous tree forms appearing to be the least preferred (Sommer & Summit, 1995; Summit & Sommer, 1999). In a recent study these results were replicated using more realistic representations of trees and scene contexts. Results once again showed spreading trees to be preferred over round and conical tree forms, and it is further suggested that spreading tree forms were more closely related to positive emotional states (Lohr & Pearson-Mims, 2006). Overall studies indicate a higher preference for deciduous tree forms (especially spreading trees) that posses a short trunk and large robust canopy.

## 2.13 Sources of Landscape Preference: Preference for Streetscapes

While vegetation and water are among the most powerful predictors of preference in urban landscapes, they are not the only elements that contribute to an individual's preference evaluation. An investigation of preferences for an urban streetscape found that elderly pedestrians placed positive value on elements that are functionally related to locomotion, such as street crossings and transit stops. Subjects of this study also associated higher volumes of traffic with positive judgments due to the suggestion of increased human presence, but placed a negative value on other elements such as litter, vacant buildings and high density development, due mainly to perceived safety concerns. In addition to these elements, perceptions of safety were also linked to the poor upkeep of the streetscapes, which was in turn shown to negatively influence preference (Borst, Meidema, de Vries, Graham, & van Dongen, 2008). In a similar study of preference for central business districts an affective evaluation instrument was used to show that the prominence of traffic is the element that is actually the most associated with negative preference judgments, whereas another study of preference for San Francisco streets indicated that cars, as well as overhead wires, had little effect on the public's evaluations of the landscape (Nasar, 1987; Stamps III, 1997). Finally, in a photo based path choice experiment Zacharias (2001) investigated choice behavior in an urban setting and, similar to Borst et al. (2008), found the presence of people in the landscape to have a strong positive influence on route choice. By manipulating the photographs the author also showed that the inclusion of elements such as signs and awnings could positively influence route choice; although Stamps and Hong (1999) report that this phenomenon may vary with the perceived obtrusiveness of these elements. Other specific elements that have been found to influence the preference of streetscapes include façade color, façade complexity and building articulation, as well as the sense of enclosure created by a particular array of buildings (Cubukcu & Kahraman, 2008; O'connor, 2006; Stamps III, 1999, 2005; Stamps III & Smith, 2002).

## 2.14 Representational Validity of Landscape Surrogates: Photos and Visualizations

Within the field of landscape assessment most studies now use landscape surrogates (i.e. photos or simulations) to measure responses to the landscape instead of actual onsite visits. Not only does this approach reduce the barriers of financial budgets or time constraints, but because these media can be easily delivered to a wide range of participants, either via mail or over the internet, they actually offer the ability to improve the generalizabilty of research results. That said the use of surrogates to measure the public's judgments of a landscape makes representational validity an essential concern for the field of landscape assessment, as research results will only possess internal validity if participants' responses to the surrogates are truly congruent with their responses to the real environment (Daniel & Meitner, 2001; Herzog, S. Kaplan, & R. Kaplan, 1976; Herzog, S. Kaplan, & R. Kaplan, 1982). As mentioned earlier, representational validity is defined as "the extent to which landscape perceptions, preferences and/or judgments based on photographs *or simulations* correspond to responses elicited by direct experience with the landscapes nominally represented" [italics added] (Daniel & Meitner, 2001, p. 62).

Several studies have found that responses to landscapes can be influenced by stimuli other than static visual cues, raising concerns regarding the use of purely visual stimuli like photographs (Carles, Barrio, & Lucio, 1999; Kroh & Gimblett, 1992). For example both Carles, et al. (1999) and Anderson, Milligan, Goodman, & Regen (1983) have identified an influence of sound on landscape preference, whereas Hetherington, Daniel, & Brown (1994) found that preferences for photos of a river were less sensitive to actual water levels in the river than ratings based on a video, suggesting a relationship between media dynamics and preference. It is also suggested that because photographs control a subject's field of view their use as stimuli in landscape assessment research limits an individual's ability to experience the landscape, unduly effecting evaluations (Meitner, 2004; Scott & Canter, 1997).

To address these concerns several studies have directly measured response equivalence between onsite and photo-based evaluations. Hull and Stewart (1992) compared scenic beauty ratings measured during an onsite hike to those measured with photographs of the same landscape, and reported that hikers rated the real landscape as more beautiful than the corresponding photographs. They concluded that preferences were influenced by differences in meaning, novelty, and mood that were elicited during the onsite and photograph evaluation trials, and argued that higher levels of excitement during the onsite visit ultimately produced higher preference ratings. Hull and Stewart have consequently questioned the validity of photographs as a landscape surrogate for active environments. Scott and Canter (1997) have came to a similar conclusion using a multiple photo sorting exercise of images depicting various environmental contexts, stating specifically that people conceptualize the content of a photograph differently than they conceptualize the place being represented.

While the above findings each highlight potential concerns regarding the representational validity of photographs, the majority of studies disagree, concluding that photographs can in fact be used as a valid surrogate for direct experience with a landscape (Daniel & Boster, 1976; Kellomaki & Savolainen, 1984; Shuttleworth, 1980; Stamps, 1990). For instance, Stewart, Middleton, Downton, and Ely (1984) state that "despite theoretical arguments to the contrary, there are aspects of judgment and perception of the visual environment that can be studied using photographs" (p. 300), and Stephen Kaplan claims that "to criticize photographs as artificial and inadequate in landscape research is to fail to appreciate the nature of human perceptual mechanisms" (S. Kaplan, 1975, p. 93).

Due to increases in computing power and the exceptional growth of their use in research and practice, the question of representational validity has been extended to CLVs. Bishop and Rohrmann (2003) contrasted responses to an urban environment that were measured during a short onsite walk, with responses measured during a viewing of an animation that mimicked a walk through the same environment. They concluded that a representative CLV should evoke responses similar to those of a direct experience in categories of identification, orientation, encoding, aesthetic response, personal liking, safety, and manipulation. They also found that while both appreciation of the landscape and retention of information were somewhat lower among subjects who viewed the animation, the animations were still generally accepted as a valid representation of reality. Following a similar research design Wergles and Muhar (2009) utilized an open-ended questionnaire to compare perceptions of an urban square that were developed during an on-site visit with those that were developed during a viewing of static simulations of the square. Through a content analysis of participant's responses the authors discovered that the on-site experience was influenced by elements that cannot be represented using static CLVs. For example, on-site participants were impacted by traffic and the associated noise, as well as the dynamic nature of the light within the setting. Alternatively, perceptions of participants viewing the CLVs were influenced mainly by the tendency of the static visual media to focus their attention on specific elements, which implied a greater importance of these features in comparison to other elements in the scene. Results also indicated that participants viewing the simulations had difficultly discerning specific design details, such as material textures or the age of structures and vegetation. Finally, the overall impression of the urban square was noted as being considerably more positive among participants viewing the CLVs, with on-site participants describing the square as poor, anonymous, bleak and sterile, while CLV participants characterized it using terms such as splendor, grandeur, impressiveness and pomp. Although numerous factors were shown to interact with judgments of the landscape, the authors ultimately attributed the discrepancies to the ability of the CLVs to focus attention on predetermined and 'admittedly more impressive' configurations and elements.

Based on the acceptance of photographs as a valid landscape surrogate other studies have compared simulations to photographs to assess their representational validity. Bergen, et al. (1995) compared CLVs of a forest landscape to photographs of the same landscape and found preferences for the two to be highly correlated (r = 0.90). Similarly, Bishop and Leahy (1989) compared photographs of a natural landscape to digitized slides of the same views and found a moderate correlation (r = .76) in the preferences for the two presentation methods. They also reported that certain landscape elements, such as transmission towers, were highly recognizable and led to a higher correlation between the photos and other representations. Finally, validity has also been assessed for particular CLV properties, such as colour depth, degree of realism and simulation type, with studies suggesting a general equivalence of photographs and accurately prepared CLVs (Daniel & Meitner, 2001; Lange, 2001; Oh, 1994).

# CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

## 3.1 Research Design

The mixed methods research design followed in this study is based on quantitative and qualitative techniques that are common to experimental response equivalence testing. (Bishop & Leahy, 1989; Scott & Canter, 1997; Shuttleworth, 1980; Wergles & Muhar, 2009). An experimental design was chosen over a correlational design as it allowed the researcher to focus on the causality of the relationship between participant's landscape perceptions/preferences and the type of simulation they were assessing (i.e. calibrated or biased) (Neuman, 2007, p. 205). As such an urban streetscape and an urban park were used as case studies in a repeated measures experiment that used depth interviews and a quantitative sorting exercise to compare participant's landscape perceptions and preferences for three visual representation types (i.e. photos, calibrated CLVs, and biased CLVs). Depth interviews were utilized due to the exploratory nature of this research and because a quantitative instrument was deemed too imprecise to capture the nuanced aspects of landscape perception in a robust way (Miles & Huberman, 1994). Alternatively, preferences for the three types of visual stimuli were measured with a quantitative sorting exercise and validated with data from the depth interviews. This mixed methods approach not only offered the ability to statistically compare participants' preferences, but allowed for a deeper exploration of the motivations behind these evaluations as well. The null hypotheses that were tested to answer research questions one and three were:

**$H_o$1:** Preferences for the calibrated 3D computer landscape visualizations *will not be* similar to preferences for the landscape photos

**$H_o$2:** Preferences for the biased 3D computer landscape visualizations *will not be* different than preferences for the landscape photos

On a broader level the choice to focus the experiment on a comparison of landscape perceptions and preferences was based on Daniel and Meitner's (2001) definition of response equivalence, which was discussed earlier in this thesis. In addition to using this established foundation to frame the methods for this research, landscape preference also offered a high level of external validity as a metric, as the public's general preference for a landscape is what planners are often looking to assess when they use simulations in public engagement. Finally, building the interviews that were necessary for this study around a preference instrument also improved reliability and ease of operationalization with the public, as it is a readily understood concept.

## 3.2 Study Site Selection

As a literature review indicated that the majority of CLV response equivalence research has focused on forested or rural landscapes, it seems that the validity of CLVs that represent urban environments has been accepted on the merits of only a few studies, or potentially on the assumption that simulation validity will be the same across environment types. This cursory acceptance is more than troubling given the extensive use of simulations to communicate urban issues and the vast differences that are known to exist between the public's perceptions of urban and natural environments. That said the case study selection for this research was driven largely by the need to assess simulation validity in an urban context. To do this two landscapes types were chosen for this study; an urban streetscape and an urban park. The justification for choosing these landscape types is that they are common targets for planning initiatives and are thus likely to be the subject of CLVs in a real world context, not to mention the fact that the use of two distinct environments allowed the reliability of results to be evaluated.

Research has shown that a subject's familiarity with a particular landscape can significantly influence their preference, making landscape familiarity an important consideration in response equivalence testing (Herzog, 1982; Herzog et al., 1976). To reduce the effects of landscape familiarity on the results of this study, which interviewed participants exclusively from the region of Waterloo, the Greater Toronto Area was selected as a starting point for a more detailed investigation of potential study sites. During field visits the criteria listed in Table 3.1 were used to evaluate five potential streetscapes and five potential parks within the GTA. Ultimately Centennial Park and a section of Queen Street East were chosen as the most suitable study sites, as they offered the best combination of the selection criteria (see Figure 3.1 for a map of the study sites).

**Table 3.1 Study site selection criteria.**

| Criterion | Justification |
|---|---|
| Familiarity | To reduce the potential influence of past experience on preference judgments the study sites should be unfamiliar to the participants |
| Diversity of Landscape | To increase the reliability of the results the study sites should be diverse enough to allow for the creation of a variety of visual landscape stimuli |
| Landscape Change Potential | To increase the validity of the results the study sites should be similar to the type of landscapes that would be the subject of CLVs in planning practice |
| Visualization Potential | To make the creation of the virtual models feasible the study sites should be typical, but not so complex that they cannot be visualized efficiently |

The selection of specific viewpoints within each study site was imperative to the success of this study as photo elicitation research requires that careful attention be given to the accurate representation of a landscape's character and diversity. Rachel Kaplan (1985) has argued that a generalization about a landscape from a sample of unrepresentative images should be scrutinized to the same level as generalizations about a population based on unrepresentative individuals. To address this concern a range of potential viewpoints were carefully investigated in each study site and a total of twelve views from each landscape were photographed during an initial field visit. These twenty-four viewpoints were then narrowed down to six viewpoints per site. Appendix A illustrates the final viewpoints that were chosen for this study and the criteria used to select these viewpoints are listed below in Table 3.2.

**Table 3.2 Viewpoint selection criteria.**

| Criterion | Justification | Example |
|---|---|---|
| Diversity | The range of viewpoints should encapsulate the diversity of functions that the landscape serves | The Queen Street East viewpoints showcase the mixed use nature of the study site, including scenes depicting residential, commercial, institutional and mixed land uses |
| Social Character | Each viewpoint should accurately reflect the social atmosphere embodied in the landscape, including aspects of cultural diversity, socio-economic status and levels of human activity | The Centennial Park viewpoints reflect the diverse cultural background of users who frequent the park, as well as the various types of social interaction that the park supports |
| Physical Character | The range of viewpoints should encapsulate the physical composition of the landscape, including the mix of vegetative species, the condition and style of buildings, and the abundance of infrastructure within the study site | The Queen Street East viewpoints showcase the evolving nature of the landscape, illustrating both old and new building stock within the area |
| Importance | Each viewpoint chosen should depict an area within the landscape that is important to the needs of it's users or to the ecological function of the landscape itself | The Centennial Park viewpoints illustrate some of most frequented areas in the park, which provide capacity for large social gatherings and serve as the main pedestrian connections between various areas in the landscape |
| Visualization Potential | The amount and complexity of physical elements in each viewpoint should be controlled to ensure that the viewpoints can be modeled in a reasonable timeframe | The Queen Street East viewpoints were intentionally positioned to limit views down the streetscape (i.e. they looked directly across the street), thus reducing the number of buildings that needed to be modeled |
| Impact | The physical and social composition of each viewpoint should allow for a range of persuasive visualization techniques to be explored, including vegetation techniques, entourage techniques and atmospheric techniques (see Section 3.5) | The range of Centennial Park viewpoints intentionally included areas with differing levels of human activity to allow for the impact of the presence and characterization of people in the landscape to be explored |


**Figure 3.1  Map of study site locations.**

## 3.3 Context of Study Sites

Centennial Park was founded in 1967 by the Etobicoke municipal council as a Canadian centennial project. Occupying 105 hectares in central Etobicoke, the original design was completed by Sasaki, Strong and Associates. Today, Centennial Park is one of Canada's largest urban parks, having grown to over 210 hectares. In addition to drawing nearly 1.5 million annual users, the park has recently undergone a master plan update to ensure its future viability. The park offers multi-season recreation opportunities and includes facilities for active recreation, such as skiing or baseball, as well as a vast network of picnic areas and walking paths that allow for more passive endeavors. One of the most distinguishing features of Centennial Park is its significant indoor recreation complexes, which are deemed to be a cultural, as well as recreational, asset to the park. The eastern portion of the park is dominated by turf, although vegetation becomes more natural towards the western extent. In total there are thirty-two distinct vegetation communities, as well as a significant lake feature and scattered wetlands that are spread throughout the park. While Centennial Park is surrounded by neighbourhoods that reflect the diverse ethic makeup of the GTA, the size of the park and the unique sporting opportunities it offers (e.g. cricket and frisbee golf) make it a regional attraction that draws users from around the city (City of Toronto, 2008).

The streetscape site chosen for this research is located in Toronto's 32nd Ward and occupies a stretch of land along Queen Street East between Greenwood Avenue and Victoria Park Avenue. The dwellings within the greater area of Ward 32 are composed mainly of a mixture of single-detached houses (21.9%), semi-detached houses (21.4%), low-rise apartments (34.7%) and high-rise apartments (12.7%). Along the Queen Street East corridor, however, the building stock is composed mainly of three to four story mixed use buildings with ground floor retail. The theater/racetrack complex near the corner of Queen Street East and Coxwell Avenue is one of the most significant structures along the corridor, although several cultural buildings such as the Corpus Christy Catholic Church and the Toronto 227 fire station also possess a strong presence on the street. Many of the structures along the Queen Street East corridor have received façade improvements, but a large portion of the buildings show significant signs of aging. The demographics show Ward 32 to be composed mainly of residents that identify English as their primary language (88.1%). They also indicate a lower proportion of first generation immigrants (31.7%) than the greater city population (59.1%), as well as a significantly lower proportion of visible minorities (21.2%) than in the city as a whole (46.9%). (City of Toronto, 2006).

## 3.4 Computer Landscape Visualization Approach

Given that the objective of this research is to evaluate the influence of CLV processes that are common to planning practice, external validity is a key concern with regards to creating the actual simulations used in this study. For this reason care was taken to adopt a 3D modeling approach that reflected industry procedures and trends, making photo-realistic, static images captured from a 3D virtual model the most representative choice. This form of simulation was deemed the most suitable for this study because even though there are drawbacks to high levels of detail, photo-realism is generally sought when simulations are used to communicate with the public (Appleton & Lovett, 2005; Karjalainen & Tyrvainen, 2002). Likewise, while animations are gaining popularity within the planning discipline, especially in the area of transportation planning, their use is still quite uncommon in the broader context of Canadian planning practice.

The 3D virtual models of the Queen Street East study site and the Centennial Park study site were created using different CLV tools. Google's Sketchup was used to create the Queen Street

East model as it is a popular tool in practice that is arguably becoming the industry standard for municipal planning offices. As such simulations created with this software are expected to be the most common within public engagement, and thus the most familiar to members of the public. Unfortunately, because the 3D modeling of more natural landscapes is less common in practice it was not possible to use industry standards to choose a CLV tool for the modeling of Centennial Park. To ensure the choice of technology was not completely unjustified, a decision was made to base the use of a CLV tool on academic studies within the fields of planning and related disciplines. After considering several visualization options, such as Blender or 3DSMax, 3D Nature's Visual Nature Studio (VNS) emerged as the best option. Not only was VNS found to be a popular tool for modeling natural landscapes in academia, but its functionality was fully capable of producing the accurate, photo-realistic images necessary for this study. Moreover, as VNS is based on a GIS platform one might speculate that it will garner more interest in the future as municipalities increasing move to GIS based data management systems (Appleton & Lovett, 2003; Appleton et al., 2002; Donaldson-Selby et al., 2007; Lewis, 2008; Von Haaren & Warren-Kretzschmar, 2006).

## 3.5 Creation of Visual Stimuli: Photos and Computer Landscape Visualizations

Using a Canon G6 digital camera a total of five photos were taken for each of the twelve selected viewpoints over the course of two weeks in early July, 2008. The camera's settings were adjusted such that raw colour photos with a 50 degree field of view were collected at the highest resolution possible (3072 x 2304 pixels). To ensure the images were representative of typical landscape views all photos were taken from accessible locations at ground level with the camera pointed parallel to the ground plane (Sheppard, 1989). Photos were taken between 10 am and 2 pm, with each viewpoint being photographed at approximately the same time each day. No specific attempt was made to avoid the inclusion of particular elements in the photos, although the images that were ultimately included in the stimuli set were carefully selected to ensure they contained representative site conditions. As such, photos for different viewpoints contain differences in sky conditions, numbers of people, numbers of vehicles, etc. It should be noted that the inclusion of such diverse site conditions in the stimuli was intentional, as it allowed for the exploration of a wider range of techniques that are commonly used to enhance the visual appeal of CLVs used in planning practice.

To create the simulations for the calibrated scenario a process was followed that would ensure the accuracy and representativeness of the images produced. A DTM for each study site was created by importing the City of Toronto's 1m contour data and altering the surface structure to include elements such as roadways, curbs, sidewalks, riverbeds and lake basins. Surface textures, such as grass, were added to the DTM using primarily geospecific textures, although a number of geotypical textures were required for the Queen Street East model. Buildings for both study site models were created in Sketchup by extruding building footprints (digitized from 7.5 cm orthophotos) and adding geospecific, geotypical or procedural textures. To ensure accuracy the textures that were used were colour matched to site photos using Adobe Photoshop. The height of buildings within various scenes were determined by comparing their height in reference photos to the height of a known scale object, and similar photogrammetric techniques were used to add accurate structural details (e.g. doors) to the buildings. Due to computer hardware limitations the buildings for the Centennial Park model could not be directly imported into VNS. To work around this limitation the buildings were first rendered in the Artlantis rendering engine and then added to the final park images using a photomontage technique.

As a one-to-one representation of entourage elements within each scene was required for the calibrated CLVs, a great deal of time and effort was spent modeling elements such as light posts, signage, waste bins, etc. Texturing of these elements was again completed using geospecific, geotypical or procedural textures, and colour matching was carried out when necessary. Vegetation and atmospherics were added to the Queen Street East model using the Artlantis rendering engine. Vegetation billboards were created from actual site photos and were located in the model with GIS reference points. Each billboard used was calibrated to the height and species of the corresponding real world tree, as measured in the field. Atmospheric conditions in the model were calibrated by colour matching the sky to site photos and by visually matching cloud and haze conditions to site photos. Lighting conditions were calibrated for each viewpoint by inputting the study site model's location into the software and matching the time and date in the lighting algorithm to the time and date that the photo of each viewpoint was taken. The addition of vegetation and atmospherics to the Centennial Park model was completed using the same methods, only in VNS.

The final images for the calibrated set of CLVs were rendered from the same relative viewpoints as the site photos, with render settings in the software (e.g. resolution) matched to the settings that the photos were taken with. Humans and vehicles were added to each rendered viewpoint as billboards using a photomontage technique in Adobe Photoshop, and the characterization of these elements was visually matched to the corresponding site photo. The result of the process followed in the creation of the calibrated CLVs was a set of simulations that accurately represented true site conditions in terms of vegetation composition and morphology, atmospheric conditions, entourage presence and general site character (See Figure 3.2 below).

The simulations for the biased scenarios were rendered from the same virtual models described above and are identical to the calibrated CLVs in properties such as viewing perspective, field of view and image resolution. As the same actual data were used to create them, the only way the biased CLVs differ is in the use of specific techniques that enhanced the visual appeal of the landscape being shown. Table 3.2 outlines the techniques that were used to enhance each viewpoint. Because these techniques are not used in planning practice in an isolated or standardized fashion, their use in this study follows no systematic design. They were simply employed much like they are in practice, using informed judgments to combine techniques in a manner that best enhances the perceived visual quality of each scene. By avoiding any reductionism that might tempt one to implement and measure only a single technique in two contrasting stimuli, this approach allows for a more externally valid exploration of the phenomenon as the CLVs are more akin to the true character of those used in practice (Fromkin & Streufert, 1978). Figure 3.2 provides an example of the biased simulations.

Photographs

Calibrated CLVs

Biased CLVs

**Figure 3.2  Example of the visual representation types that were used as visual stimuli.**

**Table 3.3 Techniques used to enhance the visual quality of the biased computer visualizations.**

| | | | Queen Street East Viewpoints | | | | | | Centennial Park Viewpoints | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Theater | Retail | Service | Fire Hall | New Residential | Mixed Residential | Lake | Pavilions | Pond | Picnic Shelter | Open Field | Pathway |
| Vegetation Techniques | | Species | | x | | | x | | | x | x | x | x | x |
| | | Amount | x | x | x | x | x | | x | | | | x | x |
| | | Position | x | x | | x | x | | | | | | x | |
| | | Age/Size | x | x | | x | x | | x | x | x | x | x | x |
| Atmospheric Techniques | | Lighting Conditions | x | x | x | x | x | x | x | x | x | | x | |
| | | Sky Conditions | x | x | x | x | x | x | x | x | x | x | x | x |
| | | Fog/Haze Effects | | | | | | | | | x | | x | |
| Entourage Techniques | Landscape Clutter | Present | | | | | | | | | | | | |
| | | Absent | x | x | x | x | x | x | x | x | | | x | |
| | Vehicles | Amount | | x | x | x | x | | x | | | | x | |
| | | Condition | x | | | | | | | | | | | |
| | People | Amount | x | x | | x | x | x | x | x | | x | x | x |
| | | Activity | | | | | x | | x | x | | | x | |
| | | Appearance | x | x | x | | | x | | x | | x | x | |
| | | Age | x | x | | x | x | | | x | | | | x |
| Water Techniques | | Colour | | | | | | | x | x | x | | | |
| | | Reflectivity | | | | | | | x | x | x | | | |

The techniques used in the creation of the biased CLVs were based on discussions with industry professionals, examinations of simulation products within the field, literature on landscape preference, as well as the researchers past experience developing landscape simulations. In general they fall into three categories:

- *Vegetation techniques* that use over mature and strategically placed vegetation billboards to buffer unattractive landscape elements.

- *Atmospheric techniques* that use enhanced lighting or sky conditions to influence the mood of the scene.

- *Entourage techniques* that exclude unattractive elements such as overhead wires and vehicles, or use billboards of specifically characterized people to influence viewers perceptions of the character of the landscape.

Digital images of the photos, calibrated CLVs and biased CLVs were used to create hardcopy pictures for participant interviews. A total of thirty-six hardcopy pictures were produced by developing the digital images into 11” x 14” matte photo-format pictures.

## 3.6 Participant Selection and Recruitment

Purposive sampling strategies should be used in research in three instances: when information being sought can best be accessed via especially informative subjects; when the objective is to gain a deeper understanding of an undefined phenomena through depth interviews; and when generating a comprehensive list of a population is impossible (Neuman, 2007). In this study the latter two conditions apply. More specifically, the influence of biased simulations on the public’s landscape preferences and perceptions has yet to be studied, thus depth interviews were required to investigate exactly how different visual stimuli might effect these aspects of a landscape evaluation. In addition to this it was not possible to develop a sampling frame that incorporated all members of the public who have experienced CLVs in a planning context, simply because simulations are communicated through so many formal and informal pathways. For these reasons specific individuals who were known to be involved in aspects of the planning process, and thus likely to have experienced CLVs in this context, were selected. Focusing on these individuals not only provided more in-depth data that allowed for a deeper exploration of the concept at hand, but also increased the external validity of the sample as responses to the simulations were more akin to those from other individuals involved in real world planning processes (Black, 1999).

Based on this reasoning three pools of potential participants were identified, including municipal councilors within the Region of Waterloo, members of neighbourhood associations within the region, and undergraduate students from the School of Planning at the University of Waterloo. All potential participants were first e-mailed a detailed description of the study and if interest was shown a phone call was placed to set up a meeting time and location. The recruitment procedure was carried out until interviews began to return repetitions in information from participants, making it unlikely that additional interviews would yield new data (Lincoln & Guba, 1985). In addition to this saturation technique a sample size calculation that was based on effect sizes observed during pretests also indicated that significant statistical results could be expected with a sample of 20-30 individuals (Stamps, 1992). Table 3.4 summarizes the key characteristics of the twenty individuals who participated in the response equivalence experiment.

**Table 3.4 Key characteristics of response equivalence participants.**

| Key Characteristic | Key Characteristic Categories | # of Participants (t= 20) |
|---|---|---|
| Experience with the planning process | University education in a planning program | 8 |
| | Active member of a municipal council | 4 |
| | Current member of a neighbourhood association | 8 |
| Experience with visualizations | **Ample:** exposure to visualizations used to communicate planning initiatives, as well as experience using visualization software | 8 |
| | **Moderate:** exposure to visualizations used to communicate planning initiatives but no experience using visualization software | 12 |
| Occupation | **Student** | 8 |
| | **Retired** | 2 |
| | **Professional** (examples: financial analyst, university professor, community program manager) | 7 |
| | **Non-Professional** (examples: general labourer, retail employee) | 3 |
| Age | **21 - 35** | 8 |
| | **36 - 50** | 8 |
| | **51 - 65** | 3 |
| | **65+** | 1 |
| Sex | **Male** | 11 |
| | **Female** | 9 |

## 3.7 Interview Procedure

A repeated measures design was used in this study to reduce the influence of unsystematic variation this is typically caused by between-participant rating differences, meaning that all participants discussed and provided a landscape preference rating for each of the thirty-six visual stimuli. The time and location for interviews were determined by participants and were generally carried out at the participant's home or place of work. At the outset of each interview subjects were provided with a general description of the study's objectives, were introduced to the stimuli that they would be working with, and were asked if they consented to the audio recording of the interview. One caveat to this is that a description of the difference between the calibrated and biased simulations was not provided until the end of the interview procedure, so as to avoid any potential influence on the subject's preference choices. During a pretest carried out in the early phases of the research process subjects indicated that rating all thirty-six images at once made it difficult to elaborate on the motivations behind their preference choices. Consequently the actual interview procedure had participants rate and discuss the images for each study site in two separate, consecutive exercises. In addition to reducing participant fatigue this alteration to the interview procedure also reduced the potential for evaluations of one environment to contaminate perceptions and preferences for the other.

Before beginning the rating exercise subjects were asked several background questions, which included how they were involved in municipal planning and what level of experience they had with CLVs. During each sorting exercise subjects organized the eighteen randomly arranged stimuli into five preference categories based on how much they liked or disliked the landscape that was being shown. To negate any desire to group images of the same viewpoint into the same pile, subjects were instructed to place the images face down. Likewise, to ensure that preference ratings were based on the landscapes being represented and not the quality of the photographs or renderings, participants were asked to imagine themselves standing in the landscapes they were rating. After sorting all the images participants were given an opportunity to alter their choices.

Upon completion of the sorting task the preference categories were used as a catalyst to discuss motivations behind subject's choices, using an interview guide to ensure consistency across all participants. Based on their preference ratings subjects were first asked if they could identify anything that may have broadly influenced the choices they had made. Following this they were asked to explain both what was similar about the images in each preference category, and what was different between the images in that category and others. Once the first sorting exercise was completed a second pile sort was carried out using the visual stimuli from the other study site. The presentation order for the two environments, as well as for the stimuli themselves, was counterbalanced to allow for the investigation of order effects. Interviews ranged in length from forty-five minutes to two hours depending on the level of detail that subjects provided in their explanations.

## 3.8 Quantitative Data Analysis

Literature discussing the analysis of response equivalence data identifies two theoretical units of analysis for examining preference evaluations. Hull and Stewart (1992) argue that because the individual actually makes the preference judgment, analysis should be based on changes in preference at the individual level. Alternatively, Daniel and Meitner (2001) claim that individual responses posses a low level of internal reliability and are thus an inappropriate measure. They state that because practical landscape management situations attempt to meet the needs of as many individuals as possible, an average group preference measure is a more appropriate unit of analysis. Based on these two arguments the analysis procedure followed in this study pays careful attention to the consistency between individual preferences and two separate group averages, thus investigating statistics at three levels of analysis. Individual ratings are examined by looking at patterns in preferences for the three representation types as given by each individual. The first group level of analysis compares the same stimuli sets by examining preferences that have been averaged for all participants for each specific viewpoint. Finally, the highest level of group analysis compares preferences for the three representation types by examining the average rating for each type across all six viewpoints in each environment (i.e. the grand mean). Figure 3.3 provides a graphical representation of the three level statistical analysis and how landscape preferences at each level are linked.

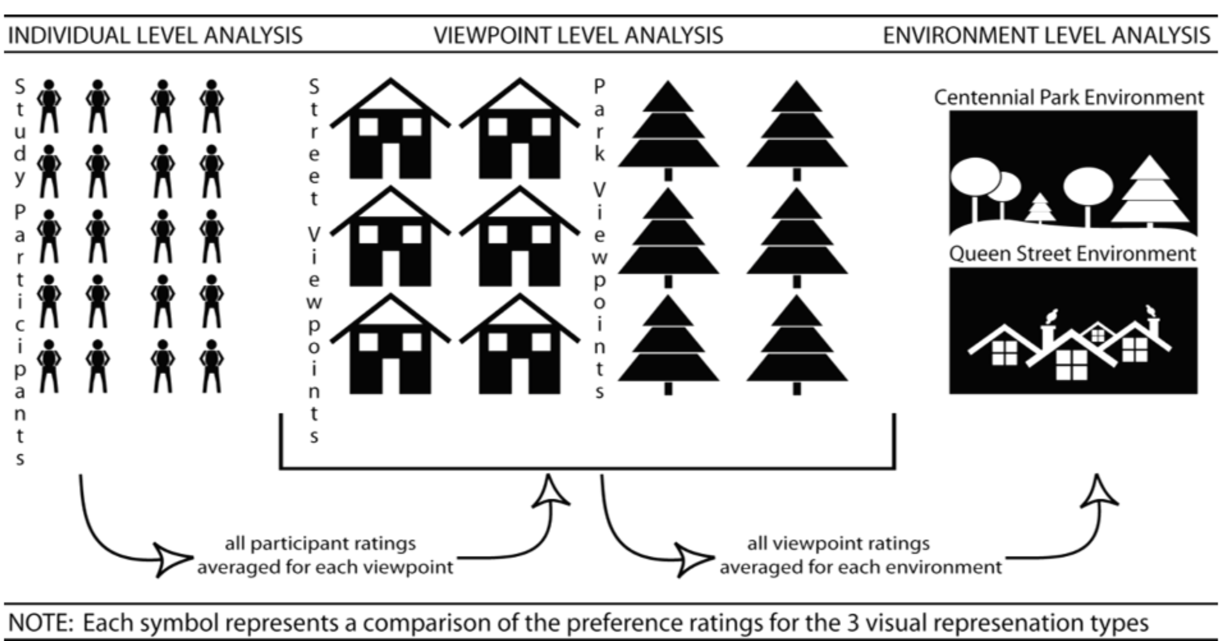


**Figure 3.3 Diagram explaining the quantitative response equivalence analysis.**

The quantitative analysis of the landscape preference scores was carried out in the SPSS data mining software using statistical techniques appropriate for the repeated measures design employed in this research. First, descriptive statistics were produced to investigate patterns in the preference ratings of the photos, calibrated CLVs and biased CLVs, as well as to identify any subjects that were potential outliers. These descriptive statistics were examined at the level of each participant, each viewpoint, and each environment, ultimately allowing for a comparison of the three visual representation types at multiple levels of data aggregation (i.e. different levels of analysis). Based on participant's self-reported familiarity with CLVs the analysis of individual preferences was organized into two participant experience categories. Category one included eight participants that had *ample* exposure to CLVs, including experience using CLV software. Category two included twelve participants that had *moderate* exposure to CLVs, but no experience creating them. The average preference ratings for the three visual representation types were compared between the experience groups using an independent samples t-test. An independent t-test was chosen over a dependant t-test, or a non-parametric alternative, because the *ample* and *moderate* experience groups were separate test conditions that both had normal distributions of the dependant variable. This test was done to determine if experience with CLVs influenced the ability of the simulations to alter landscape evaluations.

For both study sites each participant's mean landscape photograph rating was subtracted from their mean calibrated CLV rating (*C-P*) and their mean biased CLV rating (*B-P*) to produce two separate *difference measures*. These *difference measure*s were used in lieu of absolute values when a statistical comparison was between individuals, such as in the data normality tests. This was done because a comparison of the *difference measure*s, as opposed to the absolute values, reduced the unsystematic variation that could have been introduced through the idiosyncratic use of the rating scale (i.e. subjects sometimes anchor their evaluations at different places on the scale) (Daniel & Meitner, 2001). To facilitate analysis at the individual level the two *difference measure*s were also graphed for each subject and the *B-P difference measure* was used to investigate potential outliers who were subsequently removed from any inferential analysis. As mentioned the *B-P difference measure* was also used to test the normality of the preference data at both the viewpoint and environment level by using the Shapiro-Wilk test, which calculates exact significance values and is generally more accurate than the corresponding Kolmogorov–Smirnov test (Field, 2005). The internal reliability of the preference scale was assessed across all thirty-six rated images by calculating the Cronbach's alpha. A value of .80 was taken as the critical threshold to accept that each participant used the scale in a consistent manner. Cronbach's alpha coefficient was used to measure consistency of the rating scale because the variability important in this study is related to a measurement scale applied across a number of test items. If the study had included the measurement of a variable over a given time span then a test-retest consistency check would have been more appropriate. In addition, because only a single dependant variable was measured by the rating scale there was no breech of unidimensionality, meaning the alpha coefficient could be applied across all measured items to investigate the scale reliability (Cortina, 1993).

In consideration of the findings of Schroeder (1984) and the recommendation of Daniel and Meitner (2001) mean group preferences at the viewpoint and environment level were analyzed using simple inferential statistics as opposed to more complex scaling methods. The mean preference ratings of the three visual representation types were compared for each of the twelve viewpoints using a non-parametric Friedman's ANOVA and Wilcoxon Signed-Rank Post Hoc tests. A Friedman's ANOVA was chosen over a classic parametric ANOVA because the viewpoint level preference data did not meet the assumption of normality. Among the non-parametric techniques the Friedman's test was selected over a Kruskal-Wallis test because the preference ratings were collected using a repeated measures design and thus independence of responses could not be assumed. When the mean preference ratings of each visual representation type were compared at the environment level the data met the normality assumption, but not the assumption of independent responses. Due to these conditions a parametric test, which is generally more powerful than a non-parametric equivalent, was suitable. A repeated measures ANOVA had to be applied in lieu of a classic ANOVA because the classic ANOVA is inaccurate when applied to repeated measures data. As the data did not indicate a significant departure from sphericity the results of the repeated measures ANOVA were reported without applying a correction (e.g. Greenhouse-Geisser) (Field, 2005). Finally, effect sizes were calculated in all instances when a comparison was directly between a photo and a simulation (i.e. the contrasts and post-hoc tests) as they provided the ability to measure not only if the CLVs influenced preference, but how much influence they actually had (Cohen, 1988; Stamps 1999). A Cohen's D value was used to report effect sizes rather than a Pearson's r because of it's prominence as a measure in the field of environmental psychology, thus allowing a more direct comparison of these results and those of other studies.

## 3.9 Qualitative Data Analysis

Before any analysis began each participant was assigned a pseudonym that has been used to identify them throughout this thesis. Following this the tape-recorded interviews were transcribed and subjected to a schema analysis that organized participant's responses into a set of theoretical domains (Ryan & Bernard, 2003). During an initial open coding phase key comments were entered into a research database and were arranged into two categories based on whether they represented a negative or positive preference reaction to the three stimuli types. A second round of axial coding then iteratively divided these two initial categories into holistic themes that were related to the visualization techniques used in the creation of the CLVs. These themes ultimately included specific comments from participants about the influence of: sky conditions; atmospheric lighting; the presence of people; the activity that people were engaged in; the presence of vehicles; the presence of clutter; tree morphology; and the use of texturing techniques. Using findings and theories from the landscape assessment literature, a framework was then created during selective coding that linked the eight themes into five related domains that explained the influence of the simulations on landscape perception and landscape preference. One of these domains was made up of comments that directly explained the impact of the visualization techniques on the aesthetic quality of the landscapes, and as such it was used to validate the results of the quantitative preference analysis. The remaining four domains used prevailing landscape perception theory as a lens to explore the open ended discussions, providing a theoretical account of how the various visualization techniques impacted participants' evaluations by first altering their landscape perceptions. This additional step in the analysis was critical as perceptions are an important primer in the creation of preference judgments, as well as a component of the response equivalence definition used in this research. This framework is presented graphically at the beginning of Chapter 4, and the coding variables that were used in the schema analysis are included in Appendix D.

## 3.10 Addressing Reliability and Validity

Research designs employing qualitative methods are often criticized as being too open to interpretation to be considered truly empirical, and in instances where there is a poor application of the qualitative method this assertion may be true. However, this criticism fails to recognize that a carefully planned qualitative or mixed methods design contains all the reliability and validity checks required of empirical research, although they are present in a different form than those common in the quantitative research paradigm.

Reliability is related to the dependability or consistency of a research process (Neuman, 2007). More precisely, "internal reliability refers to the degree to which other researchers would match previously generated constructs with a particular data set in the same way as did the researcher who originally complied it" (S. Schensul, J. Schensul, and LeCompte, 1999, p. 275). In this research reliability was aided by the coupling of image elicitation and semi-structured interviews as a means of data collection. This interview approach created a comfortable atmosphere that helped participants clearly articulate difficult concepts, reducing the likelihood of misinterpretation on the part of the researcher (Lewis, 2008). Also, because the photo elicitation process reduced participant fatigue, misreporting of information due to disengagement became less likely (R. Kaplan and S. Kaplan, 1989). As mentioned previously the use of a simple measurement construct (i.e. landscape preference) also reduced the need for any complicated explanations on the part of the researcher, again improving measurement consistency between participants. Finally, the interviews were subject to the stringent use of an interview guide by the researcher, ensuring that questions were asked in a consistent manner, thus further reducing potential for interpretive differences between participants.

In addition to reliability benefits that were built in to the research design, internal reliability was also directly assessed for the quantitative and qualitative measures that were used in this study. As noted above the reliability of the preference scale that was used in the image sorting exercise was evaluated with the Cronbach's alpha statistic. The intercoder reliability of the schema analysis was also assessed by having a colleague, who is external to the research process, code a sample of the participant transcripts using the defined code variables. Themes developed by this external coder were compared to those developed by the principal researcher to ensure the coding variables were indeed applied in a holistic and consistent manner.

Another concern with consistency in the research process is external reliability, which "addresses the issue of whether independent researchers would discover the same phenomena or generate the same constructs as an original researcher if they did the study in the same or similar settings" (S. Schensul et al., 1999, p. 275). The external reliability of this research is considered in the context of several recommendations outlined by Miles and Huberman (1994). First, the research objective for this study is clearly defined and has been directly translated into research questions and testable research hypotheses. Furthermore, the choice of the study design was carefully constructed and implemented based on methods and techniques common to response equivalence research. Second, with regard to 'parallelisms across data sources', the field data and site conditions that were used to develop the simulations were collected over an extensive time period, giving the researcher the opportunity to accurately assess the character of the study sites. More importantly, the CLV development processes used to create the calibrated and biased simulations were based on techniques used in planning practice and were further informed by findings in the literature. Finally, many of the quality checks that were performed, including pretests and an intercoder reliability assessment, involved constructive criticism from researchers external to the study and in some instances resulted in helpful modifications to the overall research design.

Beyond the reliability of the research procedures it is also important to evaluate the validity of the research design itself. Face validity "is the extent to which a measure, on the face of things, seems to tap the desired concept" (Neuendorf, 2003, p. 115). One common threat to face validity is the use of a measurement instrument that is inappropriate for measuring the construct of interest, such as using a paint by numbers exercise to assess a person's artistic ability. In this study the instrument and definition used to operationalize participant's landscape preferences were based entirely on common practices within the landscape assessment literature. Furthermore, pretests were carried out with colleagues to evaluate whether the operational definition accurately represented the landscape preference construct. Another potential threat to face validity is the influence of unsystematic variance on the measurement of the main construct. As mentioned the repeated measures design used in this study helped to reduce this effect by eliminating between-participant variance (Field, 2005). Finally, after the recruitment process was completed member checks were performed with three participants to confirm that their initial interpretation of the preference measure was consistent with the operational definition. During these member checks participants were also shown how their individual responses contributed to the overall schema analysis database, which allowed for the researchers interpretation of the data to be validated by participants.

Criterion validity “is the extent to which a measure taps an established standard or important behavior that is external to the measure” (Neuendorf, 2003, p. 115). In this study the desired constructs were measured using both quantitative and qualitative instruments, which allowed for the validation of the measurement instruments and corresponding results against each other (Black, 1999). In addition to the use of multiple measurement instruments, triangulation was applied during the analysis of qualitative data; wherein findings were considered only if they were mentioned by at least three different participants on numerous occasions. This allowed for the internal validation of important themes that could not be directly evaluated through external measures (Miles & Huberman, 1994). Finally, where possible the results were validated using findings reported in earlier studies.

External validity or generalizability “relates to whether the results of a measure can be extrapolated to other settings, times, and so on” (Neuendorf, 2003, p. 115). In experimental research external validity is generally concerned with the representativeness of a particular sample as compared to the population, or the representativeness of an experimental measurement process as compared to a real world process. Still, while this is the generally accepted notion, Miles and Huberman (1994) actually distinguish the concept of ‘analytic generalizability’ from these traditional quantitative definitions, wherein the goal is not to generalize results from the sample to the population, but to use generalized findings to inform the creation of theory. As the research performed here was somewhat exploratory in nature, this study is concerned with the latter of these two forms of generalizability. That said it could also be argued that the use of a highly representative sample, which included real world decision makers, enhanced both forms of generalizability.

# CHAPTER 4: RESULTS AND ANALYSIS

## 4.1 Introduction

This chapter presents and discusses the qualitative and quantitative response equivalence data that were collected during interviews with subjects. The chapter begins by discussing results from the schema analysis that examined the motivations behind subjects' preferences for the three types of landscape surrogates. To facilitate this discussion the impact of the simulations on subject's perceptions and preferences is graphically depicted in a framework that links the quantitative preference ratings to the actual techniques that were used in the CLVs. Following this, results from the quantitative response equivalence tests are presented in more detail and then discussed in light of findings from the 'aesthetic quality domain' of the schema analysis. This is done first for Queen Street East and then repeated for Centennial Park. As mentioned previously, because an appropriate unit of analysis for response equivalence testing is still subject to theoretical debate, the quantitative data for each environment are examined at three separate levels of analysis that represent both individual and group metrics (Daniel & Meitner, 2001; Hull & Stewart, 1992).

To help communicate the statistical analyses in an efficient manner the presentation of each level of analysis has been divided into two sections. The first section in each level outlines in full detail the results of all pertinent statistical tests carried out at that level. These sections are distinguished through the use of grey panels that are offset from the main body of text. In contrast, the second section in each level presents a more concise summary of the results and is not offset from the main body of text. Those readers seeking a complete, in-depth understanding of the data should read all sections, whereas readers looking for a synopsis of the results should avoid the text outlined in the grey panels. The final portion of this chapter revisits the results of the schema analysis by discussing in detail four specific effects that the simulations had on participant's landscape perceptions. This section, as well as the final chapter, also uses panels to facilitate a more efficient communication of the findings, only in this case it is raw interview data that are offset from the body of the discussion.

## 4.2 Qualitative Results

The diagram in Figure 4.1 summarizes a schema analysis of the interviews that discussed the reasons for participant's various preference choices, and it indicates that eight separate visualization techniques were key motivators in subject's landscape evaluations. In a certain sense the framework might be conceptualized as a map that describes how each visualization technique ultimately produced an influence on participant's preferences. As a matter of fact, because subjects personally reported the reason for any discrepancy in preference between landscapes shown with the three surrogate types, the link between the visualization techniques and their impact on subject's evaluations is quite explicit. Moreover the quantitative preference judgments can be externally validated using both qualitative data and findings from the literature; and because triangulation was required before a technique was identified as a theme, the qualitative results also posses strong internal validity. As such each of the eight techniques presented in the framework are believed to have caused a legitimate shift in subjects' evaluations of the Queen Street East and Centennial Park landscapes. One caveat to this argument is that the quantitative dataset could not be used to directly verify the path that each technique took through certain perceptual mechanisms, as the quantitative methodology used to measure preferences was too coarse to also measure landscape perceptions. That said the qualitative interpretation that forms this portion of the framework is completely in line with the body of research on landscape perception (See Chapter 2). The following sections discuss the framework in more detail, describing how the eight visualization techniques altered preferences for the same viewpoints by simply depicting the landscapes with a different visual style.

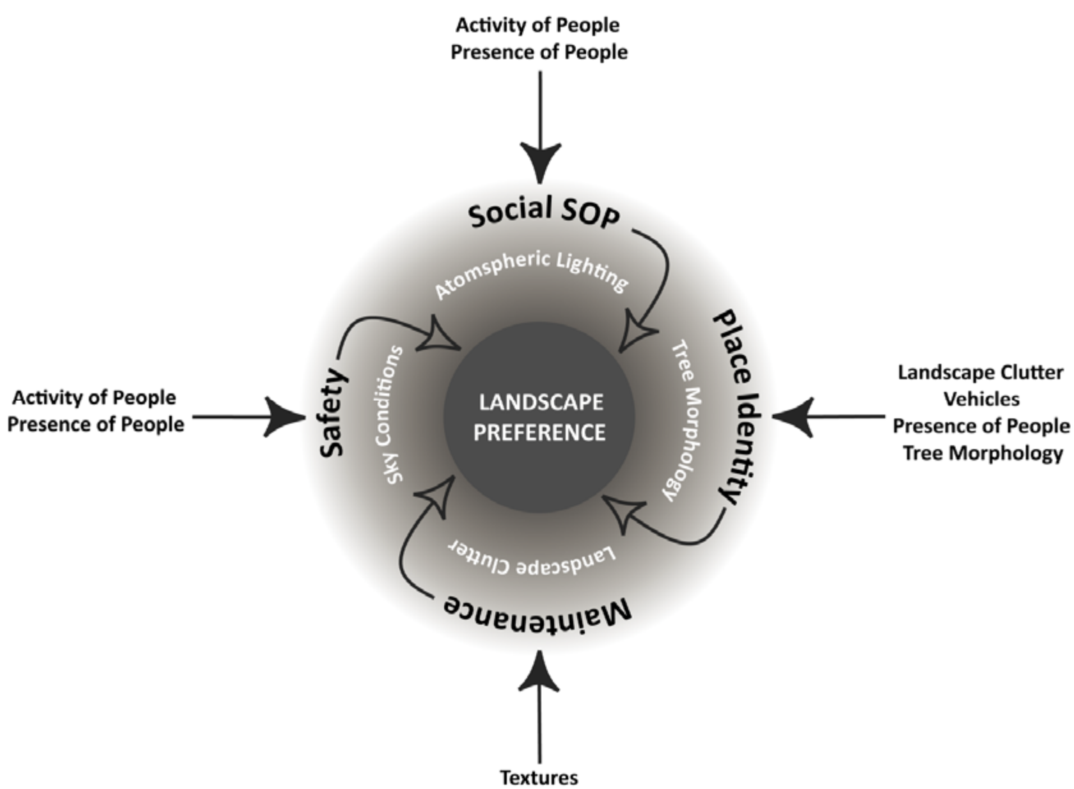


**Figure 4.1 Diagram relating influential CLV techniques to landscape preferences.**

There were two distinct paths that the visualization techniques followed to ultimately influence participant's preferences, although each technique was not necessarily bound to either specific path. Visualization techniques labeled in the framework in white (i.e. Tree Morphology, Landscape Clutter, Sky Conditions, and Atmospheric Lighting) were able to act directly on participants preferences for various scenes by improving the aesthetic appearance of the landscape in a very straightforward and obvious way. When discussing these techniques participants explicitly stated that they simply made the scene look better. Although subjects were probed further to investigate why the techniques made the landscape more appealing, in all cases the justification that was provided was not much more precise than 'it just looks better'. As a deeper investigation of the discussions was unable to find any justifiable interaction between these techniques and any significant aspects of landscape perception, these *direct influence* techniques seemed to have had a very simple and immediate effect on the visual quality of the scene. The specific impact of the *direct influence* techniques on preferences for the two study sites are discussed in conjunction with the statistical results in Sections 4.5 and 4.7, although it is worth mentioning now that the way these techniques effected landscape preference is not unlike the type of innate, biological influence that has been outlined in the literature on psychophysical landscape assessment (Daniel, 1990; Zube et al., 1982)

In contrast to the *direct influence* techniques, the visualization techniques that are labeled in black appear to have impacted preferences in a much more nuanced fashion, first interacting with aspects of landscape perception and in turn altering the preference that subjects ascribed to a particular scene. In total six of the eight techniques interacted with preferences in this way and they are not surprisingly referred to here as having had an *indirect influence* on landscape preference. Looking more closely at the framework we see that the *indirect influence* techniques that modified the presence and activity of people in the landscape worked in concert in two instances; altering perceptions of safety, as well as changing the character of the social atmosphere that subjects derived from the landscape. In addition to these two effects, the presence of people also combined with techniques that changed the level of landscape clutter, the number of vehicles, and the morphology of trees in the study sites, to produce a considerable impact on the place identity that participants attributed to certain scenes. It is important to clarify at this point that the five techniques just described only interacted with evaluations of the biased CLVs, which is not surprising given the rigorous methods that were followed in the calibrated visualization development process. That said, even though a great deal of attention was paid to ensure an accurate and representative set of simulations, the final *indirect influence* technique (i.e. how the virtual models were textured) did in fact produce an observable shift in perceptions of the calibrated CLVs. As a final clarification regarding the framework, the tree morphology and landscape clutter techniques are included in both pathways because very distinct sets of discussions showed that they both operated on their own to impact preference directly, as well as in consort with other techniques to alter preference via a perceptual mechanism. Once again while a detailed discussion of these techniques is presented in subsequent sections, it is interesting to note that in contrast to the previous claim, the *indirect influence* techniques all seemed to impact preferences by modifying cultural interpretations of the landscape, which coincidentally is more in line with the cognitive paradigm of landscape assessment (Gobster et al., 2007; Nassauer, 1995b; Relph, 1976; Steele, 1981; Tuan, 1974)

Because participants explicitly stated that the *direct influence* techniques impacted their preference, the qualitative data derived from discussions of these techniques can be used to directly support and explain findings from the quantitative response equivalence analysis that is presented in the following sections. For this reason Table 4.1 combines excerpts from these portions of the interviews with results from the statistical analysis of subject's preference ratings, allowing for a quick and straightforward contrast of results from the two datasets. To put the 'participant comments' into context it should be noted that the descriptions of the calibrated simulations are all drawn from discussions in which subjects directly compared a photo and calibrated CLV of the same viewpoint. Alternatively, the comments associated with the biased simulations are all explanations of why the biased CLVs were preferred to the photos. A detailed discussion of these datasets will not be presented until the complete statistical analysis has been reported, yet even this brief comparison shows that the Cohen's D values and participant comments imply the same conclusion regarding preferences for the simulation types. More specifically, the data clearly indicate a general compatibility of preferences for the calibrated CLVs and photos, but a considerably higher preference for the biased simulations. As Table 4.1 has already begun to blend results from the quantitative and qualitative analyses, the following sections continue this process by presenting the quantitative response equivalence results and then discussing these results in light of the qualitative data.

**Table 4.1 Comparison of Cohen's D values and participant comments.**

| *Calibrated CLVs* | | | | |
|---|---|---|---|---|
| **Environment** | **Cohen's D** | **Viewpoint** | **Cohen's D** | **Participant Comments** |
| Queen Street East | .263[a] | Theater | -.214[a] | - Is this digitally made? I actually thought they were both photos.<br>- I guess it's the exact same images, but this is just computer rendered.<br>- Now that I look at these images they are almost the same. |
| | | Retail | .435[a] | |
| | | Service | .389[a] | |
| | | Fire Hall | .089[a] | |
| | | New Residential | .073[a] | |
| | | Mixed Residential | .000[a] | |
| Centennial Park | .021[a] | Lake | -.189[a] | - Some of these pictures like this, sometimes you don't quite know if they want to replicate something like it's real, or whether it is really trying to be an image…Here you know it's a photo, or darn close to being a photo.<br>- Ok so these two are almost an exact match. One is real and one is a visualization, but they are both equally appealing to me. |
| | | Pavilions | .527[b] | |
| | | Pond | -.197[a] | |
| | | Picnic Shelter | .341[a] | |
| | | Open Field | -.330[a] | |
| | | Pathway | .000[a] | |
| *Biased CLVs* | | | | |
| ***Environment*** | ***Cohen's D*** | ***Viewpoint*** | ***Cohen's D*** | ***Participant Comments*** |
| Queen Street East | 1.809[c] | Theater | .620[b] | - What gets me is the trees. They are lovely.<br>- And the alliance atlantis theatre one at night, it really resonates with me well too. Again the lighting of it just sort of makes it a little more attractive.<br>- I like the blue skies. |
| | | Retail | 1.430[c] | |
| | | Service | .810[c] | |
| | | Fire Hall | 1.653[c] | |
| | | New Residential | .521[b] | |
| | | Mixed Residential | .098[a] | |
| Centennial Park | 1.686[c] | Lake | 1.418[c] | - Well there are evergreens, spiky trees. I mean I like them, but they are not nice and round.<br>- But really the first thing that makes me like or dislike a picture is the way the sun is hitting the sky.<br>- Of these two the one I like more, the sky is a richer blue, there are a few wispy clouds. |
| | | Pavilions | 1.462[c] | |
| | | Pond | .098[a] | |
| | | Picnic Shelter | .252[a] | |
| | | Open Field | 1.091[c] | |
| | | Pathway | .720[b] | |

[a] Small effect size; [b] Medium effect size; [c] Large effect size

## 4.3 Response Equivalence Analysis: Outliers, Scale Reliability and Order Effects

Before subjecting the quantitative data to inferential testing at a group level, descriptive statistics were produced to investigate patterns in the preference ratings given by individual participants. The box plot in Figure 4.2 identifies two participants as significant outliers, who coincidentally also represent both extremes in the dataset as they provided the highest and lowest average biased CLV ratings in this study. As mentioned these participants were not included in any inferential statistical analysis. To evaluate the reliability of the landscape preference scale the Cronbach's alpha statistic was assessed across all of the thirty-six rated images. The test resulted in an alpha value of .817 which is above the threshold of .8 that was required by this research. Potential image order effects were assessed by subjecting the counterbalanced stimuli orders to an independent samples t-test that compared the mean preferences of the three visual representation types at the environment level (see Table 4.2). For the Queen Street East study site there is no significant difference in preference ratings for the photos { *t* (18) = -.329, p > .05}, the calibrated CLVs { *t* (18) = 1.634, p > .05} or the biased CLVs { *t* (18) = .1.563, p > .05} that can be attributed to order effects. Likewise, for the Centennial Park study site there is no significant difference in preference ratings for the photos { *t* (18) = -.522, p > .05}, the calibrated CLVs { *t* (18) = -.410, p > .05} or the biased CLVs { *t* (18) = -.531, p > .05} that can be attributed to order effects.

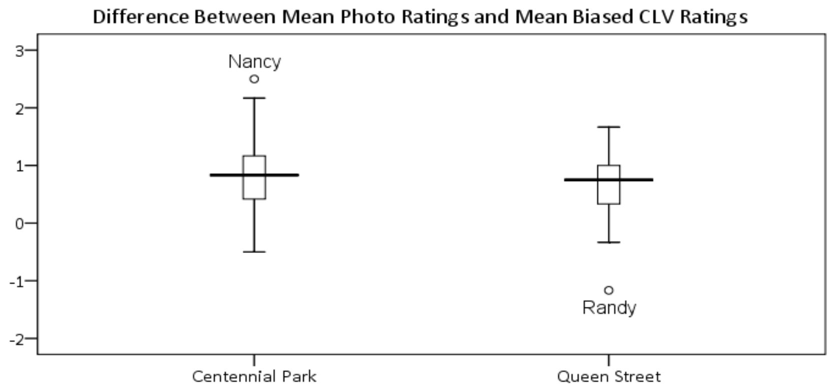


**Figure 4.2 Box plot showing significant outliers.**

**Table 4.2 T-test of image order effects.**

| Environment | Representation Type | Viewing Order | | Mean | t-test | | |
|---|---|---|---|---|---|---|---|
| | | | | | t | *df* | Sig. |
| **Centennial Park** | | | | | | | |
| | Photo | *Order 1* | 10 | 3.00 | -.522 | 16 | .609 |
| | | *Order 2* | 8 | 3.10 | | | |
| | Calibrated CLV | *Order 1* | 10 | 3.01 | -.410 | 16 | .687 |
| | | *Order 2* | 8 | 3.10 | | | |
| | Biased CLV | *Order 1* | 10 | 3.75 | -.531 | 16 | .603 |
| | | *Order 2* | 8 | 3.87 | | | |
| **Queen Street East** | | | | | | | |
| | Photo | *Order 1* | 10 | 2.75 | -.329 | 16 | .747 |
| | | *Order 2* | 8 | 2.83 | | | |
| | Calibrated CLV | *Order 1* | 10 | 3.13 | 1.634 | 16 | .122 |
| | | *Order 2* | 8 | 2.68 | | | |
| | Biased CLV | *Order 1* | 10 | 3.78 | 1.563 | 16 | .138 |
| | | *Order 2* | 8 | 3.47 | | | |

*Significant at the .05 level (2-tailed exact significance)

## 4.4 Analysis of Response Equivalence Data: Queen Street East

As we recall null hypothesis $H_o1$ stated that ‘preferences for the calibrated 3D computer landscape visualizations *will not be* similar to preferences for the landscape photos’, while null hypothesis $H_o2$ stated that ‘preferences for the biased 3D computer landscape visualizations *will not be* different than preferences for the landscape photos’. Following recommendations for the valid analysis of response equivalence data these hypotheses are addressed separately for each study site by investigating descriptive and inferential statistics that represent both individual and group based preference metrics. Results from the Queen Street East study site analysis are presented and then immediately contrasted against the qualitative data and findings from the literature. This process is carried out for the calibrated simulations first, and then repeated for the biased simulations.

### *4.4.1 Results From Individual Level Analysis of Preference Data: Queen Street East*

The graph in Figure 4.3 presents the difference between each participant’s mean photo rating and mean calibrated and biased CLV ratings (i.e. *C-P* and *B-P*) for the Queen Street East study site. Participants are grouped in the graph based on their experience with CLVs as described in Chapter 3. Within the *ample* experience category, four of the eight participants had a higher mean rating for the calibrated CLVs, three had a lower mean rating and one participant averaged calibrated CLV ratings and photo ratings that were the same. Alternatively, five of the eight participants in this experience category had a higher mean rating for the biased CLVs, while two had a lower mean rating. Once again, one participant averaged biased CLV ratings and photo ratings that were the same. As a whole, participants in the *ample* experience category rated calibrated CLVs .02 points lower and biased CLVs .48 points higher than the corresponding set of photos on the five point preference scale.

Within the *moderate* visualization experience category eight of the twelve participants had a higher mean rating for the calibrated CLVs and four had a lower mean rating. In contrast to this, all participants in this same experience category had a higher mean rating for the biased CLVs. On average, participants in the *moderate* experience category rated calibrated CLVs .26 points higher and biased CLVs 1.14 points higher than the corresponding set of photographs on the five point preference scale. The preceding information is summarized in Table 4.3 and Figure 4.3.

**Table 4.3 Participants with mean CLV ratings that are higher, lower or the same as mean photograph ratings for the Queen Street study site.**

| | | Mean Calibrated CLV Rating | | | Mean Biased CLV Rating | | |
|---|---|---|---|---|---|---|---|
| **CLV Experience** | **N** | Higher than Photos | Lower than Photos | Same as Photos | Higher than Photos | Lower than Photos | Same as Photos |
| Ample | 8 | 4 (50%) | 3 (38%) | 1 (12%) | 5 (63%) | 2 (25%) | 1 (12%) |
| Moderate | 12 | 8 (67%) | 4 (33%) | 0 (0%) | 12 (100%) | 0 (0%) | 0 (0%) |
| **Total** | 20 | 12 (60%) | 7 (35%) | 1 (5%) | 17 (85%) | 2 (10%) | 1 (5%) |

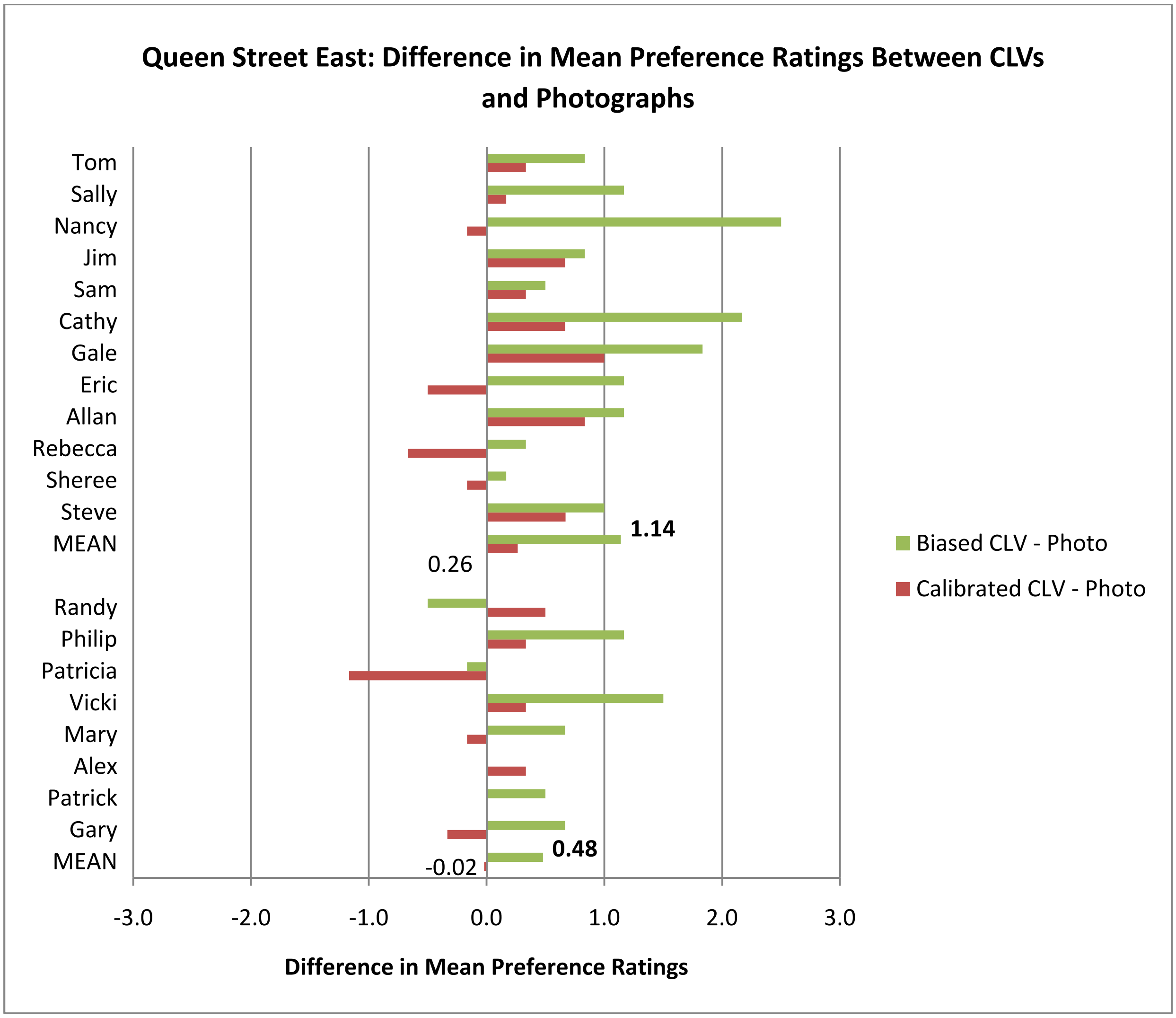


**Figure 4.3 Difference between participant's mean photograph rating and mean calibrated and biased CLV ratings for the Queen Street East study site. **The top grouping is the *moderate* experience group and the bottom grouping is the *ample* experience group****

### *4.4.2 Summary of Individual Level Analysis of Preference Data: Queen Street East*

An interpretation of Figure 4.3 indicates that there is no consistent pattern in how participants rated the calibrated CLVs of Queen Street East as opposed to the corresponding landscape photos. For example, while twelve of the twenty participants rated the calibrated CLVs higher than the photos, seven participants rated them lower and one participant actually rated them equal. Moreover, the absence of a pattern among the entire sample of participants is also apparent when data are analyzed within the smaller visualization experience groups, suggesting that each group responded the calibrated CLVs in a similar fashion. A *t*-test comparing each group's mean calibrated CLV rating (Table 4.4) confirms this finding, verifying the fact that participants with *ample* and *moderate* experience did not have significantly different preferences. More specifically, while participants in the *moderate* experience group ($M$ = 2.95) did tend to rate calibrated CLVs higher than participants in the *ample* experience group ($M$ = 2.90), this difference was not significant {$t$ (16) = -.166, p > .05}. Likewise, participants in the *moderate* experience group ($M$ = 2.65) did not rate photographs significantly different than participants in the *ample* experience group ($M$ = 3.00); {$t$ (16) = 1.427, p > .05}.

Unlike the investigation of the calibrated CLVs, a closer look at Figure 4.3 reveals a clear pattern in how individuals rated the biased CLVs as compared to the corresponding photos. Of the twenty participants a total of seventeen individuals had a mean preference that was higher for the biased CLVs, while only three individuals rated them lower than or equal to the photos. A t-test comparing individuals with *ample* ($M$ = 3.67) and *moderate* ($M$ = 3.61) visualization experience also indicates that there is no significant difference between these group's mean preferences {$t$ = -.224, p = .826}, suggesting that the biased CLVs had a universal effect on participants in this study.

Based on the interpretation discussed above, data analyzed at the level of individual preferences seem to indicate that the biased CLVs of Queen Street East were preferred to photos of the same landscape. Alternatively, results from the same level of analysis provide no clear indication that the calibrated CLVs of Queen Street East were either more or less preferred than the corresponding landscape photos. Finally, both of these assertions appear to be true for participants with *ample* visualization experience, as well as for those with only *moderate* visualization experience.

**Table 4.4 Independent t-test comparing preference ratings of *ample* and *moderate* experience groups.**

| Environment | Representation Type | Experience Group | | Mean | t-test | | |
|---|---|---|---|---|---|---|---|
| | | | | | t | *df* | Sig. |
| **Centennial Park** | | | | | | | |
| | Photo | *Ample* | 7 | 3.12 | .693 | 14.364 | .499 |
| | | *Moderate* | 11 | 3.00 | | | |
| | Calibrated CLV | *Ample* | 7 | 2.88 | -1.615 | 14.870 | .127 |
| | | *Moderate* | 11 | 3.16 | | | |
| | Biased CLV | *Ample* | 7 | 3.69 | -.793 | 16 | .440 |
| | | *Moderate* | 11 | 3.87 | | | |
| **Queen Street East** | | | | | | | |
| | Photo | *Ample* | 7 | 3.00 | 1.427 | 16 | .173 |
| | | *Moderate* | 11 | 2.65 | | | |
| | Calibrated CLV | *Ample* | 7 | 2.90 | -.166 | 16 | .870 |
| | | *Moderate* | 11 | 2.95 | | | |
| | Biased CLV | *Ample* | | 3.61 | -.224 | 16 | .826 |
| | | *Moderate* | | 3.67 | | | |

*Significant at the .05 level (2-tailed exact significance)

### *4.4.3 Results From Viewpoint Level Analysis of Preference Data: Queen Street East*

The first set of group based landscape preferences are compared for the Queen Street East study site in Figure 4.4. More specifically, the mean preference ratings of the three visual representation types are compared separately for each of the six viewpoints depicting Queen Street East, with the emphasis being a comparison of CLVs to photos. Among the representations of the Queen Street East study site the calibrated CLVs were preferred to the photos for four of the six viewpoints, while one of the remaining viewpoints received a higher preference for the photo, and yet another had a mean calibrated CLV rating and photo rating that were the same. The largest average rating difference between photo and calibrated CLV was .5 points and occurred for the Service viewpoint.

When comparing the biased CLVs to the photos the same level of variability in preferences across viewpoints is not present. In fact, for all six of the Queen Street East viewpoints the biased CLVs were preferred to the photos to some degree. Moreover, for several of the viewpoints it is obvious that preferences were considerably higher for landscapes shown with biased CLVs as compared to those shown with photos, with the largest difference occurring for the Fire Hall viewpoint (1.61 points).

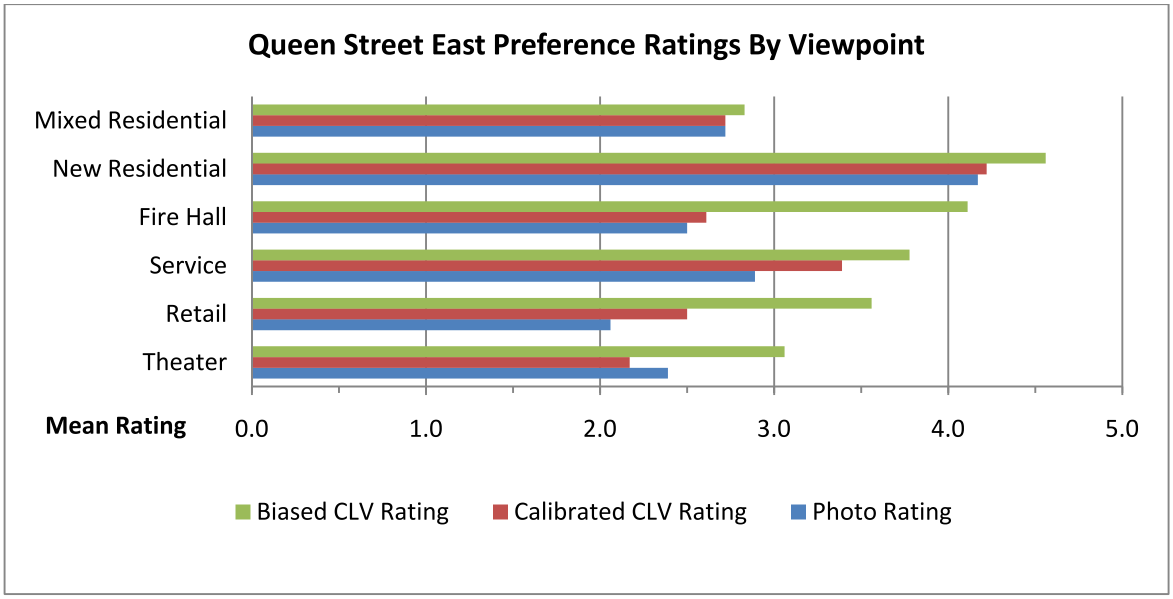


**Figure 4.4 Comparison of mean visual stimuli ratings for each Queen Street East viewpoint.**

As discussed in Chapter 3, both group based preference measures were subjected to inferential testing in addition to a descriptive analysis, although a Shapiro-Wilk test of normality indicated that most of the preference data had a non-normal distribution when it was averaged for each individual viewpoint (see Table 4.5). Because of this only non-parametric tests were used to examine preferences for CLVs and photos at the viewpoint level of analysis. Table 4.6 presents the results of the Friedman's ANOVA tests that compared the mean preference ratings of the three visual representation types, as well as the associated Wilcoxon post-hoc tests that specifically contrasted the photo ratings and CLV ratings. The subsequent six paragraphs discuss in detail the results of the ANOVA and post-hoc tests for each of the six viewpoints.

On average, participants did rate the three visual representations of the Theater viewpoint significantly different {$X^2(2) = 11.511$, p < .05}. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV (*M* = 2.17) of the Theater viewpoint significantly different than the photograph (*M* = 2.39) of the Theater viewpoint {*z* = -1.265, p > .05}, and the difference represented only a small effect size (*d* = -.214). Similarly, participants did not rate the biased CLV (*M* = 3.06) of the Theater viewpoint significantly different than the photograph (*M* = 2.39) of the Theater viewpoint {*z* = -1.831, p >.05}, although the difference represented a moderate effect size (*d* = .620).

**Table 4.5 Normality test of landscape preference data aggregated at the viewpoint level.**

| Scene | | Rating Difference | Shapiro-Wilk Test | | |
|---|---|---|---|---|---|
| | | | W | *df* | Sig. |
| **Centennial Park** | | | | | |
| | *Lake* | Bias CLV - Photo | .921 | 18 | .132 |
| | | Calibrated CLV - Photo | .839 | 18 | .006* |
| | *Pavilions* | Bias CLV - Photo | .909 | 18 | .083 |
| | | Calibrated CLV - Photo | .863 | 18 | .014* |
| | *Pond* | Bias CLV - Photo | .789 | 18 | .001* |
| | | Calibrated CLV - Photo | .753 | 18 | .000* |
| | *Picnic Shelter* | Bias CLV - Photo | .904 | 18 | .066* |
| | | Calibrated CLV - Photo | .720 | 18 | .000* |
| | *Open Field* | Bias CLV - Photo | .920 | 18 | .132 |
| | | Calibrated CLV - Photo | .788 | 18 | .001* |
| | *Pathway* | Bias CLV - Photo | .864 | 18 | .014* |
| | | Calibrated CLV - Photo | .860 | 18 | .012* |
| **Queen Street East** | | | | | |
| | *Theater* | Bias CLV - Photo | .794 | 18 | .001* |
| | | Calibrated CLV - Photo | .820 | 18 | .003* |
| | *Retail* | Bias CLV - Photo | .947 | 18 | .379 |
| | | Calibrated CLV - Photo | .867 | 18 | .016* |
| | *Service* | Bias CLV - Photo | .916 | 18 | .109 |
| | | Calibrated CLV - Photo | .856 | 18 | .011* |
| | *Fire Hall* | Bias CLV - Photo | .881 | 18 | .027* |
| | | Calibrated CLV - Photo | .919 | 18 | .123 |
| | *New Residential* | Bias CLV - Photo | .854 | 18 | .010* |
| | | Calibrated CLV - Photo | .646 | 18 | .000* |
| | *Mixed Residential* | Bias CLV - Photo | .865 | 18 | .015* |
| | | Calibrated CLV - Photo | .923 | 18 | .149 |

*Significant at the .05 level (2-tailed exact significance)

On average, participants did rate the three visual representations of the Retail viewpoint significantly different {$X^2(2) = 16.754$, $p < .05$}. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV ($M = 2.50$) of the Retail viewpoint significantly different than the photograph ($M = 2.06$) of the Retail viewpoint {$z = -1.358$, $p > .05$}, although the difference represented a moderate effect size ($d = .435$). Conversely, participants did rate the biased CLV ($M = 3.56$) of the Retail viewpoint significantly higher than the photograph ($M = 2.06$) of the Retail viewpoint {$z = -2.934$, $p < .05$}, and the difference represented a large effect size ($d = 1.430$).

**Table 4.6 Statistical comparison of visual stimuli ratings for each Queen Street East viewpoint.**

| Viewpoint | N | Mean | Friedman's Anova | | | Wilcoxon Signed-Rank | | Effect Size |
|---|---|---|---|---|---|---|---|---|
| | | | *df* | $X^2_F$ | Sig. | Z Value | Sig. | Cohen's d |
| **Theater** | 18 | | 2 | 11.511 | .002* | | | |
| *Photo* | 18 | 2.39 | | | | | | |
| *Calibrated CLV* | 18 | 2.17 | | | | -1.265 | .359 | -.214[a] |
| *Biased CLV* | 18 | 3.06 | | | | -1.831 | .064 | .620[b] |
| **Retail** | 18 | | 2 | 16.754 | .000* | | | |
| *Photo* | 18 | 2.06 | | | | | | |
| *Calibrated CLV* | 18 | 2.50 | | | | -1.358 | .204 | .435[a] |
| *Biased CLV* | 18 | 3.56 | | | | -2.934 | .002* | 1.430[c] |
| **Service** | 18 | | 2 | 5.345 | .073 | | | |
| *Photo* | 18 | 2.89 | | | | | | |
| *Calibrated CLV* | 18 | 3.39 | | | | -1.574 | .131 | .389[a] |
| *Biased CLV* | 18 | 3.78 | | | | -2.113 | .034* | .810[c] |
| **Fire Hall** | 18 | | 2 | 24.233 | .000* | | | |
| *Photo* | 18 | 2.50 | | | | | | |
| *Calibrated CLV* | 18 | 2.61 | | | | -.462 | .796 | .089[a] |
| *Biased CLV* | 18 | 4.11 | | | | -3.568 | .000* | 1.653[c] |
| **New Residential** | 18 | | 2 | 8.167 | .022* | | | |
| *Photo* | 18 | 4.17 | | | | | | |
| *Calibrated CLV* | 18 | 4.22 | | | | -.378 | 1.000 | .073[a] |
| *Biased CLV* | 18 | 4.56 | | | | -1.658 | .146 | .521[b] |
| **Mixed Residential** | 18 | | 2 | .531 | .787 | | | |
| *Photo* | 18 | 2.72 | | | | | | |
| *Calibrated CLV* | 18 | 2.72 | | | | -.000 | 1.000 | .000[a] |
| *Biased CLV* | 18 | 2.83 | | | | -.368 | .820 | .098[a] |

*Significant at the .05 level (2-tailed exact significance); [a] Small effect size; [b] Medium effect size; [c] Large effect size

On average, participants did not rate the three visual representations of the Service viewpoint significantly different {$X^2(2) = 5.345$, $p > .05$}. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV ($M$ = 3.39) of the Service viewpoint significantly different than the photograph ($M$ = 2.89) of the Service viewpoint {$z$ = -1.574, $p > .05$}, and the difference represented only a small effect size ($d$ = -.389). Conversely, participants did rate the biased CLV ($M$ = 3.78) of the Service viewpoint significantly higher than the photograph ($M$ = 2.89) of the Service viewpoint {$z$ = -2.113, $p < .05$}, and the difference represented a large effect size ($d$ = .810).

On average, participants did rate the three visual representations of the Fire Hall viewpoint significantly different {$X^2(2) = 24.233$, $p < .05$}. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV (*M* = 2.61) of the Fire Hall viewpoint significantly different than the photograph (*M* = 2.50) of the Fire Hall viewpoint {$z = -.462$, $p > .05$}, and the difference represented only a small effect size (*d* = .089). Conversely, participants did rate the biased CLV (*M* = 4.11) of the Fire Hall viewpoint significantly higher than the photograph (*M* = 2.50) of the Fire Hall viewpoint {$z = -3.568$, $p < .05$}, and the difference represented a large effect size (*d* = 1.653).

On average, participants did rate the three visual representations of the New Residential viewpoint significantly different {$X^2(2) = 8.167$, $p < .05$}. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV (*M* = 4.22) of the New Residential viewpoint significantly different than the photograph (*M* = 4.17) of the New Residential viewpoint {$z = -.378$, $p > .05$}, and the difference represented only a small effect size (*d* = .073). Similarly, participants did not rate the biased CLV (*M* = 4.56) of the New Residential viewpoint significantly different than the photograph (*M* = 4.17) of the New Residential viewpoint {$z = -1.658$, $p > .05$}, although the difference represented a moderate effect size (*d* = .521).

On average, participants did not rate the three visual representations of the Mixed Residential viewpoint significantly different {$X^2(2) = .531$, $p > .05$}. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV (*M* = 2.72) of the Mixed Residential viewpoint significantly different than the photograph (*M* = 2.72) of the Mixed Residential viewpoint {$z = .000$, $p > .05$}, and there was no effect size (*d* = .000). Similarly, participants did not rate the biased CLV (*M* = 2.83) of the Mixed Residential viewpoint significantly different than the photograph (*M* = 2.72) of the Mixed Residential viewpoint {$z = -.368$, $p > .05$}, and the difference represented only a small effect size (*d* = .098).

### *4.4.4 Summary of Viewpoint Level Analysis of Preference Data: Queen Street East*

The first group based analysis of the data shows no consistent difference in preferences for the Queen Street East landscapes that were represented with calibrated CLVs or with photos. Starting with the descriptive examination (see Figure 4.4) it is evident that while two of the viewpoints (Fire Hall; New Residential) received only marginally higher preferences for the calibrated CLVs, two others (Retail; Service) received notably higher preferences for the calibrated CLVs, while preferences for the remaining two viewpoints were even less in line with any potential pattern. In addition to the variability in this descriptive examination, the Wilcoxon Signed-Rank post-hoc tests confirm, for all six viewpoints, that preferences developed in response to the calibrated CLVs and the photos were not statistically different. Perhaps most importantly, the Cohen's D values for all six viewpoints show that the calibrated CLVs not only produced statistically similar preferences as the photos, but actually had a small impact on how much participant's liked or disliked a particular landscape (see Table 4.6).

In contrast to the descriptive analysis of the calibrated CLVs, which showed a great deal of variability across viewpoints, all six of the Queen Street East viewpoints received a higher mean preference rating for the biased CLVs as compared to the photos. Similarly, the Wilcoxon Signed-Rank post-hoc tests show that three of the landscapes (Retail; Service; Fire Hall) were actually significantly preferred when depicted with biased CLVs. This pattern of inferential statistics is quite different from that of the calibrated CLV analysis, where absolutely no significant difference was found between the two representation types. Once again what is most noteworthy is that the Cohen's D values (i.e. effect sizes) confirm the findings of the descriptive examination and post-hoc tests. More specifically, while the calibrated CLVs produced only a small effect on participant's preferences as compared to the photos, half of the biased CLVs produced a large effect and two others produced a moderate effect. These results indicate that in contrast to the calibrated CLVs, the biased CLVs had a substantial positive impact on how much participants liked a landscape.

The descriptive and inferential analyses carried out at the first level of group preferences correspond closely with the analysis of individual preferences, providing no evidence that the calibrated CLVs of Queen Street East were either more or less preferred than the corresponding landscape photos. On the other hand, evidence from the same analysis strongly suggests that the biased CLVs of the Queen Street East study site were preferred to the photos.

### *4.4.5 Results From Environment Level Analysis of Preference Data: Queen Street East*

Figure 4.5 examines the highest level of group preferences for the three visual representation types by comparing mean ratings at the environment level (i.e. grand mean of all six photos, calibrated CLVs, and biased CLVs for each environment). The graph shows that while the photos of the Queen Street East study site were rated the lowest of the three visual representation types, the mean rating of the calibrated CLVs was only slightly higher than that of the photos (.15 points on the five point preference scale). Alternatively, the biased CLVs were the most preferred of the three types of representations that depicted the Queen Street East study site and received a much higher mean rating than the photos (.86 points higher on the five point preference scale).

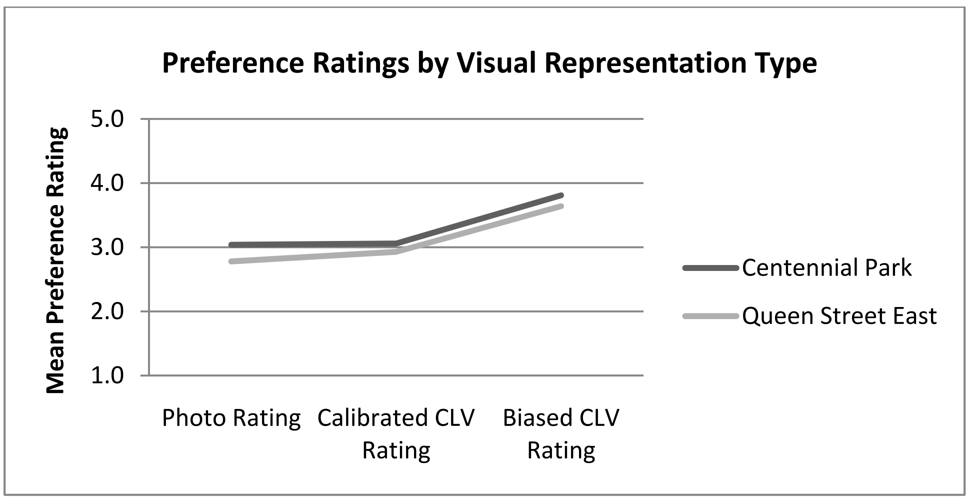


**Figure 4.5 Comparison of mean visual stimuli ratings for each environment.**

When it was applied to the landscape preference data at the environment level, the Shapiro-Wilk test of normality indicated that data for both study sites did not deviate significantly from a normal distribution (see Table 4.7), thus parametric statistics were used in the environment level analysis. Table 4.8 shows the results of the Repeated Measures ANOVA test that compared the mean ratings of the three visual representation types, as well as the results of the planned contrasts that specifically compared the photo rating with each CLV rating. The following paragraph discusses in detail the results of the Repeated Measures ANOVA and planned contrasts.

**Table 4.7 Normality test of landscape preference data aggregated at the environment level.**

| Environment | Rating Difference | Shapiro-Wilk Test | | |
|---|---|---|---|---|
| | | W | *df* | Sig. |
| **Centennial Park** | | | | |
| | Bias CLV - Photo | .966 | 18 | .720 |
| | Calibrated CLV - Photo | .909 | 18 | .081 |
| **Queen Street East** | | | | |
| | Bias CLV - Photo | .977 | 18 | .908 |
| | Calibrated CLV - Photo | .952 | 18 | .456 |

*Significant at the .05 level (2-tailed exact significance)

**Table 4.8 Statistical comparison of visual stimuli ratings for each environment.**

| Environment | N | Mean | Std. Dev. | Std. Error | Mauchly's Test of Spericity | | | | ANOVA | | Contrasts | | Effect Size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | W | $X^2$ | *df* | Sig. | F | Sig. | F | Sig. | Cohen's d |
| **Centennial Park** | 18 | | | | .708 | 5.53 | 2 | .063 | 24.160 | .000* | | | |
| *Photo* | 18 | 3.04 | .411 | .097 | | | | | | | | | |
| *Calibrated CLV* | 18 | 3.06 | .439 | .104 | | | | | | | .013 | .909 | .021[a] |
| *Biased CLV* | 18 | 3.81 | .485 | .114 | | | | | | | 35.193 | .000* | 1.686[c] |
| **Queen Street East** | 18 | | | | .952 | .780 | 2 | .677 | 22.619 | .000* | | | |
| *Photo* | 18 | 2.78 | .520 | .122 | | | | | | | | | |
| *Calibrated CLV* | 18 | 2.93 | .602 | .142 | | | | | | | 1.235 | .282 | .263[a] |
| *Biased CLV* | 18 | 3.64 | .427 | .101 | | | | | | | 35.748 | .000* | 1.809[c] |

*Significant at the .05 level (2-tailed exact significance); [a] Small effect size; [b] Medium effect size; [c] Large effect size

On average, participants did rate the three visual representations of the Queen Street East environment significantly different {$F = 22.619$, $p < .05$}. Contrasts were used to follow up this finding. Participants did not rate the calibrated CLVs ($M = 2.93$) of the Queen Street East environment significantly different than the photographs ($M = 2.78$) of the Queen Street East environment {$F = 1.235$, $p > .05$}, and the difference represented only a small effect size ($d = .263$). Conversely, participants did rate the biased CLVs ($M = 3.64$) of the Queen Street East environment significantly higher than the photographs ($M = 2.78$) of the Queen Street East environment {$F = 35.748$, $p < .05$}, and the difference represented a large effect size ($d = 1.809$).

### *4.4.6 Summary of Environment Level Analysis of Preference Data: Queen Street East*

When preferences were averaged at the environment level the calibrated CLVs of Queen Street East were found to be only marginally preferred to the photos (.15 points on a five point scale). Statistical contrasts performed as part of the ANOVA analysis (Table 4.8) confirm that this small rating difference between the two representation types was not significant {$F = 1.235$, $p = .282$}, and a Cohen's D value indicates that this difference represents only a small effect {$d = .263$} on preferences for the landscape as a whole. In contrast, the graph in Figure 4.5 clearly illustrates a higher mean preference for the biased CLVs as compared to the corresponding photos (.86 points on a five point scale), and the planned contrasts confirm that this difference is indeed significant {$F = 35.748$, $p = .000$}. More importantly, the Cohen's D value indicates that the biased CLVs, as a whole, had an exceptionally large impact on the preferences that participants developed for the Queen Street East landscape {$d = 1.809$}. As a result it is clear that data analyzed at the environment level correspond with the other levels of analyses, indicating that there is no difference in preferences for the calibrated CLVs and the landscape photos, while participants strongly prefer the biased CLVs to the photos.

## 4.5 Discussion of Queen Street East Study Site Analysis

The quantitative preference data suggests at all three levels of analysis that the calibrated CLVs of the Queen Street East study site were neither less preferred nor more preferred than the photos of the same environment. Not only did descriptive statistics from the individual level of analysis provide no evidence of a consistent pattern in the rating differences between calibrated CLVs and photographs, but the descriptive statistics from both group level analyses produced similar results. In addition to this the inferential statistics that were examined at two levels of group-based preference confirmed the descriptive analyses, as they showed there were no statistically significant rating differences between the two representation types. As a matter of fact, not only did the planned contrasts and post-hoc tests fail to produce a single significant difference between a comparison of a photo and a calibrated CLV rating, but in all of these comparisons the Cohen's D values indicated that any rating difference that was present was indicative of only a small impact on landscape preference.

As an analysis of the associated qualitative data has already been outlined, it is obviously important to consider whether the justifications that participants gave for their quantitative evaluations support the statistical analysis just described. That said a comparison of the qualitative and quantitative analyses does show that the two datasets point to similar results. For instance, when subjects were asked to elaborate in a broad sense why they choose to place images in certain piles during the preference sorting exercise, the explanations that followed focused much more on elements that were a consequence of the techniques used in the biased CLVs, rather than on any apparent dissimilarity between the photos and calibrated CLVs. Likewise, when participant's were asked to directly compare, for the same viewpoint, a photo and calibrated CLV that they had rated differently, they were generally unable to provide any precise explanation to account for the discrepancy in preference. Interestingly, this behaviour persisted even when subjects were asked to carefully consider any possibilities, as well as when they were probed further with possible suggestions. What is perhaps the most telling is that upon closer inspection of the two images some participants even wanted to recant their initial choice, having decided that the photo and calibrated simulation were in fact more or less on par.

> I guess it's the exact same images, but this is just computer rendered. (Vicki)
> Now that I look at these images they are almost the same. (Allan)

To be fair there was one caveat to the general experience that was just described, although it was only noted among discussions with participants who possessed a great deal of experience developing visualizations (Mary and Gary). When asked to explain why the calibrated CLVs were rated lower than the photos (see Figure 4.3) these subjects stated that the difference was not related to any changes in the appearance of the landscapes, but rather to the quality of the simulations; which were not deemed to be fully realistic. Although this finding represents a potential distinction in how subjects with *ample* and *moderate* visualization experience evaluated the stimuli sets, it will not be examined in more detail here as this line of reasoning was not provided by enough subjects to make it a robust finding. Furthermore, the effect of apparent realism on landscape preference was not the focus of this research and the positive impact that high perceived realism can have has already been well documented elsewhere (Appleton & Lovett, 2003; Daniel & Meitner, 2001; Lange, 2001).

> I really don't like this image. It looks completely fake…It looks like a movie. There is a movie where this guy grows up in this completely controlled town and everything is absolutely perfect and he realizes that he is actually the main character in a TV show. The Truman Show. Ya, there is something that isn't authentic. (Gary)

Taken as a whole the quantitative and qualitative data both strongly suggest that preferences for the Queen Street East landscape were the same regardless of whether it was depicted with calibrated CLVs or photos. As such any discrepancy in quantitative preferences that was found between the two representation types can be explained primarily on the basis of random differences in the way that participants used the preference scale, or potentially as a latent effect related to the capability of contemporary visualization software to produce a feel of apparent realism. With that in mind it is safe to say that the visualization process that was followed to develop the calibrated Queen Street East simulations had little impact on participants' landscape preferences. Although this finding makes it tempting to now accept the calibrated simulations as a valid representation of this environment, it is important to remember that landscape perception is also an important component of response equivalence. As such a full comment on the validity of the calibrated CLVs cannot be made until their impact on landscape perception has been discussed. Finally, while no response equivalence study that directly compares accurate, photorealistic, static simulations of an urban environment to a set of corresponding photos could be found during a comprehensive review of the literature, the findings reported here are in line with similar studies. Bishop and Rohrmann (2003) found that although retention and appreciation of an urban environment were different between an animation and on-site walk, the animations were generally accepted by participants as a valid surrogate for on-site experience. Similarly, Oh (1994) examined responses to static representations of a university campus and indicated that simulation techniques with higher levels of realism, such as surface modeling or image processing, elicited similar landscape attractiveness responses from participants as actual photos.

When preferences for the photos and biased CLVs of Queen Street East were compared the statistical analysis produced results that are completely contrary to the findings that were just discussed. Although the three levels of the quantitative analysis did agree once more, in this instance the results indicated that the biased CLVs of Queen Street East were in fact greatly preferred to the photos of the same landscape. At the level of individual preference the descriptive statistics showed a clear pattern, with the vast majority of participant's rating the biased simulations higher than the corresponding photos. In addition to this, the descriptive statistics from the group level analyses also suggested that mean preferences for all six viewpoints, and the environment itself, were higher for the biased CLVs. Most importantly the planned contrasts and post-hoc tests verified that the biased simulations were not only preferred in all comparisons, but significantly preferred for half of the viewpoints, as well as for the environment as a whole. Finally, when Cohen's D values were calculated to measure the impact of the biased CLVs on subject's evaluations, the results showed that there was a moderate impact on preferences for two viewpoints and a large impact on preferences for the remaining four viewpoints; not to mention a large impact on the average preference for the entire environment.

Once again the qualitative data collected during the in-depth interviews offer the ability to validate findings from the quantitative analysis. In this case however, rather than simply supporting the findings from the statistical analysis, participant's descriptions can be used to partially explain what elements in the biased simulations leveraged more positive evaluations of the landscape. As was noted during the description of the schema analysis, the visualization techniques that had a *direct influence* on preferences were explicitly stated by subjects as the reason that the biased simulations were preferred to the corresponding photos. Because of this it is only justifiable to use qualitative data related to these techniques to explain, or otherwise support, the results of the statistical analysis.

In the context of the Queen Street East study site the most positive effect on participant's immediate aesthetic appreciation for the landscape was derived from the use of over mature tree billboards, as well as the removal of street clutter from the scenes. In fact, while the manipulation of sky conditions and atmospheric lighting did seem to produce a positive effect on some subject's preferences, their impact was far less potent in comparison to the two techniques just mentioned. Beginning with the use of over mature tree billboards, it appeared that most participants simply preferred the morphology of the trees that were added to the biased simulations over those that were present in the actual landscape, which in turn leveraged a more positive evaluation of the scene that the trees were added to. This reasoning was noted in the justification that many participants gave for preferring the biased CLVs. For a much smaller number of participants the impact was described not in regards to the morphology of the trees themselves, but rather in the broader benefit that the increased amount of vegetation brought to the landscape. In this context a sense of enclosure was sometimes noted as the reason the trees improved the appearance of the landscape, although this justification was provided by only two subjects, making it unfair to claim with any certainty that enclosure was a significant contributor to an overall aesthetic improvement.

> What gets me is the trees, they are lovely. (Sally)
>
> Trees. Having mature trees instead of little sticks. Those are mature and not little sticks. (Nancy)
>
> Good height. Great height on the trees too. They develop like a canopy for the people walking, and they are just as tall as the buildings…They have a presence that is nice. (Phillip)
>
> In most cases the common theme seems to be more street trees. More of a sense of enclosure on the sidewalk. (Patrick)

Given the consensus in the literature regarding the positive impact of perceived naturalness on attitudinal elements of landscape assessment, it is not surprising that attempts to supplement the visualized landscapes with fully mature deciduous trees improved landscape preference. For example, both Herzog (1989) and Wolf (2005a) found that the addition of vegetation to a visual scene can significantly improve cognitive preference evaluations of an urban landscape, and Ulrich (1986) has even suggested that naturalness in the landscape can contribute considerably to positive emotional states. Furthermore, as mentioned earlier the Honey Locust billboards that were added to many of the biased CLVs possessed a large spreading deciduous crown, which is a morphology that has continually been reported as being the most preferred tree form (Lohr and Pearson-Mims, 2006; Sommer and Summit, 1995; Summit and Sommer, 1999).

The removal of elements from the biased CLVs that ‘cluttered’ the actual Queen Street East landscape had a very strong positive impact on preference, and in fact the vast majority of participants suggested in one way or another that this course of action was a considerable improvement to the appearance of the street. Interestingly, while Stamps (1997) reported that overhead wires had little effect on preferences for a streetscape in San Francisco, in this study the hugely positive influence of removing clutter from the biased scenes manifested itself almost entirely in the removal of the overhead wires and the associated infrastructure; even though several other elements were removed as well. Beyond simply noting an aesthetic improvement to the scenes, many participants illustrated quite visceral reactions to the mere presence of hydro wires in the photos, while others implied that the landscape could not garner much appeal whilst the hydro elements were still present.

> Oh yes, I hate this street for example because it has the overhead wires and I don't like that at all (Sally) –Retail-
>
> I just hate these overhead wires. They are a real sin if there ever was one. But if you take those away, then I think it can be interesting (Sam) –Fire Hall-
>
> Your missing the this pole and this box here, so you don't have your hydro wires obscuring it as much, so that look if much more appealing (Tom) –Fire Hall-

Although it cannot be stated for certain why the findings here are different than those of Stamps (1997), there is additional evidence in the literature to support the assumption that the removal of aesthetically unpleasing street clutter, such as overhead wires or obtrusive sidewalk elements, would positively influence preference. For instance, in a very specific examination of streetscapes Stamps and Hong (1999) indicated that preference for an urban landscape can be negatively influenced by the simple presence of obtrusive elements such as street signage. Still, on a deeper level it can be observed that many of the unadulterated photos of the Queen Street East study site contained a very high level of complexity, attributable largely to the abundance of overhead wires. As such, the removal of clutter from the biased CLVs might have produced a level of complexity in the scenes that was more conducive to information processing, and therefore more supportive of the formation of positive landscape preferences (Kaplan, 1987; Stamps, 2004). This tentative explanation is illustrated by one participant's statement, which describes the impact of the overwhelming presence of power lines on his ability to evaluate the scenes.

> You know what I didn't, well I did notice in the first one, power lines. I never really see them as ugly, but trying to look at the space and focus on things is very difficult when there are all these lines going everywhere. Cuz I mean your eyes are supposed to be drawn towards something, but with all the lines going, it just seems like this is where power lines come to. There everywhere, there's tons of them on the top and there going east, west, north. Like they are going everywhere. (Phillip)
>
> -Mixed Residential-

## 4.6 Analysis of Response Equivalence Data: Centennial Park

In the following sections research hypotheses $H_o1$ and $H_o2$ are once again addressed by investigating descriptive and inferential statistics that represent both individual and group based preference measures. More specifically these hypotheses are reexamined and discussed in a similar fashion to the preceding sections, only the focus is now results for the Centennial Park study site. The three part statistical analysis is again followed by a discussion that recaps the quantitative results and contrasts these results with the qualitative data and findings from the literature.

### *4.6.1 Results From Individual Level Analysis of Preference Data: Centennial Park*

The graph in Figure 4.6 presents data for the Centennial Park study site by comparing the difference between each participant's mean photo and calibrated CLV rating, as well as the difference between their mean photo and biased CLV rating (i.e. *C-P* and *B-P*). Participants are once again grouped in the graph based on their experience with CLVs. Of the eight participants with *ample* experience a total of six had a lower mean rating for the calibrated CLVs, while the remaining two averaged calibrated CLV ratings and photograph ratings that were the same. Given the numbers it is obvious that no participants in this group rated the calibrated CLVs higher than the photos. On the other hand six of these same eight participants did have a higher mean rating for the biased CLVs as compared to the photos, while only two had a lower mean rating. On average participants in the *ample* experience category rated calibrated CLVs .25 points lower and biased CLVs .35 points higher than the corresponding set of photographs on the five point preference scale.

Within the *moderate* experience category five of the twelve participants had a higher mean rating for the calibrated CLVs and four had a lower mean rating. The three remaining participants averaged calibrated CLV ratings and photograph ratings that were the same. In complete contrast, all participants in this same category had a higher mean rating for the biased CLVs as compared to the photos. On average, participants in the *moderate* experience category rated calibrated CLVs .26 points higher and biased CLVs 1.14 points higher than the corresponding set of photographs on the five point preference scale. All of the information described above is summarized in Table 4.9 and Figure 4.6.

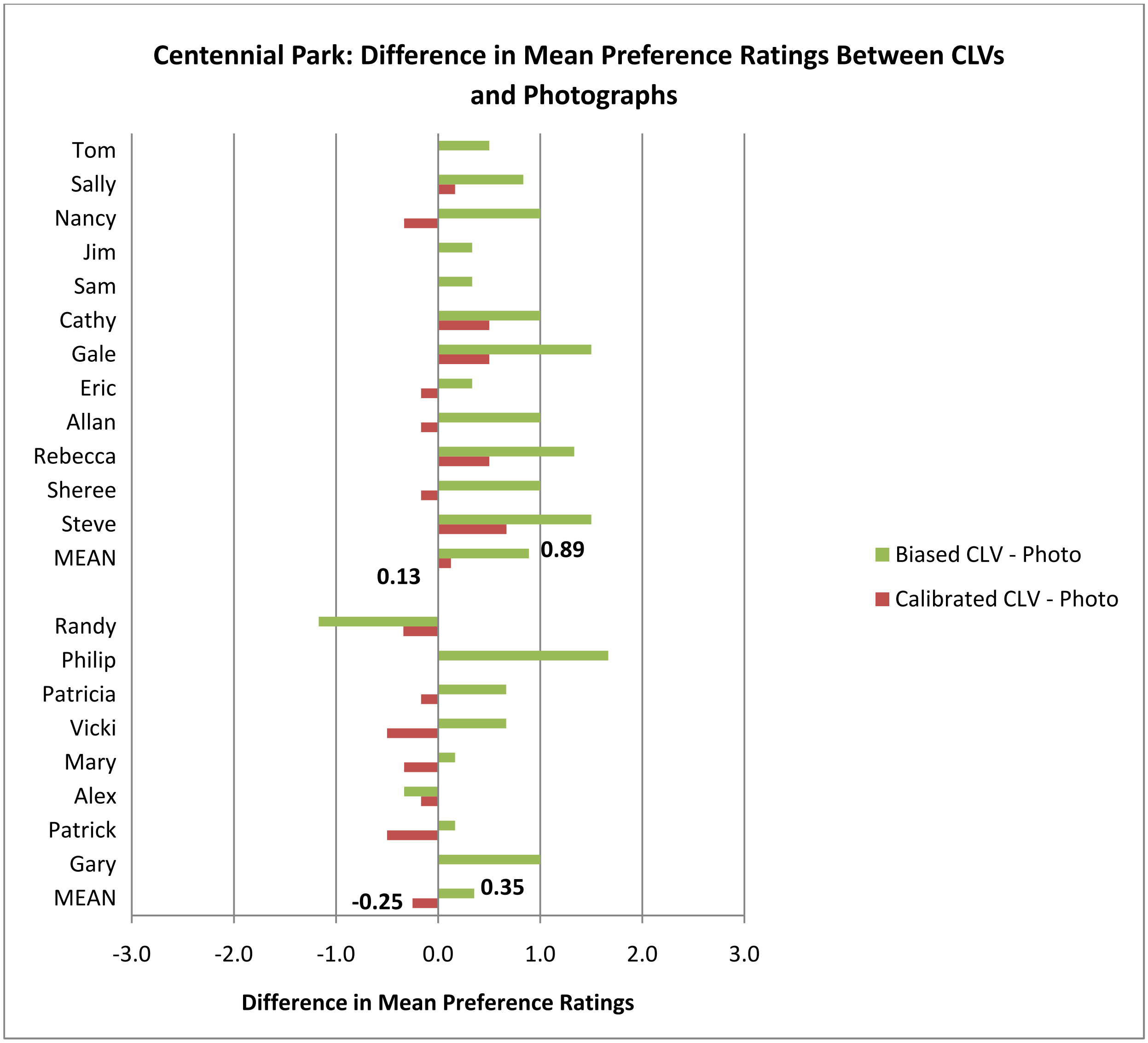


**Figure 4.6 Difference between participants mean photograph rating and mean calibrated and biased CLV ratings for the Centennial Park study site. **The top grouping is the *moderate* experience group and the bottom grouping is the *ample* experience group****

**Table 4.9 Number of participants with Mean CLV ratings that are higher, lower or the same as mean ratings of photographs for the Centennial Park study site.**

| | | Calibrated CLV Mean Rating | | | Biased CLV Mean Rating | | |
|---|---|---|---|---|---|---|---|
| **CLV Experience** | **N** | Higher than Photos | Lower than Photos | Same as Photos | Higher than Photos | Lower than Photos | Same as Photos |
| Ample | 8 | 0 (0%) | 6 (75%) | 2 (25%) | 6 (75%) | 2 (25%) | 0 (0%) |
| Moderate | 12 | 5 (42%) | 4 (33%) | 3 (25%) | 12 (100%) | 0 (0%) | 0 (0%) |
| **Total** | 20 | 5 (25%) | 10 (50%) | 5 (25%) | 18 (90%) | 2 (10%) | 0 (0%) |

### *4.6.2 Summary of Individual Level Analysis of Preference Data: Centennial Park*

Similar to the results discussed in section 4.4.1, Figure 4.6 indicates that there is no clear pattern in how participant's rated the calibrated CLVs of Centennial Park as compared to the corresponding photos. Of the twenty participants there were a total of five who rated the calibrated CLVs higher than the photos, ten who rated them lower than the photos and five who rated them the same. A similar result is also found when preferences are compared between participants with differing levels of visualization experience. More specifically, although no participant with *ample* experience rated the calibrated CLVs higher than the corresponding photos, a *t*-test indicates that the *moderate* ($M$ = 3.16) experience group did not have significantly higher preferences for the calibrated CLVs than the *ample* ($M$ = 2.88) experience group {$t$ (14.870) = -1.615, $p > .05$}. Given these results it is therefore safe to assume that visualization experience, as defined in this research, did not have a significant impact on subject's preferences for the calibrated CLVs of Centennial Park.

A descriptive analysis of individual preferences once again reveals a clear pattern in how participants rated the biased CLVs as compared to the photos, with eighteen of the twenty participants preferring the Centennial Park landscapes depicted with the CLVs to some extent. A t-test also indicates that the *moderate* ($M$ = 3.87) and *ample* ($M$ = 3.69) experience groups did not rate the biased CLVs significantly different {$t$ (16) = -.793, $p > .05$}, further implying that the techniques used in the biased representations had a somewhat universal effect on participants' reactions to the landscape.

Based on the preceding discussion it can therefore be stated that data analyzed at the level of individual landscape preferences provide no clear indication that the calibrated CLVs of Centennial Park were either more or less preferred than the corresponding landscape photos. Conversely, at the same level of analysis the data seem to suggest that the biased CLVs of Centennial Park were preferred to the corresponding landscape photos. In both cases this is true for participants with *ample* visualization experience, as well as for those with only *moderate* visualization experience.

### *4.6.3 Results From Viewpoint Level Analysis of Preference Data: Centennial Park*

The graph in Figure 4.7 compares the mean preference ratings of the three visual representation types for each of the Centennial Park viewpoints. The calibrated CLVs of the study site received a higher mean preference rating than photos for two of the six viewpoints and lower mean preference rating for three of the viewpoints; while the remaining viewpoint had a mean calibrated CLV rating and photo rating that were the same. Of the six park viewpoints the Pavilions scene garnered the largest rating difference between photo and calibrated CLV (.45 points on the five point scale). In contrast, the biased CLVs of the park had a higher mean preference than the corresponding photos for five of the six viewpoints, while the remaining viewpoint had a mean biased CLV rating that was equal to that of the photo. The largest rating difference between photo and biased CLV was 1.5 points and occurred for the Lake viewpoint.

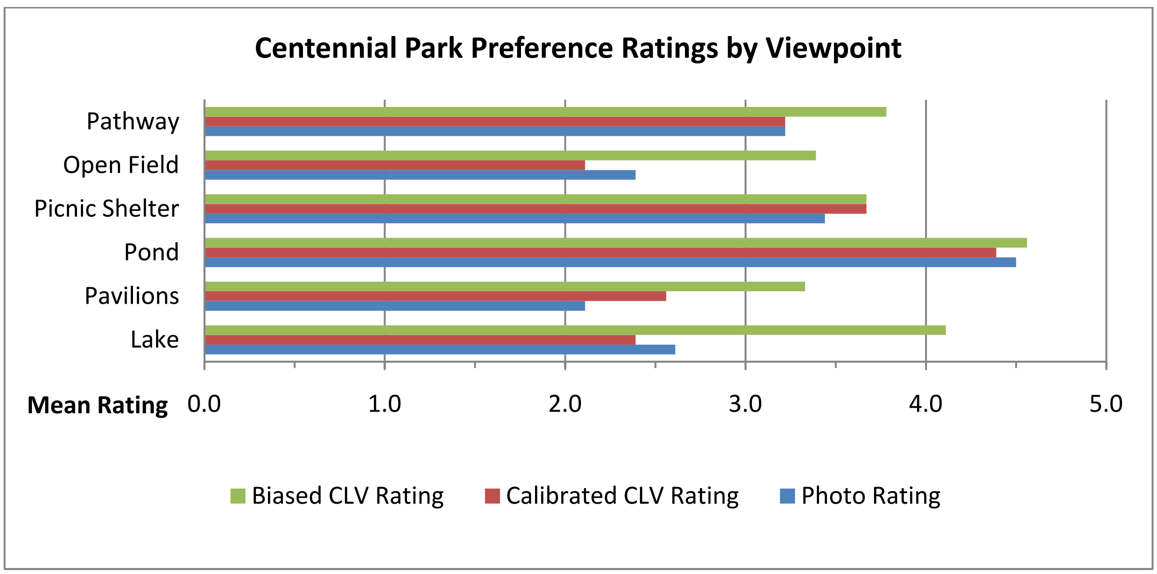


**Figure 4.7 Comparison of mean visual stimuli ratings for each Centennial Park viewpoint.**

As discussed above the Shapiro-Wilk test of normality (see Table 4.5) indicated a non-normal distribution for the preference data when analysis was carried out on individual viewpoints. Table 4.10 therefore shows the results of the non-parametric Friedman's ANOVA tests that were applied to the three mean visual representation ratings for each Centennial Park viewpoint, as well as results from the associated Wilcoxon Post-hoc tests that specifically compared the photo rating to each of the CLV ratings. The subsequent six paragraphs discuss in detail the results of these tests for each viewpoint.

**Table 4.10 Statistical comparison of visual stimuli ratings for each Centennial Park viewpoint.**

| Viewpoint | N | Mean | Friedman's Anova | | | Wilcoxon Signed-Rank | | Effect Size |
|---|---|---|---|---|---|---|---|---|
| | | | *df* | $X^2_F$ | Sig. | Z Value | Sig. | Cohen's d |
| **Lake** | 18 | | 2 | 21.143 | .000* | | | |
| *Photo* | 18 | 2.61 | | | | | | |
| *Calibrated CLV* | 18 | 2.39 | | | | -.811 | .531 | -.189[a] |
| *Biased CLV* | 18 | 4.11 | | | | -2.778 | .003* | 1.418[c] |
| **Pavilions** | 18 | | 2 | 15.250 | .000* | | | |
| *Photo* | 18 | 2.11 | | | | | | |
| *Calibrated CLV* | 18 | 2.56 | | | | -2.138 | .056 | .527[b] |
| *Biased CLV* | 18 | 3.33 | | | | -3.114 | .001* | 1.462[c] |
| **Pond** | 18 | | 2 | .929 | .720 | | | |
| *Photo* | 18 | 4.50 | | | | | | |
| *Calibrated CLV* | 18 | 4.39 | | | | -.816 | .688 | -.197[a] |
| *Biased CLV* | 18 | 4.56 | | | | -.378 | 1.000 | .098[a] |
| **Picnic Shelter** | 18 | | 2 | 2.462 | .327 | | | |
| *Photo* | 18 | 3.44 | | | | | | |
| *Calibrated CLV* | 18 | 3.67 | | | | -.1.633 | .219 | .341[a] |
| *Biased CLV* | 18 | 3.67 | | | | -.924 | .484 | .252[a] |
| **Open Field** | 18 | | 2 | 21.418 | .000* | | | |
| *Photo* | 18 | 2.39 | | | | | | |
| *Calibrated CLV* | 18 | 2.11 | | | | -1.667 | .180 | -.330[a] |
| *Biased CLV* | 18 | 3.39 | | | | -3.082 | .001* | 1.091[c] |
| **Pathway** | 18 | | 2 | 8.773 | .011* | | | |
| *Photo* | 18 | 3.22 | | | | | | |
| *Calibrated CLV* | 18 | 3.22 | | | | .000 | 1.000 | .000[a] |
| *Biased CLV* | 18 | 3.78 | | | | -2.153 | .043* | .720[b] |

*Significant at the .05 level (2-tailed exact significance); [a] Small effect size; [b] Medium effect size; [c] Large effect size

On average, participants did rate the three visual representations of the Lake viewpoint significantly different {$X^2(2) = 21.143$, $p < .05$}. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV ($M$ = 2.39) of the Lake viewpoint significantly different than the photograph ($M$ = 2.61) of the Lake viewpoint {$z = -.811$, $p > .05$}, and the difference represented a small effect size ($d$ = -.189). Conversely, participants did rate the biased CLV ($M$ = 4.11) of the Lake viewpoint significantly higher than the photograph ($M$ = 2.61) of the Lake viewpoint {$z = -2.778$, $p < .05$}, and the difference represented a large effect size ($d$ = 1.418).

On average, participants did rate the three visual representations of the Pavilions viewpoint significantly different $\{X^2(2) = 15.250, p < .05\}$. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV (*M* = 2.56) of the Pavilions viewpoint significantly different than the photograph (*M* = 2.11) of the Pavilions viewpoint $\{z = -2.138, p > .05\}$, although the difference represented a moderate effect size (*d* = .527). Conversely, participants did rate the biased CLV (*M* = 3.33) of the Pavilions viewpoint significantly higher than the photograph (*M* = 2.11) of the Pavilions viewpoint $\{z = -3.114, p < .05\}$, and the difference represented a large effect size (*d* = 1.462).

On average, participants did not rate the three visual representations of the Pond viewpoint significantly different $\{X^2(2) = .929, p > .05\}$. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV (*M* = 4.39) of the Pond viewpoint significantly different than the photograph (*M* = 4.50) of the Pond viewpoint $\{z = -.816, p >.05\}$, and the difference represented only a small effect size (*d* = -.197). Similarly, participants did not rate the biased CLV (*M* = 4.56) of the Pond viewpoint significantly different than the photograph (*M* = 4.50) of the Pond viewpoint $\{z = -.378, p > .05\}$, and the difference represented only a small effect size (*d* = .098).

On average, participants did not rate the three visual representations of the Picnic Shelter viewpoint significantly different $\{X^2(2) = 2.462, p > .05\}$. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV (*M* = 3.67) of the Picnic Shelter viewpoint significantly different than the photograph (*M* = 3.44) of the Picnic Shelter viewpoint $\{z = -1.633, p > .05\}$, and the difference represented only a small effect size (*d* = -.341). Similarly, participants did not rate the biased CLV (*M* = 3.67) of the Picnic Shelter viewpoint significantly different than the photograph (*M* = 3.44) of the Picnic Shelter viewpoint $\{z = -.924, p > .05\}$, and the difference represented only a small effect size (*d* = .252).

On average, participants did rate the three visual representations of the Open Field viewpoint significantly different $\{X^2(2) = 21.418, p < .05\}$. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV (*M* = 2.11) of the Open Field viewpoint significantly different than the photograph (*M* = 2.39) of the Open Field viewpoint $\{z = -1.667, p > .05\}$, and the difference represented only a small effect size (*d* = -.330). Conversely, participants did rate the biased CLV (*M* = 3.39) of the Open Field viewpoint significantly higher than the photograph (*M* = 2.39) of the Open Field viewpoint $\{z = -3.082, p < .05\}$, and the difference represented a large effect size (*d* = 1.091).

On average, participants did rate the three visual representations of the Pathway viewpoint significantly different $\{X^2(2) = 8.773, p < .05\}$. Wilcoxon tests were used to follow up this finding. Participants did not rate the calibrated CLV ($M$ = 3.22) of the Pathway viewpoint significantly different than the photograph ($M$ = 3.22) of the Pathway viewpoint $\{z = .000, p > .05\}$, and there was no effect ($d$ = .000). Conversely, participants did rate the biased CLV ($M$ = 3.78) of the Pathway viewpoint significantly higher than the photograph ($M$ = 3.22) of the Pathway viewpoint $\{z = -2.153, p < .05\}$, and the difference represented a moderate effect size ($d$ = .720).

### *4.6.4 Summary of Viewpoint Level Analysis of Preference Data: Centennial Park*

The mean preference ratings of the three visual representation types are graphed for each Centennial Park viewpoint in Figure 4.7. Much like the results of the Queen Street East analysis, data aggregated at the viewpoint level indicate that there was no consistent difference in the way that participant's rated the calibrated CLVs of Centennial Park as compared to the corresponding photos. For instance, while the calibrated CLVs of two viewpoints (Pavilions; Picnic Shelter) were rated higher than the corresponding photos, the calibrated CLVs of three other viewpoints (Lake; Pond; Open Field) were rated lower, while the remaining viewpoint (Pathway) had a mean photo and calibrated CLV rating that were the same. More importantly the Wilcoxon Signed-Rank post-hoc tests again confirm (Table 4.10), for all six viewpoints, that preference ratings for the calibrated CLVs and photos were not significantly different. Likewise, for all but one viewpoint (Pavilions) the Cohen's D values indicate that the calibrated CLVs had only a small effect on participant's landscape preferences.

In contrast to these results Figure 4.7 clearly shows that the Centennial Park landscape was favored by participants when it was depicted with biased CLVs as opposed to photos. In addition to all six of the viewpoints being rated higher for biased CLVs, the Wilcoxon Signed-Rank post-hoc tests indicate that four of the biased CLVs (Lake; Pavilions; Open Field; Pathway) were actually significantly preferred to the equivalent photo. This result again differs from that of the calibrated CLV analysis where no significant difference was found. Finally, while five of the six calibrated CLVs of Centennial park produced only a small effect size, five of the biased CLVs produced a large or moderate effect when compared to the corresponding photos, implying that they had a considerable impact on how much participants liked or disliked the landscape.

Based on the descriptive and inferential viewpoint level analyses there appears to be no indication that the Centennial Park landscapes were either more or less preferred when depicted with calibrated CLVs as opposed photos. Alternatively, data from the same level of analysis does indicate that the biased CLVs produced landscape preferences that were not only considerably higher than those produced by the photos, but statistically higher for the majority of the viewpoints.

### *4.6.5 Results From Environment Level Analysis of Preference Data: Centennial Park*

As mentioned before the highest level of group preferences for the three visual representation types are examined in Figure 4.5 by comparing ratings that were averaged at the environment level. In comparison to the analysis of the Queen Street East study site, the photographs of Centennial Park were once again rated the lowest of the representations. Likewise, the mean rating of the calibrated CLVs was again only marginally higher than that of the photographs (.02 points on the five point scale), while the mean rating of the biased CLVs was much higher (.77 points on the five point scale).

As the Shapiro-Wilk test of normality indicated that preference data at the environment level was normally distributed for both study sites (see Table 4.7), a repeated measures ANOVA with planned contrasts was used in the inferential analysis of the environment level preference data (see Table 4.8).

On average, participants did rate the three visual representations of the Centennial Park environment significantly different {$F$ = 24.160, p < .05}. Contrasts were used to follow up this finding. Participants did not rate the calibrated CLVs ($M$ = 3.04) of the Centennial Park environment significantly different than the photographs ($M$ = 3.06) of the Centennial Park environment {$F$ = .013, p > .05}, and the difference represented only a small effect size ($d$ = .021). Conversely, participants did rate the biased CLVs ($M$ = 3.81) of the Centennial Park environment significantly higher than the photographs ($M$ = 3.04) of the Centennial Park environment {$F$ = 35.193, p < .05}, and the difference represented a large effect size ($d$ = 1.686).

### *4.6.6 Summary of Environment Level Analysis of Preference Data: Centennial Park*

When the Centennial Park preference data were analyzed at the environment level the mean preferences for the calibrated CLVs and the photos were found to be nearly identical (.02 point difference on a five point scale), and the statistical contrasts (Table 4.8) confirm that these preferences are not significantly different {$F$ = .013, p = .909}. Likewise, the Cohen's D value indicates that the calibrated CLVs had a very small impact on participants' preference for the landscape as a whole {$d$ = .021}. In contrast to this Figure 4.5 clearly indicates that the mean preference for the biased CLVs is higher than that of the corresponding photos (.77 points on a five point scale) and the planned contrasts confirm that this difference is indeed significant {$F$ = 35.193, p = .000}. Finally, similar to the previous results the Cohen's D value once again indicates that the difference in preference that was caused by the biased CLVs is indicative of a very large impact on participants' evaluations of the landscape as a whole{$d$ = 1.686}.

The results from the environment level analysis of the Centennial Park preference data correspond with results from the other two levels of analysis, as well as the results from the Queen Street East study site analysis. As such there is strong evidence to support the assertion that participants did not like or dislike the Centennial Park landscape more when it was depicted by calibrated CLVs as opposed to photos, but did significantly prefer the landscape when it was shown with biased CLVs.

## 4.7 Discussion of Centennial Park Study Site Analysis

The statistical analysis of preferences for the calibrated CLVs of Centennial Park returned results that were quite similar to the corresponding examination of the Queen Street East simulations, with findings from three distinct levels of analysis converging once more. An investigation of preference at the individual level showed that not only was there a lack of any overall pattern in how the calibrated CLVs were rated in comparison to the photos, but that each subject's actual rating difference between the two tended to be even smaller than in the previous Queen Street East analysis. Looking at the descriptive statistics for both group-based analyses it is even more apparent that the calibrated simulations of the Park were not rated consistently higher, nor consistently lower, than the photos of the same landscape. More importantly the post hoc tests and planned contrasts performed at both the viewpoint and environment levels confirm that not only was a clear pattern absent in the preference ratings, but that preferences for the two representation types were in fact not significantly different for any comparison; be it of an individual viewpoint or the entire environment. Finally, the Cohen's D values further validate these statistical findings as the calibrated simulations had only a small impact on subject's landscape preferences for five of the six viewpoints, as well as for the environment as a whole.

In the previous discussion it was noted that when participant's explained their sorting choices the justification for different preferences was based primarily on visualization techniques used in the biased CLVs, while other comments directly suggested that the calibrated simulations and photos were congruent in terms of preference. Although a similar tendency occurred when participants were asked to justify their preferences for the Centennial Park representations, the way they actually described their choices was somewhat distinct. Rather than talking broadly about all the images in a particular preference category, subjects often chose to use specific examples to illustrate their point. Interestingly, in these instances they did not only compare a photo to a single simulation, as they were asked to do in other parts of the interview, but actually grouped a photo and calibrated CLV of a single viewpoint together and then contrasted the content of these representations, as a single entity, against the content of the corresponding biased simulation. Although measurement for this type of behaviour was not explicitly built into the interview procedure, it clearly indicates that participants evaluated the photos and calibrated simulations and deemed them to be highly congruent, although this evaluation may have occurred subconsciously. In addition to demonstrating a general compatibility, this finding could also indicate that the stimuli actually produced equivalent affective and cognitive judgments, as research in the discipline of judgment and decision-making now holds that preferences are based on a complex interplay of cognitive and affective components (Lazarus, 1982, 1984; Nabi, 2003; Russell, Ward, & Pratt, 1981; Schwarz & Clore, 2003; Ulrich, 1986; Zajonc, 1980, 1984).

> Lets start with these two. They look real in terms of real edges, I'm not sure the grass is completely real here, I don't think it is, it's probably not. These are pretty good, both are pretty good in terms of realism. The lights right in both of these, in terms of the shadows coming from the trees and how that happens. That works pretty well. (Eric) - Pond –
>
> These two pictures they don't differ very much at all, one's just a visualization of reality, and ya one has some nicer colouring to it, but other than that I'd say they were equal. Go over here, this one is vastly improved because the people can actually get close to the water , whereas the other ones it didn't seem to be the case. (Steve) - Lake –

Once again the general experience of participant's accepting the calibrated simulations and photos as equivalent requires a small caveat, which is similar to the exception discussed above. When explaining their preference choices the subjects with the most visualization experience (Gary and Mary) again tended to imply that the landscapes were less preferable when depicted with calibrated CLVs, due mainly to an insufficient level of realism, and as before these claims were partially validated by the quantitative data (see Figure 4.6). In this case however, the reasoning appeared to involve more than a mere reaction to the style of the simulation itself, but an aversion to the very idea of visualizing the landscape in this fashion at all. As this visceral attitude was absent during discussions of the Queen Street East calibrated CLVs, it appears there may exist something intrinsic to the more natural park landscape, or perhaps the relationship between these participants and landscape, that generated a distaste for the visualization of the Centennial Park environment. Given the stronger emotional ties that are attributed to experiences in a natural landscape, one plausible explanation is that the knowledge these subjects' possess about the visualization process caused them to view the calibrated CLVs not as a close facsimile of the actual park, but as an inauthentic attempt at recreating a robust experience that is impossible to capture using visualization techniques. If this is the case they likely would view the simulations as somewhat of an insult to their personal understanding of what an experience in the landscape might actually entail.

> I think some that were photographed I tended to like a little more, like if I were to put this one and this one together I'd like the photo. The visualization seems fake I guess. Or I know it's rendered so I don't like it as much. I like the realistic type. It's easier to see myself in it, and it's a higher level of visualization I think. (Mary)
> - Pond -

The attitude of these two specific individuals admittedly represents a clear exception to the general trend in the qualitative data, and implies a potential discrepancy between the calibrated CLVs and photos. That said, these individuals possessed a much greater understanding of the visualization process than other subjects and in no way were their comments indicative of the group as a whole. In fact the vast majority participant's provided highly similar explanations for their preference choices, all suggesting an equivalence of the calibrated CLVs and photos of Centennial Park. In addition to this internal consistency these qualitative data are also validated by the findings of the quantitative analysis, which showed that preferences for the two representation types were not significantly different. Finally, although recent response equivalence research has been sparse, there is also evidence in the literature that supports these findings. In a correlational study comparing CLVs and photos of a forest landscape Bergen et al. (1995) found a high group-based correlation (r = .90) for landscape preference, and although their results showed lower correlations at the individual level of analysis they suggested that improved photo-realism could lead to stronger correlations. The assertion that realism can improve response equivalence for simulations of a natural environment is also suggested by Lange (2001), as well as by Appleton and Lovett (2003) who state that:

> "in general, increased levels of detail do help people to relate to a visualization and imagine for themselves the landscape that is being presented. The search for a 'sufficient' level of realism has not yet been successful in this research, with the indication being that, if anything, certain elements might cause an artificial threshold in the ratings because they are not simulated as well as others" (p. 130).

It is not entirely surprising then that there were no significant differences, at either the individual or group level, between the calibrated CLVs and photos of the Centennial Park study site, as significant advancements in visualization technology allowed this study to use imagery with a considerable level of photorealism.

Turning attention once more to the biased CLVs, in this case for Centennial Park, we see that the results from the quantitative response equivalence tests follow an incredibly similar trend as those from the previous examination of Queen Street East. The individual descriptive statistics show quite clearly that the vast majority of subjects preferred the biased simulations to the photos. Interestingly enough even the two visualization skeptics (Gary and Mary) who showed a distaste for the calibrated CLVs of the park were sufficiently persuaded by the content of the biased simulations to rate them higher than the photos. Likewise, when participant's individual ratings were averaged for each viewpoint only one scene was not rated higher for the biased simulation, which translated into a similar result at the environment level as well. The final component of this statistical analysis, namely the planned contrasts and post hoc tests, are also in line with these descriptive statistics. The inferential testing showed that four of the six viewpoints, as well as the environment as a whole, produced significantly higher preferences for the biased simulations. Moreover, with exception of the Pond and Picnic Shelter viewpoints all of these comparisons indicated that the biased simulations had either a large or moderate impact on the preference that subjects developed in response to the landscape.

Whereas the qualitative data from the Queen Street East case suggested that sky conditions and atmospheric lighting had only a marginal impact on participant's evaluations, in the more natural context of the park these techniques, along with the use of more robust vegetation, appeared to have the most potent influence on preferences for the landscape. Another distinction between the results of the two study sites was that in the park environment the removal of landscape clutter, although noted as an improvement by some subjects, did not have nearly as much of an impact on reported preference as it did in the streetscape. A theoretical explanation for this might suggest that the particular elements that were left out of the biased simulations were simply not perceived as being incongruent with the cultural function of Centennial Park, and thus their presence in the photos was not a particularly detracting factor in participant's evaluations (Nassauer, 1995b). On a more practical level it is certainly the case that instances of 'landscape clutter' in the park landscape were far less common. For instance every viewpoint of Queen Street East contained evidence of at least some hydro infrastructure, not to mention the additional trappings of a common urban streetscape. The reduced positive impact of removing clutter from the park scenes may therefore have simply occurred because there was less to remove and therefore less associated impact.

As might be intuitively expected participants did report that their preferences for certain viewpoints were positively influenced due to the use of larger, more robust deciduous trees in the biased CLVs. Once again this phenomenon was related primarily to the morphology of the trees that were chosen, with the impact being especially salient when deciduous trees were substituted for coniferous species. For example, when describing why the biased CLVs were preferred to the photos participants provided the following comments.

> I think its the huge vegetation in all of them that caught my eye. It just seems extra tall in all of these and that is just appealing to me. (Phillip)
>
> Well there are evergreens, spiky trees. I mean I like them but they are not nice and round. (Sally)
>
> The trees seem to be a little more attractive if that makes sense. (Patrick)
>
> This one compared to the others, an attempt was made to try to clean up the, put more tree canopy as opposed to evergreens. (Cathy)

Although no trees were actually added to the biased CLVs of Centennial Park, mainly because the addition of trees to a park landscape seemed somewhat redundant, the replacement of accurate billboards with images of more robust, mature deciduous trees would indeed be expected to have a positive influence on preference given findings in the literature (Lohr and Pearson-Mims, 2006; Sommer and Summit, 1995; Summit and Sommer, 1999).

In addition to merely being more attractive, another effect of using specific tree billboards in the biased simulations was caused by the creation of a taller canopy within the scenes. Although it was unintentional, the use of tall deciduous tree billboards opened up site lines at ground level, revealing elements that were not visible in the photos of the landscape (e.g. views of a distant horizon). In this sense it could be argued that the choice to use specific tree billboards provided subjects a deeper view into the landscape, as well as a promise of additional information. If this is the case then a positive effect on preferences for these scenes would be expected as the arrangement of vegetation in a landscape has already been linked indirectly to preference via the extent that such arrangements invoke a sense of mystery (Hagerhall, 2000). Admittedly mentions of this phenomenon were less common than discussions about the more attractive tree morphology, but it is an interesting and noteworthy finding none the less.

> There's more open in the back, and so there is a feeling of being drawn into it, which I didn't particularly feel here. (Sam)
>
> You can see down at the trunks that you have a little more sky breaking through in the background. (Allan)
>
> If you just have a wall of trees your line of sight can only go so far, but when you have these layers of trees and you let me see behind them, it adds so much depth to the space. So much depth, and you get to explore it even more than just stopping your eyes visually at this wall of trees. (Phillip)

As for the impact of the enhanced lighting and sky conditions, it was fully expected that these techniques would help to create a pleasing mood within the biased scenes of the park, and maybe even enhance preferences to some extent. That said these techniques were found to be exceedingly more poignant than was anticipated. When a direct comparison was made between a photo and biased simulation many participants were shocked, at times even uncomfortable, with how much of an impact the lighting and sky conditions had on their judgments.  When reflecting on their choices others confidently described just how much of an influence these techniques had, at times even eluding to the fact that lighting and sky conditions were the most important factors in their evaluation of the landscape.

> I was clearly influenced by the lightness. This a bright sunny day, this is a cloudy day. That influenced me. (Sam)
>
> But really the first thing that makes me like or dislike a picture is the way the sun is hitting the sky. The colour of the blue. (Allan)
>
> Oh I just loved the trees and the colour of the sky. The trees really pop, and once again the way you have the light coming down on top of the trees here, there's very few colours but a lot of colours. (Gale)
>
> Like the reason I put this one here is because the sky is fantastic. Like right at dusk, and so anywhere at dusk with a sky like that is nice. (Patrick)
>
> I would say that subconsciously one is influenced by the vividness in the contrast in the sky and the lushness of the green. Even if its digitally enhanced you can't help but be influenced by that kind of thing (Tom)
>
> Ya, the ones that stand out the most, the one with the sunset, the one with the lake and the one with the elderly people walking, all have a pretty dramatic contrast between the sky and the landscape. So that definitely just jumps out at me right off the bat. Whether it should or not, it definitely makes it look a lot more attractive. (Patrick)

As mentioned in the previous discussion there were notably fewer comments about these two techniques when participants explained their preferences for the streetscape representations, suggesting that these elements were less important to evaluations of Queen Street East than they were to evaluations of Centennial Park. There are two possible explanations for this discrepancy. First, an argument from the cognitive tradition of landscape assessment would suggest that judgments of each environment were associated with a conscious evaluation of how the landscape met the particular needs of the user. As such, the use of vivid sky and lighting conditions, which conveyed a very specific mood, may have been perceived as more congruent with the function of the natural landscapes, thus amplifying any positive message already inherent to the scenes (Nassauer, 1995b). For example, the bright sunny skies, when implemented in the park scenes, may have reinforced participant's evaluations of the landscape as a desirable arena for outdoor recreation experiences. In this vein, one participant accounted for his higher preference for the biased CLV of the Pond scene based largely on the different sky conditions in it and the corresponding photo, which was noticeably more gloomy. Another participant commented that the sky conditions within scenes of the park influenced his evaluations in a similar fashion, although he described the effect as a whole, rather than in reference to a particular scene. In contrast to this, within the scenes of Queen Street East the bright sunny skies might have been associated more with uncomfortable summer temperatures that are often expected within hardscaped urban environments. If so it is likely that a somewhat negative effect on preference for the landscape would be leveraged.

> And then this last one, the landscape and everything is very nice. I like the water, I like the stonework around the edge of the water. The trees are nice. But it's a grey day and there is no one out there. I think of kinda rainy England or something. I wouldn't want to be outside too much that day. (Allan)
>
> I definitely found that the kind of day for sure. It was the weather and the sky and stuff like that for sure, 100%. Not even because it wasn't a beautiful space, but because in my mindset I would always think, well that probably wouldn't be the best time to be there. So it just didn't seem appealing to me. (Phillip)
>
> This doesn't look like a people place. Because its all concrete, on a hot day that would be killer to walk along there. (Sally)

A second explanation might be based on an understanding of landscape preference derived from the psychophysical tradition of landscape assessment (Zube et al., 1982). Using this lens the reduced impact of the lighting and sky techniques on evaluations of the streetscapes could be attributed to the actual image composition of the stimuli themselves, which was a consequence of the spatial structure in each landscape. More specifically, images of Centennial Park offered much deeper views into the landscape, allowing the sky to penetrate all the way to the midline of each image. Because of this a high proportion of the Centennial Park images were actually dedicated to views of the sky. In contrast, because the buildings in the Queen Street East scenes obscured distant views of the landscape, there was considerably less percentage of these images occupied by views of the sky. In this sense, the mere reduced prominence of sky present in the streetscape representations may have tempered the impact of the technique on overall evaluations of the landscape.

## 4.8 Research Questions Two and Four: Perceptions of Simulated Landscapes

The preceding sections have analyzed qualitative and quantitative response equivalence data that compared preferences for three distinct types of landscape representations in two very different environmental contexts. Based on the results it is possible at this juncture to reject both null hypothesis $H_o1$ and $H_o2$. Data from both environmental analyses show with little uncertainty that preferences were in fact equivalent for calibrated simulations and photos of the study site landscapes. On the other hand the same analytical procedures provide overwhelming evidence that indicates the biased simulations of both Queen Street East and Centennial Park were highly preferred to photos of the same landscapes. In addition to the support provided by two separate datasets, these findings are also well in line with past research in the field of landscape assessment. Still, as mentioned before the concept of response equivalence recognizes the importance of both landscape preferences and landscape perceptions, meaning that thus far only half the story has been told. As we remember the quantitative measurement instrument used to collect preference responses was too imprecise to also consider the effects of the CLVs on participant's landscape perceptions (Miles and Huberman, 1994). For this reason it is important to revisit the qualitative interview data when assessing the response equivalence of the calibrated and biased CLVs by specifically investigating potential impacts on landscape perception. The following sections therefore discuss the remaining domains that were distilled from the schema analysis of participant's self reported preference motivations. The only perceptual effect that was found to be related to the calibrated CLVs is discussed first, followed by a discussion of three distinct impacts that the biased CLVs had on landscape perceptions.

### *4.8.1 Effects on Perceptions of Maintenance: Calibrated CLVs*

While the schema analysis distilled a total of eight themes from discussions of the CLV techniques, as well as five domains that these techniques were related too, only one theme and one domain were uniquely associated with discussions of the calibrated CLVs. As previously described a considerable amount of care was taken to ensure that the texturing of the DTM and buildings in these simulations was completed with representative textures, which in most cases were colour matched geospecific images. Still, even given this strict approach there appeared to be an overall effect of the textures on participant's perceptions of the scenes. More specifically, when contrasting their evaluations of the various representations participants compared the buildings and ground surfaces in the calibrated CLVs to those in the photographs, remarking that the computer rendered landscapes somehow looked cleaner. For example, when describing the Service, Retail and Fire Hall scenes in the Queen Street East study site participants provided the following comments:

The buildings are in better shape than in the other one. Its cleaner looking, even with the for rent signs its cleaner looking. (Gale) - Service -

Again, this looks like the newer urban to me. Very attractive front to it. Inviting, even though they got the for rent sign, it still looks like something that people would want to migrate too. Look at this, its even got a Timothy's. It looks neat and clean. (Jim) - Service -

This is that same image as this, only the brick has been touched up. It looks like the brick has been touched up in this image and it looks like some of the colours have been softened. Even the road doesn't look as pockmarked. This is starting to be visually more appealing to the eye, but it would be better if it had trees. A lot better if it had trees. And this just looks run down. (Cathy) - Service -

Ya, you can tell by the bricks up here, that aren't shown here, so it looks a lot cleaner and more upkept compared to here. (Vicki) - Retail -

Well this is unpreferred to me that the overhead wires, that the brick is in rough shape and this architecture, this landscaping looks unkept. Here, this architecture, this landscaping has been cleaned up. (Cathy) - Fire Hall -

The picture of the Fire Hall has now been upgraded. The visualization makes it appear a lot softer than reality does. It just seems cleaner. (Steve)

When discussions of the Centennial Park study site were analyzed the same theme emerged, with numerous participants commenting on the cleansing influence of textures that were applied to both buildings and the ground surface. For example, when discussing potential reasons why a calibrated CLV might have been rated higher than the corresponding photograph, several participants discussed the manicured look of the ground textures in the simulations.

This one, again it's the, what I thought was a maintenance road now looks like a nicely groomed path somehow. The visualization again takes the edge off of it and makes it seem better somehow. (Steve) - Pathway -

It was the gravel road that intrigued me as going into something. The perspective. Here it looks so clean through here. Why is that so? Its essentially the same picture. Same Trees, same bushes and everything else. (Sam) -Pathway-

We were just talking about this gravel path…because it's a computer graphic everything seems nice and clean and crisp. Even the pathway seems like its well done now instead of, it looks maintained. It kind of looks paved in a way almost. When you stick it on a computer image, so I picture it in my head like, this is a really nice field. Nice, maintained probably.(Philip) - Pathway -

The treatment of the path in the neutral image is a little more clean and well defined than it is in the highly unpreferred photo, and the space looks more well maintained in the neutral image. (Gary) - Pathway -

As mentioned the cleansing effect of the CLV texturing technique also had a noticeable positive influence on participant's perceptions of built structures within the Centennial Park simulations, which included the breeze through picnic shelter (Picnic Shelter) and the washroom structures (Pavilions).

> Here its just more an aesthetic preference. Again these buildings, its better than the other one obviously. I don't know why there is a difference in this one. Maybe the clean edges here? Maybe that's what drove it. But in this one the buildings somehow look less utilitarian than they did here. (Eric) - Pavilions -
>
> The buildings look a lot more, way more kept up, maintained...The buildings look, they don't look as decrepit as in the other one, and the buildings in the other one weren't that decrepit, but it looks like they have been touched up so they look a little bit cleaner. It looks more sanitary. (Philip) - Pavilions -

The influence of the computer rendered textures on participant's perceptions was both unintended and unexpected, and occurred simply as an artifact of the standard texturing techniques that were used in the creation of the simulations. That said the finding cannot be ignored. The continued referral to the cleaner look of the visualized landscapes certainly suggests that the texturing techniques interacted with participant's perceptions, and perhaps even aesthetic preferences. More importantly though, the quantitative results indirectly support this claim, offering the potential to test the validity of this assumption.

Although no statistical differences were found between the photos and the calibrated CLVs, among the Queen Street East scenes two simulations did in fact (Service CLV and Retail CLV) produce positive Cohen's D values that were much higher than all others (Table 4.6). Statistically this suggests that simulations of these viewpoints had a larger effect on participant's preferences as compared to the other scenes. What is interesting is that in comparison to the rest of the Queen Street East photos, these two viewpoints contained buildings with considerably more visual deterioration, meaning there may have been more opportunity for the clean, simulated textures to improve the appearance of these scenes. A similar pattern to this can also be noted among the scenes of the Centennial Park study site. Among the six park scenes there were only two occurrences where a calibrated simulation produced a positive Cohen's D value (Table 4.7), thus indicating that the Picnic Shelter viewpoint ($d$ = .341) and the Pavilions viewpoint ($d$ = .527) were the only CLVs that were preferred on average over the corresponding photograph. Interestingly, these two viewpoints are also the only Centennial Park scenes that contained built structures, and therefore again may have possessed the most potential to be improved by the texturing technique.

Finally, while the calibrated CLVs of Queen Street East were not statistically different than the corresponding photos, it can be noted that they did produce an effect size at the environment level ($d$ = .263) that was considerably higher than the calibrated CLVs of Centennial Park ($d$ = .021). As the Queen Street East scenes unquestionably contained a great deal more infrastructure with visible signs of deterioration, this larger effect size might be accounted for partially by the more prevalent effect of the clean textures on preferences for this landscape. Considered together the quantitative and qualitative evidence point to the same finding; a positive overall influence of the texturing techniques on participant's evaluations, especially with regards to built structures. That said, if the texturing technique did in fact interact with landscape preferences, its influence seems to be quite modest as the statistical results clearly show a high level of equivalence for preferences of landscapes shown with the photos and calibrated CLVs.

As the influence of the texturing technique on participant's preference evaluations seems negligible, the question begs whether the persistent comments about 'upkeep' and 'maintenance' were symptomatic of a link to deeper, unconscious perceptions. If viewed through the lens of the ecological-aesthetic, one might consider that these comments are not simple evaluations of the physical components of the landscape, but are representative of unconscious assumptions about the human caretakers that are associated with the environment. If thought of in this manner, the clean, repeating textures that were applied to each building would have to be considered to carry information well beyond simple colour values. In fact, they would seemingly posses the ability to communicate cultural meanings such as stewardship or negligence. The potential implication of this is that something as unassuming as how a building is textured might actually have a profound influence on the cultural values that a viewer attributes to a visualized landscape. If this is the case then we must consider that when we present a simulation to the public, we are not only asking *do you like this?* We are asking *how do you feel about the potential stewards of this landscape?* One participant sharing her thoughts on why she preferred the calibrated CLV of the Mixed Residential scene over the corresponding photo conveys this point.

> This, it looks, both streets are clean and it looks like a nice place, a safe place. Not a lot of people, it looks quiet to me. Small town somewhere. Love the sidewalk, the buildings looks awesome. They look like the people that live there are looking after their homes. (Gale)

### *4.8.2 Effects on Perceptions of Safety: Biased CLVs*

Discussions of participant's preference motivations revealed three effects on landscape perception that can be attributed to the techniques employed in the development of the biased CLVs, and it should be noted that these impacts were not in any way present in discussions of the calibrated simulations. The first of these three perceptual effects related to subject's conceptions of how safe both the Queen Street East and Centennial Park landscapes were. Specifically, the general consensus seemed to be that the landscapes appeared to be safer in the biased CLVs as compared to the photos, ostensibly due to the increased presence of people within the scenes. In addition to the simple presence of people, the characterization of people that were used in the CLVs also had a considerable influence on how safe the landscapes were deemed to be, especially when families and children were included.

> The amount of people I see in them, so its usable space and there is security behind other people being there. (Mary) -Open Field-
>
> Just the element of people, because people means that its accessible, its safe, it's a more lively picture. (Tom) -Lake-
>
> All the images are sunny, people are wearing capries and t-shirts, they are walking around, the streets are active. … There are people on the stoops of the buildings and it looks warm for some reason. It's the clothing they are wearing or the position of the sun in the sky. It looks like a nice summer evening and definitely looks like a safe place to take a walk. (Gary) -Mixed Residential-
>
> There is a kid playing here that I notice, so it has to be a safe area. I mean there's a guy with his kid too. I mean its gotta be a safe area if your walking down there with your kid. (Phillip) -Retail-
>
> You've got some children that are actually enjoying the space and obviously the parents are feeling comfortable. (Nancy) -New Residential-
>
> Well this guys walking down the road with his kid, its gotta be a good place right. (Gale) -Retail-

The perceived security that was offered by the presence of certain individuals in the biased CLVs is another strong indication that the visualization process can have an impact on not only preferences, but an individual's cultural perceptions of a landscape. Moreover, in contrast to the effect of the texturing technique discussed in the previous section, the shift in perceptions of safety represents the influence of a very innate need to avoid dangerous situations and environments. As such, the choice that the visualization preparer makes when he or she is populating a simulation requires much more consideration than simply downloading and inputting a host of billboards in an appealing and lively arrangement. This finding suggests that the selection of such elements could in fact have an influence that potentially overrides other important elements within the representation that are ultimately more salient to the reason the simulation is being used in the first place. Clearly then the choice one makes when populating a simulated landscape requires a great deal of thought as to what is a representative and appropriate message for the actual landscape that is being depicted.

### *4.8.3 Effects on Perceptions of Social Character: Biased CLVs*

In addition to influencing perceptions of safety, the increased presence of people in the biased CLVs, in combination with the activity that these people were engaged in, seemed to influence the ability of subjects to personally relate to the social structure that was implied in the representations. Moreover, the capacity for subjects to develop a positive relationship with the implied users of the evaluated landscapes was at times so important that it not only interacted with preferences, but subject's very conception of what an experience in the landscape might entail. When discussing photos that were particularly devoid of social interaction participant's often attached negative connotations to the landscape as a whole, and even seemed skeptical about the possibility of having a positive experience within the scene being depicted. For example, one participant described her feelings about the Pathway photo and presented an outlook that was rather bleak, describing the landscape as being lonely due to the lack of human presence. Alternatively, when discussing the same scene depicted with the biased CLV she notes the positive impact that the addition of people had on the character of the scene. In a similar discussion with a different participant the lack of human presence in the Pathway photo even seemed to override what would have otherwise been a positive evaluation of the landscape.

> I didn't like the fact that there is no one there, again it felt lonely. (Rebecca)
>
> I do like the fact that there are more people. The path with the old people, cuz its pretty similar to the one in the other category, it helps that there are people. (Rebecca)
>
> This one, this one I kind of liked. But then there is no one really in it and it didn't seem like you could really do much here. (Vicki)

Discussions with other participants also suggested that the inferred potential for a personally meaningful experience in the landscape was derived largely from the presence of people in the representation; in as far as this presence demonstrated the opportunity for positive social interaction. For example, when describing why a grouping of Queen Street East photos and calibrated CLVs was less preferred than the biased CLVs of the same scenes, one participant made the following statement.

> Could be the lack of people. It could be, ya and with the amenities I just don't see anything that would bring me there. Now that I think about it, this one, there are just no people there so I don't have any reason to go there (Patrick)

While many participants focused on the negative effect that lifelessness had on their evaluations of the photos and calibrated CLVs, others explained their affinity for landscapes shown with biased simulations by highlighting the positive influence of the increased presence of human activity. These participants often described the biased CLVs as being 'friendlier' and consequently more supportive of a landscape character that was personally inviting. Interestingly, the experience that participant's saw themselves having in the evaluated landscapes was linked not only to the presence of people in the simulations, but also to the specific activities that these people were engaged in. This phenomenon had an especially positive impact on participant's evaluations when the activity being depicted was congruent with their own personal conception of what was appropriate for the type of landscape being shown.

> People are sitting on their front step. People are walking into their house. Its kind of nice to see interaction. Its friendly, instead of like enclosed houses. (Phillip) -Mixed Residential-
>
> In another picture you had a lady was stopping to talk to another lady on a bench, which makes a big difference. Great neighbourhood. Everybody is friendly. (Gale) -Fire Hall-
>
> Lots of people walking around doing something. Ya, I could picture myself going there with a group of people and having a picnic. (Allan) -Picnic Shelter-
>
> It just seems like there are more, people are like interacting. It just seems like people are enjoying this space, so you want to use it then. (Vicki) -Open Field-
>
> People using the space was the biggest part. I just feel, especially with a streetscape, a successful streetscape is always supposed to be one where, at least if were talking about if there are shops around, people are supposed to be walking around using the space. You feel more comfortable. If your on the street by yourself, your like, something is wrong here, why aren't people using this space. (Phillip)

While the capacity to identify with the apparent users of the landscape produced positive evaluations for most of the biased simulations, when the social activities being depicted were not congruent with participant's conceptions of an appropriate experience, there was an equally negative effect on evaluations of landscape as a whole. For example, one participant was entirely put off by the activity of people in the Picnic Shelter scene, which was staged to represent a vibrant social gathering, while another participant illustrated the same tendency, appearing to be uninspired by the activity of these individuals and consequently seeing little value in the landscape itself.

> The people for some reason annoyed me in these ones. It seemed like everybody was gathering at one point and it was just weird to me. I understand that it's a pavilion, but its something about the crowding in one place. Because if I were walking through this space I would feel like I was interrupting something. And once again its just open grass. I honestly pictured my self walking through this space and it would be really awkward, because first of all you're out in the open, and there is this large group of people that might all be there for one reason and you're the only one who isn't. (Phillip) -Picnic Shelter-
>
> The people I see are just standing around, they are in the distance. They don't look that interesting. They are not doing anything that I find all that intriguing. (Gary)

The ability for subjects to imagine themselves having a positive social experience in the landscapes being depicted, which was in turn a function of the message conveyed by the apparent users of those landscapes, seems to partially explain the highly positive evaluations of the biased CLVs. The interview data therefore suggest that the characterization of the biased simulations used in this study was indeed an accurate prediction of the types of social structures that could be employed to unduly coerce subjects into a more positive evaluation of the landscape as a whole. In some instances this prediction admittedly had the opposite effect, as the social structures that were depicted superseded any ability to imagine a different, perhaps more personally meaningful experience. That said, for the most part populating the biased simulations with well to do individuals, arranged in way that suggested a vibrant social setting, did in fact greatly encouraged the development of positive evaluations, as subjects were able to reaffirm their relationship with the landscapes that were being shown.

The impact of the social message that was communicated though the simulated landscapes, as well as the relationship that developed between participants and the apparent users of these landscapes, can best be explained with concepts from the SoP literature. Using this lens, the representations to which participants responded have to be thought of not as a mere catalyst for some innate preprogrammed judgment, but as a window to an experience based evaluation that is based on an interpretation of personal meanings, behavioural intentions and particular cultural values. In this sense the biased simulations were not able to enhance evaluations of the landscape because they made the physical elements more aesthetically pleasing, but because they constructed a social atmosphere that enhanced the ability of subjects to become personally attached to the landscape. This perspective becomes especially intriguing when one considers just how easily a simulated landscape can be changed in comparison to the real place. Relph (1976) acknowledges that an authentic SoP should develop organically through the accretion of cultural values and individual experiences in a landscape over an extended period of time. In contrast, the biased simulations used here were able to alter attachments to the landscape not by introducing subjects to a prolonged, legitimate string of personal experiences, but merely by incorporating specific human elements that were noting more than the subjective choice of the visualization preparer. This finding thus suggests that the concept of positionality (MacFarlane et al., 2005) is indeed as critical to the production of valid landscape surrogates as the choice of the technology, as has been speculated in the visualization literature.

### *4.8.4 Effects on Place Identity: Biased CLVs*

Drawing on Proshansky's (1978) early work on place attachment, Jorgensen and Stedman (2001) claim that place identity is one of three factors that are important to the creation of a SoP, defining it as the cognitive development of conscious and unconscious beliefs, preferences, and ideas that serve to bond an individual to the landscape. In a more concrete description Relph (1976) asserts that the identity of a place is comprised of the link between three specific component parts; physical features, observable activities or functions, and meanings or symbols that the observer attaches to the landscape. If these explanations are blended it then makes sense to state that a change in beliefs or ideas about a landscapes features, function or meaning is indicative of a shift in the perceived identity of that landscape. Taken a step further it can also be concluded that the validity of a simulation would thus be questionable if it did not produce beliefs or ideas about these components that are the same as those produced by the actual landscape. In this research the impact of the biased simulations on perceptions of place identity was measured specifically by examining participant's discussions about the function of the landscapes, which were considerably different when the focus was the biased CLVs as opposed to the photos or calibrated simulations.

As the schema analysis diagram in Figure 4.1 illustrated, the perceived identities of the study site landscapes were under pressure from a number of the visualization techniques used in the biased simulations; including the removal of landscape clutter, the addition of robust vegetation, and the replacement of vehicles in the scenes with billboards of specifically characterized people. Among the viewpoints of Centennial Park the identity of the Pathway landscape was especially susceptible to influence from these visualization techniques. For example, when considering why he preferred the biased CLV of the Pathway scene to the corresponding photo one participant explained that the addition of people to the landscape somehow changed the apparent purpose of the path itself, which did not actually change physically, from serving vehicles to serving pedestrians. In a similar discussion of the same viewpoint another participant was even more direct in describing the impact that the newly added people had on defining the purpose of the scene. In this case however it was not so much the perceived purpose of specific elements in the landscape that was influenced, but the function of the landscape as a whole. More specifically, with the addition of a human element this function seemed to become predicated as much on the characterization of users in the landscape, as on the physical affordances of the landscape itself. Since the biased simulation in this instance depicted two elderly pedestrians, the landscape was thus deemed to be appropriate for walking or small group activities.

> Well the fence is gone. The path, now that it has people on it, looks narrower and really does look like a path rather than a maintenance road. Lot of tree, more trees covering the path. It's a walking area now. (Steve)
>
> The lack of development or the minimal development in the case of this one with the walkers. The people say something about what the use will be. The use will be walking or small group activities that are unplanned and unstructured (Nancy)

An impact on place identity attributable to the addition of people to the biased CLVs was also noted in scenes depicting the Queen Street East study site. For one participant the presence of people in the biased Retail scene was enough to overcome the lack of signage on the buildings, which reduced his ability to discern the landscapes function in the photo and calibrated CLV. For example, when discussing why the retail photo was disliked he provided the following comment.

> With this one, honestly the one thing that turned me off was that there is no names. How the heck do you tell what kind of store this is. That is so sketchy to me, because it looks like these three buildings are going out of business, so what the heck are they being used for. They are really run down at the top, that probably doesn't actually bother me as much if people were actually using the space, if there was names on everything. (Phillip)

Alternatively, when the biased CLV of the Retail scene was compared to the corresponding photograph there was a notable shift in his attribution of the landscapes function; changing from an area where shops are likely 'going out of business', to a retail area that is ostensibly more successful given the amount of users in the space. The interaction of people in the scenes with the unnamed buildings was even suggestive enough to allow this participant to overcome any trepidation that was associated with the lack of a buildings identity, which negatively impacted his judgment of the photo.

> Once again I was kind of skeptical of putting this one in the neutral cuz there are still no signs on the buildings, but people are actually using the space so I become way more comfortable, because I'm just like who cares, if tons of people are using the space it can't be bad. (Phillip)
>
> This guy is walking into a building with no name on it. And I mean, if he can do it, I can do it. (Phillip)

For a different Queen Street East scene the increased presence of pedestrians in the biased CLV also acted in consort with the introduction of trees to significantly alter a participant's perception of the landscape's function in a broad context. When discussing the Fire Hall photo this participant attributed the landscape as a potential site for industrial activities. In contrast when discussing the biased simulation of the same scene, the participant came to a much different conclusion feeling that the landscape was now probably a residential community of some sort. Although it operated in tandem with the other techniques, the reduced number of vehicles in the biased scenes of the Queen Street East study site also served to redefine the purpose of certain landscapes in this fashion. In this case however the function of the landscapes shifted from being a thoroughfare that carries mainly traffic, to a streetscape that serves the needs of the pedestrian rather than the automobile. One participant was so heavily influenced by the removal of vehicles from the New Residential scene that the reduced presence of vehicles even changed her entire conception of how the neighbourhood might fit spatially into the larger structure of the community.

The fire hall is much improved because now you have the greenery, we have people walking around. Again the visualization softened it a bit. I didn't even notice there was a coffee time back there if I hadn't seen the other images I wouldn't have known. This seems like a community now, versus what could have been an industrial area before, or the outskirts of an industrial area (Steve) -Fire Hall-

There isn't traffic that is detracting from the people, so it looks like there might not even be that much through traffic, which would make walking as a pedestrian much safer. (Rebecca) -Service-

I was surprised how influenced I was by the lack of cars in pictures, and how my brain didn't say, well how can you have an urban setting with no cars, and I was willing to accept that and disregard that and like pictures more that didn't have automobiles and traffic in it (Allan)

They are all looking quieter , they are all looking less intense from a people point of view because there are no cars. (Nancy)

It wasn't clear to me with all the cars there that it wouldn't be as friendly or welcoming, so the lack of cars on the street, meant a more easy flow of people, looks safer. (Tom) -Service-

There's cars all over the place parked. They obviously don't have, there's no garages, or maybe in the garages are in the back. In this one maybe they don't need cars because they live where they don't need to have a car and they are taking care of the environment. (Sheree)

Finally, the removal of specific elements that 'cluttered' the landscapes (namely power lines), in cooperation with the addition of robust billboards of deciduous trees, considerably changed the identity that several participant's attached to various scenes depicted with biased CLVs. For the Centennial Park study site this influence is best illustrated by the overwhelming role that the hydro infrastructure played in defining the identity of the Pavilions scene when it was represented by the photos and calibrated CLVs. For example, when discussing this scene as represented by the photo participant's had a tendency to describe the landscape based on its apparent functional role within the broader context of the community, accrediting it with an industrial character. Conversely, when the character of this same scene was described based on the biased simulation the connotation of the landscape as industrial was entirely absent. In fact, without the hydro infrastructure present participant's tended to describe the Pavilion scene much more in terms of other structural elements within the landscape, and how these elements met the needs of the people within the scene.

These make me think of pollution. All the wires in the background with the water, that makes me think there is a factory close by. A city close. It makes me think there is a big Toyota plant over there somewhere. (Gale)

The negative is the electric wires, it implies industrial. I mean those wires are going somewhere, so it implies you are in an industrial area. (Nancy)

I saw the little poles in behind here and I saw the pavilion structures match that, and it looks much more utilitarian. Like this should be part of the electric infrastructure rather than being a play area. (Eric)

Well these are not showing, although this one has little buildings in it, its not a games area. The path, the activity here is walking its not a play area. (Nancy)

There are people in some of the images, I think that animates the space in some way. I think they are walking so it seems like they are doing something active and interesting… It looks like there is a major pedestrian path in the preferred image, so people are moving over here to the right of this image. It makes me want to explore what's over there. And people are wearing short sleeves, it looks nice. (Gary)

The replacement of hydro infrastructure with robust mature trees seemed to have a similar effect on place identity when responses to the photos and biased CLVs of the Queen Street East scenes where compared. That said the impact in this instance tended to manifest itself in the addition of the trees, as apposed to the removal of the hydro infrastructure. One participant contrasted the photo and biased CLV of the Fire Hall scene and distinguished the character of the biased landscape, which appeared to him to be a pedestrian oriented neighbourhood, from that of the landscape shown in the photo, which he described as a 'driving street'. In a similar discussion that compared the photo and biased simulation of the Retail scene the addition of trees seemed to have an even larger impact on the apparent identity of the landscape. In this case though, rather than the apparent function being altered, the participant noted that her entire perception of how unban the setting might be had changed significantly.

There has been some vegetation added that makes it look more like a neighbourhood. The other ones look more like a driving street than a walking street, and the vegetation makes it look like, and it could be because there is more people in the picture, but the vegetation lends it self to a neighbourhood. Like across the street there could be a whole residential neighbourhood. (Patrick)

The vegetation for sure, it adds a lot. Mainly visual, and the fact that if you are experiencing this it would add a lot of character and you feel not so much like your in an urban setting, but more like your in a park like setting (Vicki) -Retail-

Although numerous techniques used in the biased simulations interacted with the identities that subjects ultimately ascribed to the various scenes, there is common thread that can partially explain the overall impact that the techniques had. The theme that is prevalent throughout the discussions appears to be one wherein the biased simulations depicted the landscapes under conditions that induced a far more experiential evaluation of the landscape than was prompted by either the photos or calibrated CLVs. For example, when participants addressed the photos they seemed to base their descriptions mainly on the landscapes perceived function from a land use perspective. Conversely, when they provided descriptions of the same landscapes based on the biased simulations there was a much stronger tendency to highlight the relationship between the people in the scene and the physical landscape, and how the function of the landscape supported the needs of this human element. In this sense the biased simulations seemed to change the scale at which participants evaluated the landscape, shifting their frame of reference from what Relph (1976) describes as large scale ‘pragmatic spaces’, which support societal function from a survival standpoint (i.e. industrial area), to more intimate ‘authentic existential places’ that offer a means to personally belong to the landscape and its associated culture (e.g. neighbourhood).

# CHAPTER 5: CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS FOR PLANNING

## 5.1 Introduction

The representational validity of CLVs has received insufficient attention since Oh (1994) provided the first assessment of a computer based 3D visualization. Interestingly, while subsequent comparisons of simulations to actual landscapes have suggested a potential incompatibility between the public's evaluations of real and virtual environments (Neto, 2006; Wergles and Muhar, 2009), the literature seems divided as to whether this discrepancy is of any concern to the employment of CLVs in practice or research (Bergen et al., 1998; Bishop & Rohrmann, 2003). One factor that has arguably led to these opposing attitudes is the unremitting faith has been placed in the future of computer visualization technology. Within this body of research the implication continually seems to be the potential for a surrogate with perfect 'ecological validity' that will erase any perceptual gap between experiences in the virtual and the real (Ervin, 2001). Admittedly, such devotion to the technology is not entirely unfounded as there has been a remarkable transformation of CLVs over the past three decades. Still, as exciting as the prospects may be it can not be overlooked that such a trenchant commitment to the future of the technology inevitably causes us to neglect the true needs of decision making processes in planning, which cannot be measured in terms of realism or interactivity. More worrisome is the fact that this technocratic attitude entirely ignores the truth about the visualization process, which is and always will be driven by a fallible human element. We must remain cognizant then of the fact that even if advances in computing power produce an ostensibly perfect surrogate, there is no assurance that such a representation will be beneficial to stakeholders in the planning process (Orland et al., 2001). In fact, given what is known about photorealism there is reason to believe that further investment in visualization technology, without a full understanding of its impact, could be detrimental to public engagement and decision making if it's application goes unchecked (Sheppard, 2001).

In light of this realization the objective of this research has been to explore the human element in the visualization process, and more specifically the impact that deliberately biased landscape representations have on the public's perceptions and preferences of urban environments. As there are potentially important practical lessons to be learned from this research it must be reiterated that the findings discussed earlier are important only in as far as they are representative of the actual use of CLVs in planning practice. The remainder of this thesis will therefore reconcile the results discussed in Chapter 4 with findings from an exploratory investigation of the institutional procedures and professional attitudes that exist regarding simulation use in the Canadian planning process. First, the response equivalence findings of this research will be summarized and the validity of the CLVs that were investigated will finally be stated. The methods used in the exploratory investigation will then be presented, followed by a discussion of some key findings from the interview and survey data. Finally, implications of the response equivalence results for the current use of CLVs in practice and research will be discussed and recommendations for effective simulation use will be offered.

## 5.2 Summary of Response Equivalence Findings

The following two sections will summarize the quantitative and qualitative response equivalence results for both the calibrated and biased CLVs, as well as comment on the validity of each as a surrogate for the landscapes examined in this research. It would be helpful then to reiterate the definition of response equivalence that was followed in this study one final time. Response equivalence is the "the extent to which landscape perceptions, preferences and/or judgments based on photographs o*r simulations* correspond to responses elicited by direct experience with the landscapes nominally represented" [*italics added*] (Daniel & Meitner, 2001, p. 62). More specifically, a landscape surrogate should evoke perceptions that are similar to those of a direct experience in categories of identification, orientation, encoding, aesthetic response, personal liking, safety, and manipulation (Bishop & Rohrmann, 2003).

### *5.2.1 Is Calibration Enough? Is It Practical?*

The procedures that were followed to develop the calibrated CLVs used in this research were carefully crafted to ensure the accurate and representative depiction of the two study site landscapes. This required fieldwork to be carried out in both study sites to accurately measure and document specific site elements (e.g. tree species), as well as to gain a representative impression of the landscapes' general character that could later be translated into the final simulations (e.g. social atmosphere). As discussed in Chapter 4, when preference responses to these representations were compared to those of a corresponding set of photos statistical evidence indicated that neither landscape was more preferred or less preferred when depicted with calibrated CLVs as opposed to photos. In addition to this all but two individuals, both of whom possessed a considerable understanding of the visualization process, provided explanations for their rating choices that clearly suggested the calibrated simulations had little effect on their preferences. In contrast to these findings a schema analysis of the same personal accounts suggested that participant's evaluations were under the *indirect influence* of the texturing techniques used to create the CLVs, although the quantifiable impact was negligible. More specifically, both simulated landscapes were noted by participants as appearing cleaner or more up kept than the actual landscapes, signaling an impact of the simulation development process on perceptions of landscape maintenance. As might be expected the cleansing effect of the textures was most prevalent when the landscapes contained built structures with noticeable signs of aging, although to a lesser extent the texturing of ground surfaces also seemed to influence perceptions of maintenance.

Given these somewhat contrasting results the chief question becomes whether the calibrated CLVs were a truly valid representation of the Queen Street East and Centennial Park landscapes. Certainly results from the response equivalence analyses show that the preference evaluations of the calibrated CLVs and photos were highly congruent. On the other hand, if the texturing technique did indeed influence unconscious perceptions of landscape maintenance, then there may be cause to reject the CLVs as valid in the strictest sense. While this situation may seem irreconcilable without further testing, it is important to note that the texturing effect was quite unexpected and was not explicitly controlled for in the calibrated visualization process (even through photos of the actual building materials - geospecific textures- were used to texture the virtual buildings). In hindsight it would have been relatively easy to replicate the deteriorated building facades using an image manipulation package like Photoshop to introduce imperfections to the virtual building facades. Had this been done it is entirely possible that the cleansing effect of the simulated textures could have been negated. Therefore, while there may have been some mild perceptual differences between the photos and calibrated simulations, what is of consequence is the clear indication that a visualization process that champions accuracy and representativeness can produce landscape surrogates that elicit a substantial degree of response equivalence.

As a final note on the calibrated visualization process it is worth mentioning that the procedures followed here were not at all unlike those used in the development of CLVs in planning practice. In fact, the process followed in this research used no actual techniques or data that are unavailable to practicing professionals, meaning the representations required only a small investment of additional time to ensure that all elements were accurate and representative. The approach that was utilized was therefore nothing more than an open acknowledgment of the visualization preparer's fallibility, which limited the number of uncertainties and assumptions in the visualization process and reduced the potential for positionality to influence the final appearance of the landscapes. It is not unreasonable then to state that any visualization preparer could adopt such an approach to limit the influence of his/her subjective choices and personal values, thus improving the defensibility of their work.

### *5.2.2 Do Accuracy and Representativeness Matter?*

While it has been acknowledged in the literature that persuasive simulations can influence evaluations of a landscape, to date there has been no attempt to empirically measure the impact of such representations on the public's landscape perceptions and preferences. Furthermore, no study has fully mixed a quantitative response equivalence assessment with qualitative interviews to explain exactly how a lack of accuracy or representativeness might influence preferences among the public. In this research a set of biased CLVs was produced by employing common visualization techniques that advocate the inauthentic enhancement of landscape character over accuracy or representativeness. Statistical evidence from the quantitative response equivalence tests confirm the speculation in the literature, illustrating an overwhelming ability of biased simulations to positively impact the public's preference for both a streetscape and an urban park. In addition, because the participants in this study had previous experience interpreting simulations the results (i.e. effect sizes) may actually understate the ability of biased visualizations to influence perceptions and preferences. As such, if similar representations were used to communicate with a less experienced segment of the population even larger effects than those measured in this research might be expected.

Finally, while the impact of each technique was not quantified separately, the in-depth interviews did suggest which techniques interacted with participants' aesthetic preferences. More specifically, a schema analysis of interviews that explained why participants preferred various images showed that aesthetic judgments of both landscapes were directly impacted by techniques that reduced the accuracy of the CLVs, as well as those that impacted their representativeness. In the context of the Queen Street East study site the visualization techniques that supplemented scenes with enhanced vegetation, or removed landscape clutter (especially hydro infrastructure), had the largest positive *direct influence* on preferences for the landscape and unquestionably reduced the accuracy of the simulations. Conversely, for scenes of Centennial Park the techniques that replaced existing trees with larger deciduous species, as well as those that created vivid sky and lighting conditions that, had the most positive *direct influence* on participant's evaluations. While it would be hard to prove that the lighting and sky conditions used in the biased simulations were inaccurate, (i.e. the potential range of atmospheric conditions at any given site is immense) the intensity with which they were depicted can easily be argued as being less than representative of the average experience.

Beyond the direct impacts on preference a schema analysis of the interview data also indicated that many of the bias techniques interacted with one another to produce a number of *indirect influences* via participant's landscape perceptions. In a number of the biased CLVs from both study sites the increased presence of people and the perceived character of those people encouraged a sense of safety that was not apparent in the corresponding photos. This was especially true when children were added to the simulated landscapes. Similarly, when people in the biased CLVs where arranged to suggest an inviting social atmosphere the general disposition that participants took towards the quality of the entire landscape became increasingly positive. In many cases the addition of people engaged in activities that subjects could identify with even impacted their impressions of whether the landscape being shown was suitable for personal use. Finally, the increased presence of people and trees, as well as a general lack vehicles or hydro infrastructure, caused numerous subjects to derive completely different functional identities for the same scenes depicted with biased CLVs and photos.

Given the substantial positive influence that the biased simulations had on participant's preference evaluations, as well as the numerous changes they produced in landscape perceptions, it can be stated with great confidence that the biased CLV development process did not produce a set of surrogates that elicited a reasonable degree of response equivalence. If the goal is to use simulations in public engagement to genuinely incorporate the public's evaluations of a project, it appears that accuracy and representatives not only matter, they are paramount.

## 5.3 Context of Computer Landscape Visualization Use in Planning Practice

The findings discussed above provide a sound theoretical reason to question the veracity of any planning process that uses inaccurate or unrepresentative simulations to appraise the public's opinion of a future landscape. Still, this theoretical claim can only be considered a true practical concern if the techniques employed in the biased simulations produced here are akin to those employed in actual planning practice. Furthermore, as the foremost objective of the biased development process followed in this research was to artificially enhance the visual appeal of the landscapes being represented, for this theoretical claim to be taken seriously there should also be evidence that a similar motive is present in the development of CLVs used in a real world context.

To address these two considerations an exploratory study was carried out to examine the use of CLVs in a Canadian planning context. In keeping with the mixed methods approach employed throughout this research, the exploratory study included a national survey of planning departments, as well as depth interviews with key informants in the planning discipline. The methods and findings related to the survey and interview data are discussed below.

### *5.3.1 Computer Landscape Visualization Use Survey and Interviews: Methods*

Based on Sheppard's (2005b) code of ethical conduct for visualization use, as well as the results of Appleton and Lovett's (2005) interviews with U.K. planning professionals, a survey was developed to investigate how CLVs are used and regarded by planning professionals in Canada. A draft survey was pretested with three practicing municipal planners to ensure no important concepts were overlooked and to determine if the questions were worded appropriately. Given the intention of the survey respondents to the pretest felt that no concept had been overlooked, although the wording of several questions was modified based on feedback. In addition to an explanation of the research and a working definition of a CLV, the final survey package included questions that addressed institutional procedures for using CLVs, as well as questions that gauged professional attitudes towards this use. The complete survey is attached in Appendix B.

As municipal governments are the primary interface for the public to enter the planning process the surveys were distributed exclusively to the planning departments of Canadian municipalities. The survey package described above was distributed non-randomly to the planning departments of the 54 municipalities across Canada that had a population greater than 90 000 people. The planning departments of municipalities below this population threshold were excluded to maximize the cost efficiency of the survey distribution as staff at these smaller municipalities would intuitively be less likely to have experience with CLVs (Paar, 2006). While this sampling strategy admittedly limited the ability to generalize results to the field as a whole, the exploratory nature of the questions contained in the survey negated this potential anyhow. As such the sampling strategy is not viewed as a weakness. The actual distribution of the surveys followed a two phased approach. Surveys were first e-mailed to each planning department with instructions to forward the survey to a senior staff member who had considerable experience with CLVs. One month after this a hardcopy of the same survey package was mailed with similar instructions to the general address of each planning department who had not yet replied. The results of the visualization use survey are discussed in Section 5.3.2.

The information collected from the visualization use survey was supplemented by interviewing professionals who have extensive experience developing and using CLVs in a planning context. A snowball sampling technique with two separate entrance points was employed to recruit interview participants, which included three municipal planning staff, as well as four professionals working for planning consulting firms. Although a diverse disciplinary background was not intentionally sought in the recruitment process the informants interviewed ultimately included two architects, two landscape architects, two urban designers and one urban planner. To ensure consistency between the two modes of inquiry the same survey that was sent to planning departments was used as a guide during interviews, although interviews frequently veered to more open ended discussions of attitudes toward the use of CLVs in practice. With one exception interviews were approximately forty-five minutes in length and were carried out at the informants' place of work. All interviews were audio recorded with permission and were transcribed for subsequent analysis. Key results from a schema analysis of the professional interviews are discussed along with the survey data in the following section.

### *5.3.2 Computer Landscape Visualization Use Survey and Interviews: Results*

Thirteen of the fifty-four planning departments that received a digital copy of the survey returned a completed survey during phase one of recruitment and an additional six hardcopy surveys were returned as a result of the second phase, yielding a response rate of 35%. Of these, a total of fifteen planning departments indicated that they used CLVs to communicate with the public, meaning that the following discussion is based on information collected from fifteen respondents. Before discussing the full results of the survey it is worth mentioning that the planning departments who do not use CLVs identified them as a desirable tool none the less. They reported a lack of technical capacity (in terms human skills and computer hardware and software) and a perceived high cost of attaining this capacity as the primary reasons for not employing the tool to date. This line of reasoning is similar to that found in a national sample of attitudes towards CLV use in Germany (Paar, 2006).

> Our department is very interested in using 3D visualization but have not had the opportunity. The amount of training and cost of the software has made it out of reach for our company…Our understanding is that it's difficult to learn 3D visualization software, as well, we don't usually have access to the detailed architectural plans usually necessary to start drawings. We do hope to look in to using 3D visualization in the near future.
>
> (Planning Department 19)

Results from the remaining fifteen surveys are summarized in Table 5.1. It should be noted that the response categories for each question are not mutually exclusive, and as such a single planning department could, for example, indicate that they use CLVs *to consult with the public* as well as *to present information to council*.

| Question | | Total |
|---|---|---|
| | | |
| When would 3D computer visualizations be used? | To consult with the public | 8 |
| | To present information to the public | 13 |
| | In professional communication | 12 |
| | To present information to Council | 15 |
| | | |
| Who produces the 3D computer visualizations used by your organization? | Municipal staff | 13 |
| | Consultant for municipality | 10 |
| | Applicant seeking planning approval | 12 |
| | | |
| Are 3D computer visualizations produced by/for your organization subject to formal assessment criteria before being used in public engagement? | No | 9 |
| | *Yes* | 6 |
| | *Visual inspection by visualization preparer* | 3 |
| | *Written assessment by visualization preparer* | 1 |
| | *Visual inspection by project manager* | 4 |
| | *Written assessment by project manager* | 1 |
| | | |
| What types of information are provided to the public along with 3D computer visualizations during public engagement? | Photos of existing conditions | 14 |
| | Viewshed diagrams | 7 |
| | Visualizations of multiple viewpoints | 13 |
| | Documentation of visualization process | 2 |
| | Data sources for visualizations | 3 |
| | | |
| Is a 3D visualization/3D model a requirement of your development approvals process? | Yes | 4 |
| | No | 9 |
| | No, but it will be in the future | 2 |

**Table 5.1 Results of municipal computer landscape visualization use survey.**

Similar to findings reported in the literature (Appleton & Lovett, 2005; Neto, 2006; Paar, 2006), the role of CLVs for the planning departments surveyed here seems predominantly to be the communication of information, as opposed to the collaborative exploration of planning alternatives. While 87% of the surveyed planning departments reported that they use CLVs to present information to the public, only 53% reported using CLVs as a means of consulting with the public; suggesting that the flow of information is still principally from expert to lay person.

The importance of this communicative function as a driver in the use of simulations in practice is also apparent in survey and interview responses that described the perceived primary benefit of CLVs to the planning process. Overwhelmingly respondents indicated that the ability of CLVs to improve the public's understanding of 2D plans was the chief benefit, while mentions of the capacity for CLVs to integrate local knowledge into the planning process were entirely absent.

> It allows council and the community to better understand planning and development proposals. Few people outside the planning, architecture and engineering professions have the ability to translate two dimensional plans and get a sense of what a development may look like. 3D computer visualization greatly enhances the ability to communicate what a proposed development may look like.
>
> (Planning Department 10)
>
> Mainly in making planning and urban design concepts more understandable. Mostly to people who have trouble understanding two dimensional illustrations or even 3D illustrations printed to show a concept from a single vantage point.
>
> (Planning Department 17)
>
> Urban design is relatively new in municipalities. Just the recent few years. But we are finding for a lot of our work in the city, the visualization component is very important. That's the main difference between planning and urban design, because planners like to write, but the problem that we find in public meetings is that, a picture speaks a thousand words. So if your able to illustrate what your writing then the message and communication becomes very much clearer.
>
> (Urban Designer 1)
>
> I think a lot of the public, and even professionals to be honest, have a problem reading plans, and visualizing in three dimensions. We look at a plan that's 2D sitting on a table and there might be a grade change on the site, lets say fifteen meters, and people have a hard time visualizing what that is in reality.
>
> (Landscape Architect 2)

Although the results of this investigation agree with similar surveys about the perceived benefit of simulations (Ibid.), the data collected here suggest that in the Canadian context communication with simulations goes well beyond merely presenting information to the public. In fact, all of the fifteen planning departments who returned surveys indicated that CLVs were used as a means to communicate information to council, suggesting that the media has become integrated with the formal decision-making process in these municipalities. Some participants even suggested that simulations have served as part of expert testimony at the OMB.

> In my own experience, 3D visualization has also been used in assisting in the review of development applications and presenting expert evidence on specific development applications at the OMB. But so far, I am probably the only person who has used this technique at the City.
>
> (Planning Department 13)
>
> What I find though, like if we are talking about the planning department in various cities, you know you do a site plan approval, you go to the OMB and you do all these things, and visualization becomes very important.
>
> (Architect 1)

Another interesting distinction between the results discussed here and those presented in other studies is the suggestion of a dualistic attitude that professionals hold regarding the primary role that CLVs serve in planning. While it is true that the majority of participants in this research focused heavily on benefits related to public communication, there was also evidence indicating that CLVs are viewed as a tool that is internal and inseparable to the intellectual process of planning. In this sense, CLVs appear to function as a means for professionals to reason with their own concepts and designs in an individual analytical process, providing the ability to produce better solutions to a given problem. A similar dichotomy of visualization use (communication – analysis) is noted by Sheppard and Cizek (2009), although here the analytical function is argued to be one that is more exclusive to each user's internal cognitive process, as opposed to serving as a means for the analysis of planning issues in a broader institutional sense (e.g. shadow studies).

> In brief, visualization is not only a presentation skill to be used for communicating a planning and design idea with the "lay people" who may or may not have a good visual sense. It is also an internal intellectual process that can not be separated from the process of design. So, in this regard, 3D visualization (of various forms) does not only "facilitate" the planning process, it is in fact part of the planning process, if such a planning process involves a strong design component.
>
> (Planning Department 13)

In addition to the dual roles that CLVs are presumed to serve, data specifically from the key informant interviews also illuminated a somewhat troubling aspect of the attitude that some professionals hold regarding the use of simulations in practice. More specifically, when discussing the potential for CLVs to be used in a persuasive manner with the public the majority of participants indicated that they in fact personally saw little benefit in deliberately attempting to influence an audience, "because that tends to come back and haunt you" (Urban Designer 2). However, when the same participants were asked to reflect on this issue while considering simulations produced by other firms, there was a consensus that persuasive CLV techniques were quite prominent within the planning process. In addition to this there appeared to be a general acceptance that the marketing of proposed developments to council and the public was a necessary function fulfilled by CLVs, and in this sense attempts to positively influence opinions were to be expected.

> It's a selling tool, that's what it is in this business, and I'm sure that 3D modeling and animations, I'm sure that has sold more than a few people on projects, I don't doubt it's happened, but I can't say personally that I've seen it happen.
>
> (Planner)
>
> I think you want to show the public as much as possible, just showing flat elevations, front elevations, back elevations, side elevations is not enough sometimes for them to fully understand it. But you show them an isometric, sometimes that can wow them. If it's a birds eye view looking down on a site, sometimes that's interesting, or showing a proper perspective from eye level, this is what it's going to look like when your coming down the street, sometimes that is more important to the public. For advertising you can make a building look pretty glamorous when at the end of the day it is not.
>
> (Landscape Architect 2)
>
> Ya it's basically, the product itself, it is up to you to use it. You can use it for explaining very simple things, and it can become a marketing product, so it's a win win situation.
>
> (Urban Designer 1)
>
> Anytime you are dealing with the public you know that visualizations are going to be important, because it's the easiest way to communicate what you are trying to do. Now there is a dark side to this, you can always use visualizations to your benefit. So if your on the side of the developer unfortunately, and if the developer wants to do something he or she knows that the public is not going to like, you can always use visualizations to kind of sell them on something that might not be realistic…Yeah, so visualization in my opinion is really marketing. If you want to call it that. Like design marketing.
>
> (Architect 1)

In addition to the shared recognition of the marketing function of CLVs all of the interview participants also offered knowledge of at least one persuasive technique that they have experienced when it comes to presenting planning initiatives to the public. Examples that were given included: using human billboards that are targeted to send a specific message to the audience, using exaggerated lighting conditions to enhance the mood of the scene, selecting unrepresentative viewing perspectives that downplay the visual impact of a project, and using strategically placed vegetation to screen undesirable elements of a project.

> I guess the joke always is when your drawing elevations in landscape architecture you always draw kids flying kites in parks, but no I haven't really thought about that. But if it's going to be a residential development, lets say entry level homes, you'd probably want to be showing a family with young kids. Personally I would take it to that level, that's context. You would be pitching it to young families and saying, you could picture yourselves in this development. So I think, ya that's advertising. That's salesmanship. That's part of visualization too, it's salesmanship.
> (Landscape Architect 2)
>
> Yeah I mean I certainly can tell things like that. Whether the average member of the public can, I can't speak to that. I do see those. They do come around, especially from the larger companies. You know we have a development right now, its from Infrastructure Ontario. They have used 3D stuff and you know while it may be accurate, they use perspectives that, lets say, help their case in terms of they don't show things that show how high the building is and things like that… Again the public may or may not be noticing these tricks of the trade if I can call it that.
> (Urban Designer 2)
>
> In our industry we are in a weird spot that we are advocates for our client and at the same have a responsibility to the public. So if your client comes in with a thirty story condo tower in this neighborhood that has no buildings, you are going to have a lot of resistance. You know that the client knows that too, so what do you do at the public meeting? You have to reduce that and mitigate that and you have to go in without offending too many people and try to ease them into it. Now how does visualization help. Its extremely important because you don't show up with a bunch of floor plans and elevations and show this huge tower and show little houses next to it. People will just freak out. So what you do is you show them a rendering of their street where you see the houses and you see the tower in the background. Then you put people walking their dogs and you put like kids playing, very different from the condo rendering, and when people see that subconsciously they say, oh look at that old nice couple walking their dog and you know its like commercials its all subconscious. Subconsciously they are accepting what they see. They will still consciously argue about the height, but you are already starting to convince them deep inside. They will still argue, but its easier for them. They will say you know its not that bad, but what they are looking at is something that they probably wouldn't see, you know its not real.
> (Architect 1)

Due to the exploratory nature of the data collected during this phase of research it can certainly not be stated that employing persuasive techniques to ease public resistance is the norm for CLV use in the Canadian planning process. In fact, a good deal more research would have to be completed to even claim that such use is particularly prevalent. That said results from this investigation do confirm that a marketing based attitude, as well as the development and use of persuasive simulations, does exist to some extent within the planning process. As such the previous criteria that were deemed necessary for the external validity of the response equivalence results have been met.

Given the findings presented above another important question is whether planning departments are positioned to detect and guard against distortions that persuasive CLVs might introduce into the planning process. Proponents of communicative planning theory would argue that it is the planner's role to act as an intermediary to ensure that information exchanged between stakeholders does not distort communication in a manner that subverts decisions or oppresses the public voice (Sager, 1994). With this in mind professionals who facilitate public engagement or other decision making processes should thus seek to counteract the types of ad hoc misinformation (which develops out of an unavoidable division of expertise and access to information) or systematic misinformation (which represents an attempt to distort information for a particular purpose) that are inherent in many simulations. Doing this is important not only because these types of misinformation can obscure the truth, create false assurances or produce a pretention to legitimacy, but because these outcomes can in turn have an unwarranted impact on formal decisions or the public's ability to provide a genuine input into the planning process (Forester, 1989). A comment provided by a local council member illustrates the unjustified impact that systematic misinformation in CLVs can have on the formal decision making process.

> Well I think that around city councils you tend to have some folks who are very environmentally green in their thinking and so the images that are warmer and have green tones can be stronger. Landscape architecture images that take away the visually ugly stuff like the overhead wires and that kind of thing. I think absolutely it makes it easier to say yes to. Because if you listen to comments in council chambers people often say this looks beautiful, this design, this development, and they are basing it on the image.

On the issue of facilitating simulation use, the survey data collected here seem to indicate that many of the planning departments have yet to recognize the importance of mitigating against misinformation. Of the fifteen planning departments who use CLVs to present information to the public or council, thirteen indicated that at times these images are produced by outside parties, including municipally contracted consultants or even applicants who are seeking development approval. Given the acknowledgement of simulations as a tool for marketing proposed developments it might be expected that these departments would actively seek to identify and limit potentially misleading information. Unfortunately the opposite seems to be true. Only six of the surveyed departments reported that CLVs used in formal public engagement or decision making processes are subjected to any sort of assessment before they are used. Furthermore, of these six only two indicated that a written assessment was used to ensure the reliable application of criteria across a range of projects. Interestingly, while a written assessment was perceived by some participants as yet another piece of unnecessary red tape, it is worth noting that only planning departments with a written document would be in a position to prove an assessment was performed should a project be legally challenged based on inaccurate or misleading information.

In addition to not guarding against damages caused by systematic misinformation, the propagation of ad hoc misinformation also seems to be a salient problem among the surveyed municipalities. Only two of the fifteen planning departments indicated that they describe to the public the assumptions and uncertainties that go into the production of CLVs. As such, much of the simulation use described in this survey could unintentionally be reinforcing the knowledge disparity between planning experts, who understand the uncertain nature of the CLV development process, and the public, who often expect a proposed project to materialize as an exact replica of the image it was depicted with (Appleton & Lovett, 2005).

This brief snapshot of simulation use in the Canadian planning process captures a worrisome picture depicting non-existent regulations, questionable attitudes, and a general landscape that does not appear to be appreciably different from the proverbial “wild west” that CLV preparers enjoyed nearly a decade ago (Sheppard, 2001). However, what is even more troubling is that attitudes regarding the future of CLVs in planning were entirely divided among professionals polled in this research, with many comments suggesting that procedures should not be put in place to guard against potential problems. Starting with participants who were more skeptical of simulations, there was a general recognition that the potential to mislead is a considerable problem and a threat to the validity of decisions predicated on simulations. Based on this recognition these individuals were not only quite open to a discussion about regulations like a code of conduct for visualization development, but even suggested that this might be necessary to ensure that unethical simulations do not distort the planning process. One interviewee even went as far as to suggest that a formal peer review process might be the only way to fully ensure the appropriate use of CLVs. He suggested that while a code of conduct would be a step in the right direction, it might ultimately be insufficient because it still relies on each visualization preparer to interpret the rules and decide what is appropriate given a range of factors, which he claims often include motivation for a loose interpretation of the rules.

> There should be guidelines to ensure that the subject matter is being depicted fairly, accurately and consistently. Failure to adhere to prescribed standards could unduly influence perception. The modeling is intended to accurately portray existing and future conditions. Any distortion would have to be disclosed to ensure that future conditions are not manipulated to favor one side or the other.
>
> (Planning Department 8)
>
> Yes, to ensure that the 3-D presentations are not misleading. For this reason a prescribed and consistent format for the presentation is required.
>
> (Planning Department 15)
>
> Yes, there should be a code of conduct instituted to govern the use of 3D visualizations, to ensure that all projects are created using the same criteria and assumptions, so that no project is biased one way or another. Would involve a town wide adoption of acceptable practices.
>
> (Planning Department 16)
>
> Personally, I'd have to be in there. I'd have to see for sure. It's like labeled dimensions on a drawing, it might say 1.2 meters, but you get into the drawing and its .99 meters. Those types of things happen. There are professional standards, but sometimes developers will ask consultants to cheat here and there. It can happen.
>
> (Landscape Architect 2)

While the attitudes of the preceding practitioners provide tentative hope for the adoption of a visualization code of conduct, responses from the remaining participants suggest that an attempt to regulate CLV use would also be met with considerable criticism. Some of the participants who disagreed with a code of conduct simply appeared to be unaware of any misuse, or were unwilling to admit that such misuse was a significant problem given the benefits of the tool. Individuals who took this stance seemed to equate CLVs with traditional visual representation methods and failed to see any reason to adopt new standards for a tool that has ostensibly been used for decades. At best this group saw the standardization of computer formats as a means to improve compatibility between municipal datasets and data provided by the rest of the field. Alternatively, another attitude that was noted among several participants was much more adamant that a code of conduct was entirely undesirable. These participants generally claimed that any attempt to regulate CLV development would be unnecessary infringement on their artistic license and would ultimately produce more harm than good.

I've never thought about this. I don't know what the issue related to guidelines or code of conduct might be. Maybe some guidelines related to standardization of programs or quality of images used. Not a big issue to my mind.

(Planning Department 4)

No, not specifically to the use of 3D as a tool. I would rely on the professional code of conduct for the person using the tools. 3D visualization is only a tool for providing information, just like a market impact study, land use analysis, planning justification report, etc.

(Planning Department 5)

The application of 3D visualization in planning and design is not a new thing at all (though the computer-aided 3D visualizations is). Planners and urban designers have been using it for decades if not centuries. So before we are going to develop guidelines and code of conduct, we should ask why now? Why do we need guidelines and code of conduct for the computerized 3D not the traditional one?

(Planning Department 13)

## 5.4 Implications for Planning Research and Practice

This research is among the first to provide empirical support for the longstanding theoretical assertion that the human element in the visualization process is as important to the creation of valid landscape surrogates as the quality of the technology being utilized. The mixed methods design used in this research was also somewhat novel in terms of the application of response equivalence techniques to the evaluation of CLVs, as existing studies have only occasionally integrated qualitative and quantitative methods in this context. Consequently, there are several notable implications for research and planning practice that deserve discussion, especially given the apparent state of CLV use in planning practice.

### *5.4.1 Defining Computer Landscape Visualizations in Future Research*

Much of the discourse over the past several decades regarding simulation use in urban planning has emphasized the progression of visualization technology and the benefits that increased interactivity, immersion and realism can provide to public engagement and decision-making processes. A critical examination of this discussion also reveals that there has often existed an underlying assumption that the primary function of CLVs is the communication of information from expert to layperson. However, as visualization tools have been continuously adapted to fit a wider range of applications within the planning process, there is now reason to question whether CLVs are still primarily a means of communication, or whether they have taken on more important roles. Findings from the survey and interview data discussed above suggest that CLVs have indeed progressed beyond a means of merely delivering information, and other research has also began to highlight a more analytical function for the tool (Schofield & Cox, 2005; Sheppard & Cizek, 2009). As such, it does in fact seem that any conception of CLVs as being only a communication medium is no longer valid.

In addition to our conception of a simulation's purpose, another important consideration is exactly how we operationalize this conception into a definition of what a simulation is. Doing this not only shapes our personal view of the link between the technology and the planning process, but should force us to be more upfront with ourselves about true implications of this relationship for the actual stakeholders who are involved. That said it is unlikely that definitions based solely on technological aspects of the tool will be tenable in the future, especially given the constant introduction of new visualization properties that will make this approach unnecessarily complex (e.g. realism v. abstraction, dynamic v. static, interactive v. non-interactive, etc.). It would seem advisable then for future research on CLV use to employ more precise definitions than have been applied in the past, focusing less on properties that are intrinsic to the simulation and more on the role it plays in the broader scope of a given situation. Clearly a considerable amount of debate is required to unearth the best approach to achieve such a definition, placing any specific suggested course of action well beyond the scope of this research. Nevertheless, one simple and straightforward solution that could be used to better frame research in the interim is a definition that simply includes a more explicit focus on the purpose that a CLV serves within the planning process.

### *5.4.2 The Social Context of Response Equivalence*

The number of studies that have tested the response equivalence of CLVs with an experimental design is quite small and in most cases these studies have overemphasized the use of purely quantitative measures such as landscape beauty ratings (Bergen et al., 1995; Bishop & Leahy, 1989; Daniel & Meitner, 2001). Even the studies that have used a qualitative survey (Wergles & Muhar, 2009), or integrated a survey with other quantitative instruments (Oh, 1994), have tended to stress the quantitative aspect of the datasets. In fact, to the authors knowledge only one previous study has used a genuine mixed methods design that fully realizes the benefits of qualitative inquiry by employing depth interviews with participants (Bishop & Rohrmann, 2003). This overly quantitative focus in past applications of the method seems to be an unfortunate legacy for response equivalence research, as the mixed methods design followed here offered a rich understanding of the opic at hand, uncovering numerous findings that would have been overlooked had only one approach been chosen.

In this sense the quantitative bias in past studies has neglected the social components of landscape perception, and more significantly has overlooked the impact these components have on viewer's evaluations of a landscape. The reason for this is that the cognitive measures that research has used are too coarse to untangle complicated cultural concepts that involve links to values and experiences at both personal and communal levels. The current notion of what is salient to the representational validity of simulations is thus based heavily on an understanding of the physical environments' contribution to cognitive evaluations of the landscape. Admittedly the qualitative data collected in this research can only begin to suggest the importance that experiential knowledge plays in provoking valid responses from simulations. Still, the considerable impact that social context had on participant's perceptions and preferences cannot be ignored, and is quite similar to the type of influence that contextual elements had in the study carried out by Wergles and Muhar (2009). Moreover, the majority of landscape perception literature overwhelmingly supports that fact that cultural information is at least as important as tangible physical stimuli to the formation of landscape judgments. It is suggested then that in addition to the categories already proposed by Bishop and Rohrmann (2003), future response equivalence studies should explicitly consider human elements in the landscape by measuring the influence of inferred social or cultural information on the validity of surrogates.

Finally, while the paradigm of 'judgment and decision-making' in the discipline of psychology has begun to adopt affectively driven frameworks to explain how individual's make decisions (Damasio, 1994; Nabi, 2003; Peters & Slovic, 2000; Wilson, 2008), there is still little understanding of the influence that simulations have on affective appraisals of a future landscape. In the broader sense the potential implications of this influence on formal decision making can also only be speculated as case study research in this area is entirely absent. This will be critically important area for future research as an open acknowledgement of the short term and long term impacts of emotions on engagement is growing (Baum, 1996).

### *5.4.3 Using Computer Landscape Visualizations in Public Engagement*

Chronologically speaking it could be argued that CLVs are simply the newest addition to a long line of visual representation methods employed by professionals in planning and related disciplines for decades. Likewise, the potential of these 'next generation' visualizations to facilitate comprehension and meaningful discussion in public engagement can hardly be disputed when the totality of the literature on the subject is considered. Still, while the chronology of visualization techniques is an interesting story, from a theoretical standpoint it is essential for planning practice to acknowledge the fact that CLVs are in actuality unlike any traditional representations used to date. Unparalleled levels of immersion, realism and interactivity provide viewers the ability to experience virtual landscapes in a manner that is infinitely more congruent with experiences of the real world. As such, treating simulations as conceptually equal to two dimensional plans, or even three dimensional penned sketches, is not only unjustified but irresponsible. More importantly, because public engagement in planning is often carried out as a legislative obligation rather than a genuine attempt to include local knowledge (Innes & Booher, 2004), it would be naive to assume that simulations are always used in an appropriate manner. Certainly the survey and interview data presented here support this assertion.

Although the final section of this thesis offers broad recommendations for the effective development and use of visualizations, using this study's findings to justify a detailed set of visualization procedures would be unwarranted given the exploratory nature of the research. Moreover, specific guidelines for effective visualization development have already been covered in great detail in the body of Stephen Sheppard's work, and the expanding disciplinary application of the technique may make certain prescriptive regulations ineffective in the future anyhow. Still, the overwhelming positive influence of the biased CLVs examined in this research is inline with the type of impact the literature has postulated for some time, and although experimental in nature the results are also analogous to the real world impacts described by professionals interviewed for this thesis (e.g. simulations are used as marketing media to pacify public resistance). As this type of use effectively oppresses the public voice and delegitimizes the role of the public in the planning process, a comment on approaches to negating the damaging effects of persuasive CLVs cannot be avoided.

Suffice to say the most obvious approach to mitigating the impacts of persuasive CLVs is to remove distortions from any information used in the engagement process. One way to accomplish this, which has been the primary focus of academic discussions, is to regulate the production and use of simulations with prescriptive standards for CLV development. From a theoretical standpoint this approach can control and limit the source of misinformation (i.e. the visualization preparer) by applying procedures or best practices, although it has not gained traction in practice because many professionals are unaware of the need to self regulate, or unwilling to do so (Sheppard, 2001). Moreover, even if a code of conduct were universally adopted it may do little to actually rectify the systemic source of the problem; the view that CLV use as a marketing tool is expected and acceptable. For this reason it may be necessary to integrate attempts to control slipshod and crooked preparers with a solution that can quell the desire to use simulations in a persuasive manner in the first place.

Once again an exact course of action for changing professional attitudes is beyond the scope of this research. That said, one intuitive approach could be to supplement existing technical CLV training programs with education that raises awareness about the potential damage created by improper use of the tool. As the communication of future landscapes will undoubtedly remain a practical function for CLVs in planning the broad scale adoption of any educational intervention will require a program that integrates technical training and an understanding of landscape perception and response equivalence. As such an effective program would require conceptual input from a host of practitioners and researchers to ensure the content of the program is theoretically grounded, but capable of delivering the skills that practitioners require in their daily routines. Finally, given their role as the administrators of the code of conduct for planning professionals, and the fact that they already offer numerous professional education workshops, a partnership with the Canadian Institute of Planners would be most advisable in the development and delivery of any such training program.

Regulating the actions of visualization preparers or attempting to change the attitudes they have toward CLV use are distinct practical approaches to tackling the issue of persuasive simulations. From a conceptual standpoint, however, these seemingly different courses of action essentially promote the same solution to the problem; removing from the planning process the propagation of persuasive messages. The unfortunate reality is that even if regulations and a proper training program were widely adopted in practice, there would be no guarantee that they would eliminate the unethical use of the tool. In fact, given the countless opportunities and motives for misusing CLVs, which are perpetuated by the growing interdisciplinary adoption of the technique, it is likely they would probably not. In addition to controlling the message we must also find ways to ensure that any message that is being sent is less capable of distorting the public's perceptions of the relevant content in a planning initiative in the first place.

Future attempts to produce an ethical landscape of CLV use, be they in practice or research, should dedicate as much energy to educating the public as they do to educating professionals. This suggestion is not meant to imply the traditional type of education that involves simulations, which uses them to improve comprehension of spatial issues related to planning. Nor does it suggest the mere provision of a warning regarding the potential for misuse. Rather, as planners we need to provide forums that improve the publics' understanding of how CLVs function in the broader context of the planning process, as well as the limitations that are inherent in their development. By relinquishing our hold on the tool and letting the public 'see behind the curtain' we can offer them a greater appreciation of the uncertainty that actually exists in the visualization process, making it difficult for intentional distortions, or unintentional mistakes, to subvert their judgments. Ultimately this knowledge will not only reduce the potential for unethical visualization preparers to induce widespread public skepticism of CLVs, but could give back some of the power that planners have coveted, making the public a more equal partner in discussions about our future landscapes.

### *5.4.4 The Future of Computer Landscape Visualizations in Urban Planning*

There is no question that CLVs will continue to play an important role in shaping of our future landscapes. As professionals continue to augment the already widely recognized communicative benefits of the tool with more analytical applications, it could even be suggested that their importance to the discipline of planning will surpass all expectations in the very near future. That said, the long term integration of CLVs in the planning process as they are currently used may prove to be somewhat incompatible with the theoretical foundations of the discipline. To date planning practice has operated on a form of rationality that makes process subservient to predefined ends, wherein information is valued only if it can provide an opportunity to legitimize the means to these ends (Hudson, 1979). Similarly, while endeavors for true collaboration in the process exist, there has none the less been a strong tradition of using cognitive media, such as plans and elevations, to present information to the public. It is much rarer that these tools are used to attain knowledge from them, or better still to collaboratively explore the most acceptable solution to a given problem. This suggests that the goal of public engagement to date has been a shared comprehension of facts about the planning process, as opposed to a shared understanding of the cultural values and personal experiences that are important to the physical and social fabric of our communities. This further implies that desirable and credible knowledge in public engagement, and planning as a whole, is that which is based on logic and reason. Alternatively, when the knowledge offered in public forums is value laden and experience based there appears to be an inability or unwillingness to integrate this information in a meaningful way. Regrettably it is most often the personal values and detailed experiences that are disregarded, or worse delegitimized, when the final decision is made.

The continued introduction of CLVs, which inevitably contain an experiential message that is laden with personal values, cultural connotations and deep emotional meanings, into a process that is predicated on generalized principles and rational facts, therefore produces two probable outcomes. If used openly and effectively accurate CLVs could provide a vehicle for the controlled consideration local values and experiences in the planning process, allowing the discipline to refocus on the collaborative creation of what Relph (1976) calls ‘authentic places’, rather than the mere economic division of ‘pragmatic space’. Indeed this would be a lofty and desirable legacy for the tool. Alternatively, if used continually in an unfettered fashion simulations may do nothing more than introduce additional emotion into a process that is already emotionally charged, yet lacking the means to incorporate emotion in a constructive way (Baum, 1996). Furthermore, even if the tool is used in an ethical fashion there is no guarantee that the emotions that are tapped will be positive in nature, or that the local knowledge that is recovered will be legitimate (Van Herzele & van Woerkum, 2008). With a lack of documented practical evidence we are thus left only to speculate about the long term effects that the continued penetration of simulations into planning practice will have on decision-making and the tentative relationships between stakeholders in the process (Forester, 2006). Ultimately, when considering the role of CLVs in urban planning there will always be those who argue that ‘a picture speaks a thousand words’ and given the vast history of visualization use there is certainly no cause to disagree. This aside, in a future where decisions will be made under circumstances that will seemingly offer more and more uncertainty, it might be suggested that these words should be chosen wisely.

## 5.5 Recommendations for Effective Visualization Use

The following section provides seven recommendations distilled from the findings of this study that relate to the use of visualizations in public engagement. The purpose is not to present a step-by-step guide to creating an effective visualization, but to provide broad guidance for those who wish to use visualizations as a vehicle to improved communication and decision-making.

1. **The use of dramatic lighting and sky conditions within a visualization should be avoided** as they cause viewers to evaluate a scene based on the atmospheric context rather than the content of the landscape. Intentionally focused lighting can also subconsciously direct attention to specific elements in the scene, hindering evaluations of the landscape as a whole. **Atmospheric conditions should be based on the most common conditions that a user is likely to experience in a given landscape.**

2. Visualizations using billboards of fully mature trees greatly overstate the short term impact of a project if the realized design uses adolescent trees. As the public will judge the truthfulness of a visualization based on the initial appearance of a constructed project, **at least one visualization should illustrate a project as it will appear immediately upon completion.**

3. The specific characterization of people within a visualization can have a profound influence on a viewers' overall evaluation of a landscape, at times overriding judgments of the physical elements within the scene. **The social and cultural context that is communicated in a visualization should be representative and justifiable.** A justifiable characterization would be based on an audit of the landscape's users carried out during a field visit, or demographic data attained from a reputable source. If such an approach is not possible humans should be represented as simple silhouettes to avoid communicating an inaccurate or persuasive message.

4. The standard techniques used to texture buildings within a visualization cause built structures, especially aging buildings, to appear more maintained and visually appealing than in reality. As a visualization of a project should depict the surrounding context, care should be taken to ensure the façades of existing structures are accurately depicted. **Using a photomontage technique to illustrate changes exclusively related to a project is the best way to avoid any unwarranted influence from texturing techniques.**

5. As visualizations become commonplace within planning practice they will become a threat to the legitimacy of formal and informal decisions if professionals continue to view them as a form of 'design marketing'. **Bodies such as CIP and OPPI should offer training programs to help planning professionals gain insight and skills in the area of effective visualization use.**

6. The public that consumes visualization products has only a basic understanding of the technology's limitations and drawbacks. When visualizations are used to communicate landscape change **supplementary information should be provided that openly presents the uncertainties and assumptions associated with a project.** This should include information related to the raw data used to create the visualization, as well as the credentials of the visualization preparer.

7. Visualizations should not be viewed as a means to merely communicate objective facts from expert to layperson. For visualizations to truly enhance engagement and decision-making processes the technology must be used to communicate knowledge and values in a two-way process. In this sense **visualizations should be thought of as a catalyst to the collaborative exploration of ideas and potential futures.**

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# Appendix A:  Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Theatre' viewpoint

Calibrated CLV of 'Theatre' viewpoint

Biased CLV of 'Theatre' viewpoint

# Appendix A:  Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Retail' viewpoint

Calibrated CLV of 'Retail' viewpoint

Biased CLV of 'Retail' viewpoint

# Appendix A:  Queen Street East and Centennial Park Visual Stimuli

Photograph of ‘Service’ viewpoint

Calibrated CLV of ‘Service’ viewpoint

Biased CLV of ‘Service’ viewpoint

# Appendix A:  Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Fire Hall' viewpoint


Calibrated CLV of 'Fire Hall' viewpoint


Biased CLV of 'Fire Hall' viewpoint

# Appendix A: Queen Street East and Centennial Park Visual Stimuli

Photograph of 'New Residential' viewpoint

Calibrated CLV of 'New Residential' viewpoint

Biased CLV of 'New Residential' viewpoint

# Appendix A:  Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Mixed Residential' viewpoint

Calibrated CLV of 'Mixed Residential' viewpoint

Biased CLV of 'Mixed Residential' viewpoint

# Appendix A: Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Lake' viewpoint

Calibrated CLV of 'Lake' viewpoint

Biased CLV of 'Lake' viewpoint

# Appendix A:  Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Pavilions' viewpoint

Calibrated CLV of 'Pavilions' viewpoint

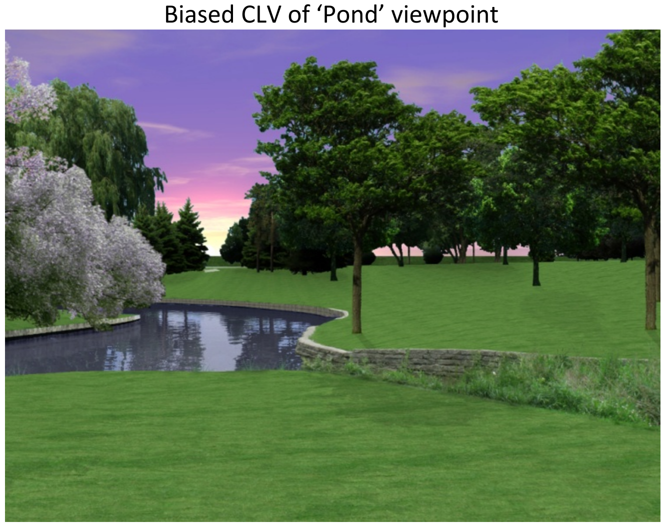
Biased CLV of 'Pavilions' viewpoint

# Appendix A: Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Pond' viewpoint

Calibrated CLV of 'Pond' viewpoint

Biased CLV of 'Pond' viewpoint



## Appendix A: Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Picnic Shelter' viewpoint

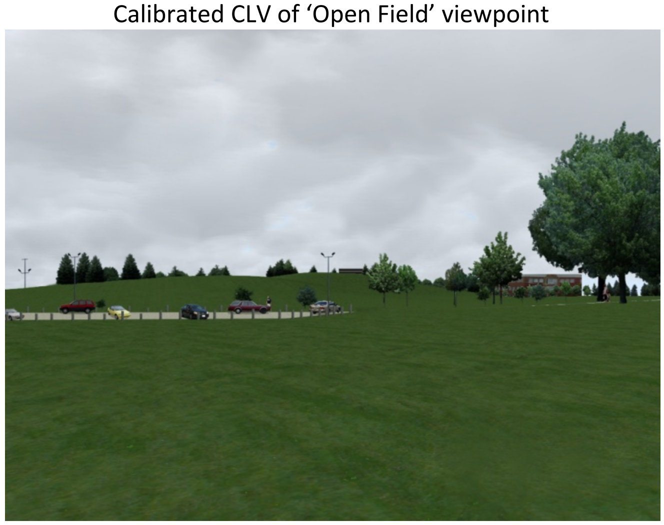
Calibrated CLV of 'Picnic Shelter' viewpoint

Biased CLV of 'Picnic Shelter' viewpoint

# Appendix A: Queen Street East and Centennial Park Visual Stimuli

Photograph of 'Open Field' viewpoint

Calibrated CLV of 'Open Field' viewpoint



Biased CLV of 'Open Field' viewpoint

# Appendix A:  Queen Street East and Centennial Park Visual Stimuli

Photograph of ‘Pathway’ viewpoint

Calibrated CLV of ‘Pathway’ viewpoint

Biased CLV of ‘Pathway’ viewpoint

## Appendix B: Municipal Visualization Use Survey Package - Questionnaire

UNIVERSITY OF
Waterloo

School of Planning
Faculty of
Environmental Studies

University of Waterloo
200 University Avenue West
Waterloo, Ontario, Canada
N2L 3G1

The urban and natural landscapes we utilize undergo constant change and the use of 3D computer visualizations is becoming commonplace as a means to communicate this change to the public. This research investigates how and why 3D computer visualizations are being used within the planning profession.

**Please consider the following definition when answering the questions below**

*'Visualizations are graphic depictions of real places, seen from a particular perspective, which can be manipulated in several ways to show features of importance or future conditions based on land management decisions'*

**1) What types of visualizations does your organization use to communicate with the public?**

- ☐ Maps
- ☐ Plans
- ☐ Drawings
- ☐ Photographs
- ☐ 3D computer visualizations (virtual models)
- ☐ Other

…If other, please elaborate below (Check all that apply)

***If 3D computer visualizations are used, please answer questions 2 thru 9. If 3D visualizations are not used, please indicate why they are not used below.***

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2) **When would 3D computer visualizations be used?**

- ☐ To develop planning scenarios in consultation with the public
- ☐ To present planning scenarios to the public
- ☐ To communicate planning scenarios to other professionals
- ☐ To present planning scenarios to council
- ☐ Other

…If other, please elaborate below (Check all that apply)

3) **Who produces the 3D computer visualizations used by your organization?**

- ☐ Municipal staff
- ☐ Consultant hired by the municipality
- ☐ Applicant seeking planning approval
- ☐ Other

…If other, please elaborate below (Check all that apply)

4) **What 3D computer visualization software does your organization use, and how do visualization preparers typically learn this software?**

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5) **Are 3D computer visualizations produced by/for your organization subject to formal assessment criteria before being used in public engagement?**

☐ YES ☐ NO (Check answer)

**If yes, what form does this assessment take?**

- ☐ Written assessment completed by visualization preparer
- ☐ Written assessment completed by project manager
- ☐ Visual inspection by project manager
- ☐ Visual inspection by visualization preparer
- ☐ Other

…If other, please elaborate below (Check all that apply)

6) **What types of information are provided to the public along with 3D computer visualizations during public engagement?**

- ☐ Site photographs of existing conditions
- ☐ Viewshed diagrams
- ☐ Visualizations showing multiple viewpoints
- ☐ Documentation of the visualization process (e.g. assumptions, uncertainties)
- ☐ Source data used to create visualizations
- ☐ Other

…If other, please elaborate below (Check all that apply)

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7) **Is a 3D visualization/3D model a requirement of your development approvals process?**

- ☐ Yes
- ☐ No
- ☐ It will be in the future

(Check answer)

…Please elaborate below

8) **In your professional opinion, how do 3D computer visualizations facilitate the planning process?**

9) **In your professional opinion, should there be guidelines or a code of conduct put in place to direct the development and use of 3D computer visualizations used in the planning process? Why or why not?**

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I agree to the use of anonymous quotations, from the above answers, in a thesis or any academic publications

☐ YES ☐ NO

Please Indicate Name of Municipality Below

Your participation is appreciated

Sincerely

Mark Groulx
MA Planning (Candidate)
University of Waterloo
E-Mail: mgroulx@uwaterloo.ca
519-591-2923

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# Appendix B: Municipal Visualization Use Survey Package - Cover Letter

UNIVERSITY OF
Waterloo

School of Planning
Faculty of
Environmental Studies

University of Waterloo
200 University Avenue West
Waterloo, Ontario, Canada
N2L 3G1

Dear Planner,

This letter is an invitation to consider participating in a study I am conducting as part of my Master's degree in the School of Planning at the University of Waterloo under the supervision of Professor's John Lewis and Roger Suffling. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

The urban and natural landscapes we utilize in society undergo constant change. In response to this change, virtual reality is being used more and more as a means to communicate with the public. While it has been widely recognized that virtual reality is a powerful tool that can increase public engagement and even improve comprehension, there has been insufficient attention paid to the effect this tool might have on the decisions that individuals make. Furthermore, legislation and guidelines for directing the appropriate development and use of visualizations are lacking. The purpose of this study, therefore, is to assess the development and use of visualizations, in a planning context, in Southern Ontario, and to determine the potential visualizations have to influence public opinion regarding landscape change.

As a participant in this study you will be asked to provide your professional opinion to questions related to the development and dissemination of visualizations used in a planning context. Please be aware that your participation in this study is completely voluntary. The completion of the associated survey, which has been sent to you by the method of your request, requires approximately 10 minutes. The survey may be returned via e-mail, or by mail in the self addressed stamped envelope provided for the mail out option. You may decline to answer any of the survey questions if you so wish. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used. Hardcopy data collected during this study will be retained for 7 years in a locked filing cabinet at my personal residence. Digital data will be retained anonymously for 7 years in a password protected folder on my desktop computer. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact myself, or my supervisors (contact information below).

I would like to assure you that this study has been reviewed and received ethics clearance through the office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes of this office at (519) 888-4567 Ext. 36005 or ssykes@uwaterloo.ca

I hope that the results of this study will be of benefit to those involved in the study, as well as organizations related to planning, and the general public.

Thank you in advance for your assistance in this project

Sincerely,

Mark Groulx
HBSc, MA (Candidate)
School of Planning
University of Waterloo
20289487
mgroulx@uwaterloo.ca
1-519-591-2923

Dr. John Lewis
Assistant Professor
University of Waterloo
j7lewis@fes.uwaterloo.ca
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Dr. Roger Suffling
Associate Professor
University of Waterloo
rsuffli@fes.uwaterloo.ca
1-519-888-4567 ext. 33184

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Appendix B: Municipal Visualization Use Survey Package - Consent Form

UNIVERSITY OF Waterloo

School of Planning
Faculty of
Environmental Studies

University of Waterloo
200 University Avenue West
Waterloo, Ontario, Canada
N2L 3G1

I have read the information presented in the information letter about a study conducted by Mark Groulx of the Department of Planning at the University of Waterloo under the supervision of Professors John Lewis and Roger Suffling. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I am aware that I may withdraw from the study without penalty at any time by advising the researcher of this decision.

This project has been reviewed by, and received ethics clearance through the Office of Research Ethics at the University of Waterloo. I was informed that if I have any comments or concerns resulting from my participation in this study I may contact the Director, Office of Research Ethics at 519-888-4567 ext. 36005.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

YES NO

I agree to have my interview audio recorded.

YES NO

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.

YES NO

________________________________________
Print Name Signature of Participant

________________________________________
Witness Name Signature of Witness

____________________
Dated at Waterloo, Ontario

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# Appendix C: Public Interviews - Cover Letter

UNIVERSITY OF
Waterloo

School of Planning
Faculty of
Environmental Studies

University of Waterloo
200 University Avenue West
Waterloo, Ontario, Canada
N2L 3G1

Dear Waterloo Region Resident,

This letter is an invitation to consider participating in a study I am conducting as part of my Master's degree in the School of Planning at the University of Waterloo under the supervision of Professor's John Lewis and Roger Suffling. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

The urban and natural landscapes we utilize in society undergo constant change. In response to this change, virtual reality is being used more and more as a means to communicate with the public. While it has been widely recognized that virtual reality is a powerful tool that can increase public engagement and even improve comprehension, there has been insufficient attention paid to the effect this tool might have on the decisions that individuals make. Furthermore, legislation and guidelines for directing the appropriate development and use of visualizations are lacking. The purpose of this study, therefore, is to assess the development and use of visualizations, in a planning context, in Southern Ontario, and to determine the potential visualizations have to influence public opinion regarding landscape change.

As a participant in this study you will be asked to rank 36 images based on your preference for what you are viewing. Images include photographs and visualizations of an urban streetscape and an urban park. Please be aware that your participation in this study is completely voluntary and you may withdraw from participation at any time. The preference survey takes approximately 5 minutes to complete. You may decline to answer any of the survey questions if you so wish. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this study. Hardcopy data collected during this study will be retained for 7 years in a locked filing cabinet at my personal residence. Digital data will be retained anonymously for 7 years in a password protected folder on my desktop computer. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact myself, or my supervisors (contact information below).

I would like to assure you that this study has been reviewed and received ethics clearance through the office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes of this office at (519) 888-4567 Ext. 36005 or ssykes@uwaterloo.ca

I hope that the results of this study will be of benefit to those involved in the study, as well as organizations related to planning, and the general public.

Thank you in advance for your assistance in this project

Sincerely,

Mark Groulx
HBSc, MA (Candidate)
School of Planning
University of Waterloo
20289487
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Dr. John Lewis
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FACULTY OF ENVIRONMENT

# Appendix C: Public Interviews - Consent Form

UNIVERSITY OF
Waterloo

School of Planning
Faculty of
Environmental Studies

University of Waterloo
200 University Avenue West
Waterloo, Ontario, Canada
N2L 3G1

I have read the information presented in the information letter about a study conducted by Mark Groulx of the Department of Planning at the University of Waterloo under the supervision of Professors John Lewis and Roger Suffling. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I am aware that I may withdraw from the study without penalty at any time by advising the researcher of this decision.

This project has been reviewed by, and received ethics clearance through the Office of Research Ethics at the University of Waterloo. I was informed that if I have any comments or concerns resulting from my participation in this study I may contact the Director, Office of Research Ethics at 519-888-4567 ext. 36005.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

YES NO

I agree to have my interview audio recorded.

YES NO

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.

YES NO

Print Name Signature of Participant

Witness Name Signature of Witness

Dated at Waterloo, Ontario

UNIVERSITY OF
Waterloo
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# Appendix D: Public Interviews - Schema Analysis Codebook

## Coding categories used to code public interviews

*Note: while each code description represents a potential theme, not all codes were included as a legitimate theme in the final stages of the schema analysis*

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CODE FORM DESCRIPTIONS

**Name:** Pseudonym of interviewee

**Gender:** Gender of the interviewee

**Type:** Indentifies the interviewee's connection to municipal planning

Public: Member of the general public who is part of a neighbourhood association
Councillor: Member of a municipal council
Student: Student enrolled in a planning program

**Experience:** Participants reported experience with computer landscape visualizations

Moderate: Moderate exposure to CLVs as a passive viewer
Ample: Ample exposure to CLVs as a passive viewer or CLV preparer

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SCHEMA ANALYSIS THEMES

*sky conditions: Positive*

A mention of a favorable effect of specific sky conditions on the aesthetic appearance of the landscape (includes mentions of colour, cloud structure, tone, visibility of the sun etc.)

*sky conditions: Negative*

A mention of an unfavorable effect of specific sky conditions on the aesthetic appearance of the landscape (includes mentions of colour, cloud structure, tone, visibility of the sun etc.)

*atmospheric lighting: Positive*

A mention of a favorable effect of atmospheric lighting conditions on the aesthetic appearance of the landscape (includes scene brightness and shadow effects but not manmade lighting or the visibility of the sun)

# Appendix D: Public Interviews - Schema Analysis Codebook

### *atmospheric lighting: Negative*

A mention of an unfavorable effect of atmospheric lighting conditions on the aesthetic appearance of the landscape (includes scene brightness and shadow effects but not manmade lighting or the visibility of the sun)

### *clutter*

A mention of an unfavorable effect of general street clutter on the aesthetic appearance of the landscape (includes street signs, newspaper dispensers, fire hydrants etc.)

### *hydro: Aesthetics*

A mention of an unfavorable effect of hydro infrastructure on the aesthetic appearance of the landscape (includes telephone poles and overhead wires in the urban environment and high tension infrastructure in the park environment)

### *trees*

A mention of tree morphology having a positive effect on the aesthetic appearance of the landscape

### *presence: Positive*

A mention of a favorable effect of the presence of people on the perceived affordance of the landscape (related to simply to the presence or absence of people (or amount) in the scene)

### *presence: Negative*

A mention of an unfavorable effect of the presence of people on the perceived affordance of the landscape (related to simply to the presence or absence of people (or amount) in the scene)

### *activity: Positive*

A mention of a favorable effect of the activity of people on the perceived affordance of the landscape (related to the interaction of people with each other and elements of the landscape)

### *activity: Negative*

A mention of an unfavorable effect of the activity of people on the perceived affordance of the landscape (related to the interaction of people with each other and elements of the landscape)

### *vehicles*

A mention of the effect that the presence of vehicles has on the perceived function of the landscape

### *hydro: Function*

A mention of an unfavorable effect of hydro infrastructure on the perceived function of the landscape (includes telephone poles and overhead wires in the urban environment and high tension infrastructure in the park environment)

# Appendix D: Public Interviews - Schema Analysis Codebook

*textures*

A mention of surfaces (i.e. brick, grass, pavement) looking cleaner and more up kept due to the influence of using a computer rendered texture

*water*

A mention of the effects of the water texture on the attractiveness of the landscape

*softness*

A mention of the visualizations looking softer than photos of the landscape

*safety*

A mention of landscapes seeming safer in visualizations due to the presence and character of people used to populate the visualizations

*spatial*

An effect of using larger trees on people's perception of the size of the space

*realism*

A mention that identifies the realism level of a visualization as a factor in the preference of an image