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Exploring the Geosensory in Geography: Examining Olfaction and Geo-virtual Immersion as Contributors to a Sense of Place and Embodiment

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to the Eberly College of Arts and Sciences
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ABSTRACT

Exploring the Geosensory in Geography: Examining Olfaction and Geo-virtual Immersion as Contributors to a Sense of Place and Embodiment

Aaron Michael Ferrari

Immersive, virtual environments have proven to be valuable tools for geographic research of place, embodiment and experience. Although current trends in Geography indicate a shift toward 3D GIS and visualization, there remains a visucentric focus that has, so far, discounted additional senses beyond sight and sound. This research implemented a case study using a virtual representation of Wheeling, WV in the 1860's as described in the book *Life in the Iron Mills*, by Rebecca Harding Davis to study the effectiveness of olfactory stimulation in contributing to and evoking a sense of place. Because of the direct link between the olfactory and limbic systems, olfactory stimulation can instantly evoke vivid memories and emotional responses that sights and sounds alone often cannot attain. Through questionnaire responses and focus group discussions, this work found that the addition of scents into a geo-virtual environment does enhance a person's sense of place.

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CHAPTER 1—INTRODUCTION

“The sweet *smell* of success!”—A phrase often uttered as one relishes certain accomplishments, but could this term mean more than an informal idiom? Considering the fact that the human mind only recalls 65% of visual cues after just three days, in contrast to nearly 100% of scent recall after one year, it is evident that olfactory stimulation could be an extremely powerful tool in studying experience and place (Tuan, 1976; Parrish, 2013). The link between memory and smell has been well documented in the fields of psychology and biology; however, the discipline of geography has been hesitant to venture beyond the realm of the visual (Driver, 2003). Immersive, virtual environments are valuable tools for examining geographic research of place, embodiment and experience (Hillis, 1999). Although current trends in Geography indicate a shift toward 3D GIS and visualization (Taylor and Lauriault, 2007), there remains a visucentric focus that has so far discounted additional senses beyond that of sight. Recent developments in olfactory stimulation technologies have occurred in the tourism industry to “...create virtual experiences that tourists may accept as substitutes for real visitation...”, even with the absence of visual cues (Guttentag, 2010). The success of this tourist application supports increased attentiveness to the role of olfaction in studies of embodiment in virtual reality. This research will review the concepts of embodiment and immersion and their influence in constructing an experience of place in a virtual environment and build on this through an examination and evaluation of olfactory stimuli in a Computer Assisted Virtual Environment (CAVE) in contributing to, and evoking, a sense of place.

GEOGRAPHY, PERCEPTION AND SMELL

The prominence of visuospatial research has risen considerably since the development of Geographic Information Systems (GIS) (Cartwright et al., 2001). Broadly defined, GIS is a tool used to capture, manage, analyze, and display spatial data (Longley et al., 2015). The ability of GIS to efficiently process spatial data from the stages of collection through analysis has made GIS a very effective research tool. GIS has been used to influence legislation, manage national infrastructures, and model potential natural disasters (Nyerges, Couclelis and McMaster, 2011). Although GIS can identify the consequences of such a complex scenario, the results would be lessened without the critical, final step of a GIS project—display and communication.

Maps are the most common media through which the results of spatial analysis are displayed in a GIS (Davis, 2001). With environmental issues, such as air pollution from an expanding industrial park, GIS has been used to both model predicted pollution as well as analyze current pollution levels (Nichols, 2014). In contrast to the traditional use of GIS for mapping and spatial analysis, in 2004 smell was used in a British GIS study that examined urban pollution levels through public engagement (Cinderby and Forrester, 2005). Interestingly, residents were interviewed about their opinions of air quality in locations throughout their city. Their responses, such as “Station Road has bad smells”, provided a location from which an air quality map was produced. The researchers used this map output to advocate for increased engagement between local governments and their constituents.

Since Cinderby and Forrester (2005) conducted their study, geographic technologies have advanced tremendously. Geo-virtual environments are some of the newest technologies to emerge in the field of geography (Taylor and Lauriault, 2007). These systems are designed to immerse users in a virtual environment typically consisting of 3D visualizations that are

powerful virtual representations of reality (Garcia-Ruiz et al., 2008). Not only does a virtual representation provide a level of depth transcendent of a flat, paper map, but it also allows an audience to interact with spatial data through powerful geovisualization techniques. This visuospatial focus has led to a strong push for bigger, brighter, and higher resolution displays, leaving the geosensory olfactory, tactile, and aural technologies behind. In order to create an immersive experience within a virtual reality, it is perhaps a disservice and a potential loss to the audience to ignore these other senses of sound, smell, touch, and taste.

This research will extend beyond geovisualization and explore how additional sensory stimulation in the form of odors can enhance a person's understanding of place within what Harris (2015) terms a "geosensory" virtual environment. Geosensory studies focus on experiencing data conveyed through additional and not necessarily visual stimuli. Force-feedback devices, for example, have been used in surgical training (Wu et al., 2014). Holophonic sound systems have also been used in "soundscape" research (Bonenberger and Harris, 2013). The chemical senses of gustation and olfaction (taste and smell, respectively) have received far less attention in geosensory research. Part of this neglect can be attributed to the lack of available technologies capable of producing the level of realism that immersive environments require (Taylor and Lauriault, 2007).

Geo-virtual CAVE's are not only limited by the quality of the display device such as screen resolution and refresh rate, but also by the scale of the data being presented. A common pitfall of virtual reality systems is the uncanny valley. The uncanny valley is concerned with the extent to which an artificial phenomenon, such as a 3D virtual scene, resembles reality. Because a scene may fall short of appearing 'real', the dissimilarity between the scene and reality is heightened (Uncanny Valley, 2014). Small differences can become so prominent that the scene

is perceived as being clearly artificial such that the sense of immersion is diminished. For this reason, the use of sensory stimuli in a virtual environment to reinforce a virtual sense of realism is particularly valuable.

Perception is a primary agent influencing one's sense of presence (Slater, 2009). Presence involves the relationship between a body and the space surrounding it. Distinct from self-location, the spatial experience of being inside a body, presence is a term used to represent a sense of "being there" (Slater, 2009). Referring to presence within a virtual context as "place illusion", Slater suggests that presence is a key component of a sense of embodiment, which is perhaps best explained using the rubber hand illusion (Kilteni et al., 2012). This experiment involves a simple, artificial hand placed on a table, while a person places his/her real hand out of sight behind a wall next to the artificial hand. Synchronous visuotactile stimulation is applied to both hands with a soft brush. Even though the artificial hand does not have the intricate aesthetic details of a real hand, the person becomes embodied in that hand and believes the hand is theirs. This phenomenon occurs because the relationship between one's self and the environment is based on multisensory experiences.

The humanist geography writings of Yi-Fu Tuan introduced the notion of a sense of place (Tuan, 1975). Tuan suggested that a sense of place occurs when some experience, meaning or significance is attached to a space. Because people experience space differently, a sense of place can vary across space and people. For example, to a geology student a large, multipurpose lecture hall may be the place where they first discovered their interest in geology. But for a journalism student, that same lecture hall may be the place where they failed a final exam. If both students were put in that lecture hall, their experience of that place would likely differ significantly. The geology student would likely experience feelings of excitement and nostalgia whereas, the

journalism student might experience anxiety and stress. Their memories would be conjured up by the sights, memories, sounds and smells of the room.

The human olfactory system possesses the robust ability to evoke memories of events and places from decades past (Tuan, 1982). Even though the diffusive properties of odors do not manifest a structured sense of *space* for humans, they can evoke an emotional experience of a *place* through strong scent-memory linkages (Csillag, 2005). Olfactory nerves are linked to the limbic system, the part of the brain responsible for memories and emotions (Fox, 2009). Because of this direct connection, people can recall a specific place and time merely by catching a hint of a reminiscent smell. Such flashbacks have proven to be much more vivid than those that ensue if a picture of that place were displayed.

The olfactory system is considered both the most important and the most primitive of the human senses (Brodal, 2010). Since they first existed as a species, humans have relied on their sense of smell to survive. Indeed, people use their sense of smell to even identify suitable mates (McCarthy and Auger, 2002). Women have a heightened sense of smell during their ovulation period to better identify men who would be best suited for reproduction (Singh and Bronstad, 2001). If a man were to be closely related to the woman, her olfactory system could detect the similarity between their bodily scents and consequently inhibit her body's level of hormones responsible for arousal. In addition to ensuring healthy reproduction, smells also allow people to distinguish between safe or spoiled foods (Brodal, 2010). The olfactory nerves can detect chemicals at concentrations of less than one part per billion, which is equivalent to one drop of water in an Olympic sized swimming pool (Bray, 2014). Even at this weak concentration, the precision at which the olfactory system can distinguish odors is astounding. Compared to the eyes, which can detect 'only' 7,000,000 distinct colors, the nose can detect over one trillion

unique odors (Morton, 2015).

TECHNOLOGICAL APPROACHES TO OLFACTORY STIMULATION

The extremely precise odor discrimination threshold of the human olfactory system presents a difficult challenge for incorporating smell into geosensory environments. While studies have encouraged such applications, few have attempted to do so (MacEachren et al., 1999). In only one instance was a study performed where olfactory stimulation was used to measure levels of immersion (Jones et al., 2004). Although the results of this study were found not to be significant, it should be noted that the authors attributed their statistical results to issues in the research design. A further study captured a scent in one location and reproduced an equivalent scent at a remote location (Nakamoto et al., 2008). Even though this study was successful at capturing a scent and recreating it remotely, the scents were predetermined. Because a specific mixture of chemicals is required to replicate a specific scent, the researchers had to limit their scent collection to a predetermined list.

Other devices designed to capture and preserve scents for emission have been developed such as the DigiScent device created by computer scientist Marc Canter (Platt, 1999). Although these devices showed potential, advancements in these technologies were relatively dormant until 2013. Expanding upon the research performed by Canter, a device was created that captured scents and accurately recreated them from a liquid solution (Wainwright, 2013). Named “The Madeline”, the device was developed for the textile industry in Europe, though it is expected to serve more general applications in the coming years. Aside from these few examples where olfactory immersion has been investigated, the literature on olfaction and certainly its influence in recreating a sense of place stops at the suggestion of its

implementation (Hillis, 1999). Although the Madeline would be the ideal device for this study, only one individual device has been produced to date. At a production cost of nearly \$1 million, it far exceeds the budget limitations of this study.

Of the other scent diffusers on the market, the designs vary depending on the manufacturer. Some devices rely on heat or fans to disperse a fragrance through the air (Figures 1-2), whereas other devices utilize aerosol or compressed liquids to introduce tiny droplets of fragrant liquids into the air (Figure 3). The medium in which the fragrances are stored varies as well. Although a few devices utilize alcohol-based fragrances, such as those used in colognes and perfumes, the most common medium in which fragrances are stored for diffusers is an oil-based solution

Figure 1—The RetroScent Classic is manufactured by RetroScent®, a Netherlands-based company

Figure 2—The ScentWave, manufactured by ScentAir, operates by attaching an oil-based scent cartridge (right), to the fan apparatus (left).

Figure 3—The ScentDirect device uses an atomizer programmed to compress the liquid fragrances into tiny droplets emitted at various intervals.

Figure 4—ScentPOP; scent cartridge (bottom); fan (middle)

(Systems, 2012).

One simplistic device was designed in such a way that anyone could recreate a smell themselves. Named “Olly”, this device is comprised of a 3D printed casing, a miniature CPU, a small fan, a USB cable, and a few lines of code to operate (Make One, 2012). The scent is provided by the user as well. Users can place anything that fits inside the 2”x3”x1” drawer of the casing to be the source of the scent. Once the device is activated, a fan blows air through the casing and disperses the scent. Because of its small size and limited ability to disperse scents throughout the entire CAVE, it was not deemed suitable for this study.

A device that provides more powerful scent dispersion than that of the Olly was recently developed for synchronous use with a smartphone app (How it works, 2014). Known as the oPhone, the device allows a user to select up to three out of 32 base substances to be combined and emitted from another web-connected oPhone at a remote location. The designers likened it to a scented attachment appended to an email or text message. Because the combination of prime fragrances allows over 300,000 different scents to be created, this device would combine well with this research. However, the developers have delayed the oPhone’s public release to a future date.

The remaining devices considered for this project and subsequently adopted are produced by ScentAir, a scent device manufacturing company based in Charlotte, NC (Why scentair?: Solutions, 2015). ScentAir produces devices capable of scenting areas as small as 100 ft² as well as industrial-scale devices directly attached to HVAC units for scenting areas up to 500,000 ft³. The ScentPOP device (Figure 4) is the smallest device produced by ScentAir. It uses an open scent cartridge attached beneath a fan apparatus to blow air over the cartridge and scent the surrounding environment. A motion detection bulb placed above the fan allows the ScentPOP

to be activated only when motion is present. The device can also be operated using a push button control attachment in place of the motion detection bulb. The ScentPOP device cost \$100. Each scent cartridge, of which ScentAir offers a wide variety, costs \$25. Based on the affordability of the device and its appropriateness to the size of the CAVE, one ScentPOP device and five fragrances were used in this study.

RESEARCH OBJECTIVE AND QUESTIONS

It is apparent that the nonvisual senses, particularly smell, have been traditionally overlooked as contributors to place-making. Therefore, this research studies the influence of olfactory stimulation on a person's understanding and experience of place as recreated in an immersive, geosensory environment.

RESEARCH QUESTIONS

- 1) What is place and how do people experience place?
- 2) What is meant by geosensory and how does it relate to geography?
- 3) How does the human olfactory system operate?
- 4) How does embodiment in a scented, geo-virtual environment evoke a sense of place?
- 5) How can one's sense of place in a sensuous GIS environment be tested and analyzed?
- 6) What is the potential value of pursuing the olfactory in geography?

METHODOLOGY

A case study was performed in an immersive environment in the CAVE to analyze how a person's understanding of place is influenced by smell. A GIS and immersive scene were created based on the book *Life in the Iron Mills*, by Rebecca Harding Davis (1861). Set in the mid-nineteenth century, Davis gives a detailed and evocative description of daily life in a growing, industrialized city. Davis describes her sensory experience of Wheeling, WV at that time that provides the reader with a powerful understanding of mid-nineteenth century Wheeling. This case study sought to replicate elements of that environment using a serious gaming engine and smell to enhance a user's understanding of place.

Buildings in the virtual scene were designed using Trimble SketchUp and ESRI CityEngine before being transferred into the serious gaming software, Unity. Within Unity, the focus was to recreate the main street scenes on which Davis focused most of her writing. Unity can incorporate particle physics, environmental conditions, and interactive graphics that facilitate a realistic rendering and display of 3D spatial data that cannot be achieved by a static 2D map alone. These features were used to add smoke billowing from factory chimneys and into the streets, 3D models of people and animals, and hazy skies enveloped in smog that suppress sunlight in the scene, as Davis relates, even at mid-day. The visual aspects of the scenes were enhanced by incorporation of sound effects in the environment. Adding sounds such as verbal conversations among people on the street, animal calls and grunts, church bells, and industrial operations, manifested everyday activities and brought representations of life to the scene. Unity allows users to place sounds in a scene such that they will only be audible when a user is within a defined proximity of the source of that sound. This feature was used to add realism to the dynamic scene by increasing the volume of a sound as a user gets closer to the source.

Because the CAVE has a 7.1 surround sound system, the sounds actually emanated from the corresponding location in the scene, replicating directional spatialized sound. For instance, as the user, navigating through the scene, passed by a church to the right, the sound of church bells would be heard from that direction.

The primary sensory focus of this research, however, was olfaction. As part of the literature review, a review of scent devices was performed based on the following four principles: 1) Realism of the scents. 2) Ability to emit scents throughout the entire 10 foot cube CAVE. 3) Ability to be activated/deactivated remotely. 4) Ability to operate without detracting from the participant experience. It was concluded that one ScentPOP device (Figure 4) worked best for this research and was capable of integrating the following scents into the demonstration: fresh cut grass, barnyard/livestock, woodfire, and oily chemical. A push-button activator was connected to the device and wired behind the screens to the side area away from the space in which the participants entered. Thus, during the scented portion of a demonstration, as users navigated toward the animals in the street scene, the barnyard and woodfire scents were activated. The scents could then be switched out as users continued down the virtual street toward the area behind a series of representative buildings. The scents were replaced with oily chemical and fresh cut grass as users approached the garden and factory areas in the virtual scene. The demonstration was concluded with a focus group discussion of what the participants of the presentation had experienced.

This latter demonstration was performed using a sample of 20 participants. Participants were recruited from geography student group meetings and geography classes. Volunteers who did not have an impairment with their sense of smell were asked to participate in a brief exercise about smells and a sense of place. A time was scheduled in which four to six

participants would meet in the CAVE. Upon their arrival, informed consent was obtained from them. Although there was minimal risk associated with their participation, participants were provided with optional information regarding resources available to them in the event they should experience any discomfort or emotional stress as a result of their participation in this project. They were also given the option to leave the demonstration at any time.

After covering the ethical aspects of the study, a group of participants was guided into the CAVE. There, the following short section from Davis's writings about Wheeling was read to set the scene from a written perspective.

"A cloudy day: do you know what that is in a town of iron works? I want you to hide your disgust, take no heed to your clean clothes, and come right down with me, here, into the thickest of the fog and mud and foul effluvia. I want you to hear this story.... I want to make it a real thing for you." (Davis, 1861 p1-2)

By showing a virtual representation of Wheeling, the issue of participants having unequal levels of familiarity and prior experience with the environment was addressed. The demonstration was run through first without olfactory stimuli for about five minutes. This demonstration was then repeated with olfactory stimuli added. Participants were given about five minutes to experience the scene with smells. Following this second presentation, participants were asked *in situ* to participate in a brief focus group discussion. The focus group began with the facilitator asking everyone to fill out a brief questionnaire. Following the participants completion of the questionnaire, a group discussion was held.

Questionnaire responses were tabulated and analyzed. A Wilcoxon Rank Sum Test was subsequently performed on the ordinal questionnaire data. Verbal discussions were recorded and transcribed into a password-protected document. A text analysis was performed to identify patterns or

trends in the responses. Any patterns found in these responses were discussed and used to support or refute the significance of olfaction as it relates to conveying a sense of place in a geo-virtual environment.

SUMMARY

Although researchers in numerous fields of study have published literature regarding olfactory stimulation in a virtual environment, geographers have tended to neglect the role of olfaction in their respective studies of place. Seeing that *place* is one of the rudimentary concepts of many geographers (Johnston, 2005), it can be said that place studies via geo-virtual environments should replicate a place as accurately as possible, while also being cognizant of the uncanny valley. Considering that an advanced virtual environment typically addresses just two of the five senses, it seems logical to explore a geosensory environment in which olfaction is incorporated as well. The direct link between the limbic and olfactory systems would allow the detection of scents to stimulate subconscious processes that would actually reduce the probability of one experiencing the uncanny valley. This link also enhances the user's experience of a scene because of the additional sensory stimulation. It was predicted that the experience of place in the context of historic Wheeling would be enhanced when scents were introduced into the environment. Conversely, it was predicted that participants would report a diminished sense of place when no scents were used.

CHAPTER 2—PLACE, SMELL AND IMMERSION

At its most basic form, place can be defined as the significance of a space (Tuan, 1975). In the English language, place does not elicit the same meaning as “space,” although it is often used interchangeably in common conversation. Space requires people in order to make it a place. Without people, a space is no more than a specific area within set physical features (Tuan, 1975). Even the presence of people alone does not create place. In order for people to have a sense of place, they must first have some form of experience or interaction with the types of space they are occupying. Likening place to a pause in movement through space, Tuan discusses that people must stop and experience a space before they can develop any understanding of place (Tuan, 1977).

Simply spending time in a space does not automatically yield a sense of place. For example, to a businessman on a train from New York City to Washington, DC, a quick stop at the station in Newark, DE could have no significance to him whatsoever. On the other hand, to an incoming freshman at the University of Delaware, that station could be the place where a teary-eyed embrace with a family member began the next phase of life. The primary difference between these two individuals is that the student had an emotional experience at the station which shaped an association and emotional feeling of place at that location.

As a sense of place relies upon first-person experience, it is suggested that place frequently happens at the “lived” or “local” scale (Tuan, 1977). Spaces at the lived scale often evoke the strongest sense of place for a person, even though they typically are difficult to display on a map. For instance, a bed is a space that can yield a powerful sense of comfort and security within a home. Even though the house as a whole may be afforded a symbol or an image on a map, this does little to convey the sense of place that is experienced when one occupies the bed

(Rodaway, 1994). On the other hand, if the same person were to get up and walk to the kitchen, s/he would have a greatly different experience of that space as the kitchen is a unique place in its own merit. One house can be full of numerous, diverse places; but, on a map, a house is no more than a spatial entity.

The World of Scent

In order to understand the ways in which humans interpret scents, one must first engage with the manner by which odors are sensed. When an odor is detected, we sense the odor carrying molecules present in the air (Csillag, 2005). The composition of chemicals in the air is interpreted by humans and animals differently and as different odors. For instance, when someone smells the equivalent of a “rotten egg” as is associated with sewage, s/he is actually detecting the presence of hydrogen sulfide (H_2S). Chemical molecules in the gaseous state can be inhaled through the nose triggering our interpretation of smells.

The ability of volatile molecules to move about in space depends upon environmental conditions. Decreased air pressure, which decreases inversely with altitude, leads to thinner air and fewer odor molecules being present in the air (Philpott et al., 2004). Temperature has the strongest impact on the movement of airborne molecules since the speed of molecular movement is directly correlated to air temperature. This explains why food odors proliferate when being heated in an oven. Increased humidity, also related to temperature, is believed to increase the volume of air that contributes to a higher concentration of odorous molecules (Philpott et al., 2004). Not only do temperature and humidity affect the chemicals themselves, they also affect the operation of the olfactory system (Kuehn et al., 2008).

Unlike sight and touch, which are physical senses, the olfactory sensation is a chemically induced sense (Brodal, 2010). Believed to be the earliest developed human sense, the olfactory system aids in a broad range of human activities from distinguishing between safe/spoiled foods, identifying ideal mates, and detecting potentially toxic atmospheric conditions (McCarthy and Auger, 2002). Air is inhaled through the nasal cavity and some of the volatile molecules in the air are absorbed into the mucus that lines a small section at the rear of the nasal cavity. Cilia projections, lined with olfactory receptors, extend into the mucus membrane and detect variations in the chemical composition of the mucus. Each cilium can be stimulated by a variety of chemical changes (Csillag, 2005).

Upon detecting a chemical change, information is transmitted through the cilia into the olfactory receptor neuron below the mucus membrane. Each trigger is relayed through an axon along the olfactory nerve to the olfactory bulb in the brain. This direct connection to the brain is unique to olfaction. Information from other human, sensory systems must first be relayed through the thalamus before it can be processed and interpreted. The interpretation of olfactory signals takes place in the olfactory bulb, a structure of the brain's limbic system, which importantly is responsible for memory formation, memory recall, emotions, and some behaviors associated with addiction, pleasure and attraction (Zahm and Heimer, 2009).

Designed to detect significant changes in volatile molecules in the air, the olfactory system can exhibit a rapid desensitization period after only a few minutes of continuous stimulation (Csillag, 2005). Biologically, this desensitization allows the olfactory system to detect that which is different from the norm (i.e. ovulation, wood burning, spoiled meat) or that which is anomalous in some way. Significantly, abnormal olfactory experiences often contribute to and become part of human memory (Annett, 1996). Memories are retained with embedded

olfactory information because they are both processed within the limbic system (Csillag, 2005). Thus, thoughts and emotions that were felt at a particular time and place can be evoked at the hint of a smell that was also experienced at that point in time or place (Tuan, 1982).

As a person navigates through space, the limbic system is continuously forming associations and connections between the current surroundings and prior experiences (Jones and Evans, 2012). As Pamela Richardson (2016, p. 1) wrote, “Our bodies are at the core of our experience of the geographies we inhabit”. One’s sense of place is directly influenced and formed by our relationships between body and environment, and is pivotal in understanding the influences that shape that relationship. The way in which a body interacts with its environment is directly influenced by the type of body one inhabits or embodiment (Sebanz and Guenther, 2009). The same is true for understanding the way in which a person experiences space in a virtual reality setting, such as a CAVE (West et al., 2015).

The Sense of Immersion

Conventional mapping practices fail to adequately represent spaces at the lived scale, and do little to involve the intrinsic, mental capabilities of the limbic system which allows us to experience a sense of place (Rodaway, 1994). Although the medical community has not fully explained the process by which humans create and recall memories, there is evidence that significant emotional experiences yield a higher likelihood for a person to store and recall an experience as a memory (Zahm and Heimer, 2009). Often the degree to which a person’s emotions are triggered coincides with the level of detail associated with a memory. An example would be to ask someone who lived in the United States on Sept. 11, 2001, what they remember

when they heard the news of the attack on U.S. soil. The response would likely be more vivid for this day than if the person were asked about another random day in 2001.

Cartography and mapping as a whole have been changed substantially by the development of GIS. GIS has the power to manage, analyze and display spatial data with ease (Nyerges et al, 2011). Software packages from AutoDesk and ESRI have revolutionized operations across numerous disciplines. The transportation, land management, and planning sectors, both public and private, have largely adopted GIS into their business practices. Industries have embraced GIS technologies not only for its analytical functions, but also for its display capabilities. With the increasing occurrence of “big data,” a traditional method of data presentation, such as the map, can accommodate significant quantities of information and yet can be overcrowded with information to the point of being unreadable. Technological advances have contributed to exponential growth in geovisualization capabilities. Geovisualization refers to the techniques and tools available to present large amounts of spatial data in an alternative, interactive manner (Dykes et al., 2005). In its simplest form, geovisualization predates modern computers as evidenced by maps produced by Charles Minard in 1861, which were able to accurately convey six different datasets on a two-dimensional map (Kraak, 2003). Although analysis within a GIS is valuable, it must nonetheless convey the results to the end-user. In the case of 3D data, this becomes even more important. Adding the third dimension to a display enables sophisticated analysis and visualization in three dimensions. The ability to visualize 3D representations rather than a “flat”, 2D map allows for a considerably better understanding of information such as 3D landscapes, subsurface soil properties and groundwater patterns (Harris and Hodza, 2011).

Modern geovisualization uses advanced computer graphic rendering capabilities to display massive quantities of data at one time using three-dimensional graphics. Technologies such as the Computer Assisted Virtual Environment (CAVE) provide astonishing visual representations of spatial phenomena that surround and immerse users within a dataset. The intuitive nature of 3D presentations provides an innovative system of data visualization that is revolutionizing human- computer interaction. In order to enhance the intuitive, immersive nature of 3D geovisualization, immersive technologies have been developed that allow users to interact with 3D data without being limited to the traditional computer mouse and keyboard. Using the Microsoft Kinect device, a fellow colleague at West Virginia University developed a tool that allows users to interact with 3D spatial data using hand gestures and voice commands (Haas, 2013). Another device that translates user movements to the computer is a head-mounted device, such as the ones created by Intersense (Steinicke et al., 2013). The Intersense device tracks the head movements of the user and simulates corresponding movements on the screen. Although these interactive techniques deal with the human movement, this is not the only way that locomotion has been implemented in a CAVE scenario.

In addition to virtual displays, geosensory studies examine how spatial data analysis can be augmented by multisensory stimuli. Traditional visucentric data displays are effective as far as the eye can see, literally. Yet, humans can only process a limited number of visual stimuli at one time (Taylor and Lauriault, 2007). Geosensory technologies might perhaps circumvent the limiting threshold of visual stimuli processing and augment the visual by simultaneously stimulating multiple sensations in addition to those of sight.

The intuitive nature of non-visual stimuli promotes a more immersive, experiential learning environment (Garcia-Ruiz et al., 2008). For example, in the urban planning and development field, moving floor platforms have been employed to simulate the kinesthetic sensation within virtual environments by allowing the user to physically walk through a virtual representation of a proposed development area (Steinicke et al., 2013). This movement provides developers an opportunity to experience an environment before construction has even begun to ensure that the final project meets the expected criteria. These technologies help developers test and manipulate their designs to ensure that the desired experience for the end user is achieved.

Even more common than kinesthetic geosensory systems is the implementation of powerful surround-sound systems. Bernie Krause, an American ecologist, used sound to show the impact of human interaction within natural bio-landscapes (Krause, 2013). Even though textual and visual reports, for example, stated that selective human timber harvesting activity had no significant impact on an ecosystem studied by Krause, in reality, his sound recordings indicated otherwise. Evidenced by the dramatic decrease in insect and bird sounds after deforestation had begun, the changing sounds of the forest were the most effective way to analyze the eco-status of the forest. Some geosensory studies have investigated using holophonic sound systems to spatially locate sounds within a virtual environment (Harris, 2016). The research in this study focuses on the underdeveloped geosensory technique of using olfactory stimulation in a geo-virtual environment.

The concept of embodiment deals with the multiple aspects of the ways in which people interact with the space surrounding them. One facet of embodiment is spatial representation, which deals with the spatial experience of being inside a space, referred to as presence, and the spatial experience of being inside a body (Kilteni et al., 2012). The experience of being

inside a body is commonly referred to as self-location and involves haptic perception, specifically proprioception, which is a haptic sensation providing information about the position of one's hand or feet (Kangas et al., 2014). Self-location plays a role in one's geosensory experience of an environment.

A major roadblock that virtual reality research has attempted to circumvent is the embodied sense of agency. Agency provides a sense being in control and this plays a strong role in influencing people's sense of embodiment because of the ability to generate a sense of agency primarily through tactile stimuli. One's sense of agency is a result of predicted sensory consequences that match the actual sensory result of one's actions (Kilteni et al., 2012). For instance, if an orange is squeezed and subsequently implodes, a person would feel global motor control through the body. Some virtual reality environments, for example, utilize force-feedback devices to give users such a sense of agency. However, this does not directly correlate with creating a sense of place for users since tactile sensations do not necessarily stimulate the limbic system as effectively as the olfactory sensation (Annett, 1996; Larsson, 1997).

Currently, many corporations manipulate the limbic processes through the detection of various scents. For instance, some retailers have developed point-of-sale displays that emit the scent of particular products, such as chocolate, to the customer (Ward et al., 2007). Even more popular is the incorporation of ambient scent into an environment. In an effort to brand their business, Westin Hotels infuse a soothing white tea scent into their HVAC units so that every one of their locations will smell the same (Why scentair?: Solutions, 2015). The "Westin White Tea" scent was designed so that when a person walks into a Westin they will experience a boost to their mood. This type of ambient scenting contributes to memory and to a sense of known place for Westin Hotel patrons. Other applications have built on studies that found

people are less likely to feel impatient, angry, or negative when they are in the presence of pleasant scents (Ward et al., 2007). In the United States alone, casinos, apparel stores, and grocery stores have all implemented ambient scents into their locations with the goal of influencing customers to spend more time (and money) in their establishments (Smiley, 2014).

Instances of applications of olfactory stimulation for the purpose of enhancing a sense of place beyond simple ambient scenting are less common in the literature as it is more difficult to control multiple scents (Levent et al., 2014). Visitors to the “What’s the Message” exhibit at the Boston Museum of Science are presented with the smell of smoke to complement the sights and sounds of firemen responding to a fire (Levent et al., 2014). ScentAir, the company that created the devices used in this study, has developed scents that resemble those that veterans may experience during a combat tour in the Middle East. These have been used in Post-Traumatic Stress Disorder treatment for veterans (Aiken and Berry, 2015). Aiken and Berry suggest that scents are an under-researched, but potentially highly effective method for enhancing virtual reality systems.

Recent work in the spatial humanities has shown that deep mapping can also forge powerful representations of place (Bodenhamer, Corrigan, and Harris, 2015). Deep mapping involves representing many aspects of a reality to represent the place, time and space of that reality. Harris (2015; 2016) utilized the spatial narrative in the realist writing of Rebecca Harding Davis to study deep mapping through literary GIS. Other studies have developed virtual environments based on spatial narratives (Ryan, 2015). However, there has been a consistent lack of olfactory stimulation being incorporated into this latter research. Using a geosensory lens, this study combines concepts of embodiment, the geosensory, virtual reality, and immersion to explore the role of olfaction in contributing to a sense of place.

CHAPTER 3—METHODOLOGY

Drawing from the works of Literary GIS presented by Harris, Lafone, and Bonenberger (2016), a Computer Aided Virtual Environment (CAVE) and a ScentPOP olfactory device were used to test the concept of linking place and smell through the representation of antebellum Wheeling, WV. The immersive scene was designed based on the Main Street scene on which Rebecca Harding Davis focused her writing in *Life in the Iron Mills* (1861). Her expressive descriptions of Wheeling and Main Street provide a robust and evocative framework for constructing the virtual scene. Because present-day Wheeling does not reflect its nineteenth century design, Sanborn maps were referenced to recreate the buildings and geography accordingly. To these scenes, scent was added to examine the role of olfaction in place making.

Select buildings in the virtual scene were created using Trimble SketchUp software which afforded extensive architectural design capabilities. Structures designed in SketchUp can be exported via multiple GIS formats and imported into display software, such as the serious game engine Unity. Once completed, models were exported via COLLADA (.dae) files. Texture maps were exported with the .dae so that features retained their unique textures and colors when imported into the Unity engine.

Trimble SketchUp was used to create detailed building reconstructions for the focus area surrounding Davis's house. Peripheral buildings away from the primary scene were generated using ESRI's CityEngine software. CityEngine was used because of its capabilities to perform the mass modeling of buildings based on a defined set of procedural rules. After the building footprints and street centerlines were digitized from the Sanborn maps using ArcGIS, the shapefile was imported into CityEngine. Procedural rules were written to generate basic, 3D models of ancillary buildings based on the attributes of the footprints. The resulting non-

essential models were predominantly textured as gray-black and were rectangular models of up to three stories in height with a select few having additional details such as a pointed steeple to reflect that it was a church which would be visible from Main Street. Only one footprint, the one representing the iron mills, was manually extruded in CityEngine. Because the iron mills would appear at a distance from the focal area, they were given a complete black texture. In addition to being several stories in height, the iron mills were given towering chimney stacks that were associated with additional visual effects, such as billowing smoke, within Unity. All models in CityEngine were exported as .fbx for use in Unity.

The serious gaming engine Unity was selected as the primary interface through which the demonstration was presented due to its powerful, 3D rendering capabilities. Unity can incorporate and recreate particle physics, environmental conditions, and interactive graphics that facilitate an impressively realistic, first-person rendering and display of spatial data that cannot be achieved by static maps alone. Unity also allows users to place sounds in a scene such that they will only be audible when the user is within a defined proximity of the feature generating that sound. Three-dimensional sound adds realism to the scene and by increasing or decreasing the volume as a user gets closer to or moves away from the source. This directional sound adds to the immersive experience. Because the CAVE has a 7.1 surround sound system, the sounds emanate from the corresponding location in the scene creating directional sound such that as a user navigates through the scene and passes a church to the right, the sound of church bells is heard coming from that direction.

For the olfactory component of the study, one ScentPOP device (Figure 4) was placed near the corner of the opening to the CAVE. Placement away from the participant area allowed scents to be interchanged without distracting the participants (Figure 5). A push-button

Figure 5—Scent device directed from side of CAVE to facilitate circulation of scents throughout entire space.

activator connected to the device activates the fan component and distributes the scent into the air. When activated the fan blows air through the fragrance cartridge and out through the opening on the front of the device and into the CAVE area.

The room that houses the CAVE has specific environmental conditions which can affect how the scents are dispersed. As a whole, the CAVE space operates under slightly negative pressure so that incoming air is drawn out through the HVAC system. This is advantageous because it allows scents to be removed from the area relatively rapidly after the scent device is deactivated. An additional fan is placed near the CAVE to funnel air away from the participants and towards the air intake. The air in the CAVE maintains a steady temperature of 67° F with a low relative humidity (< 40%). This keeps the sensitive machinery in the CAVE from overheating or experiencing other damage.

Participants in this research were recruited from students in the undergraduate and graduate programs in Geography at West Virginia University. Thus, the participants possessed, at a minimum, a rudimentary idea of the concept of place and the CAVE. This allowed for a reduction in the time needed to prepare participants for the demonstration. Students in the graduate program were recruited via the following message sent via email:

Hello all,

I hope this message finds you well. I am a second year Master's student studying the influence of scent on a person's sense of place in an immersive environment. I am currently looking for volunteers who do not have an impairment with their sense of smell to participate in a brief demonstration in the CAVE. Participants will be presented with a virtual scene of Wheeling, WV and asked to respond via questionnaire and group discussion about what they experienced. This should be a fun exercise which will last no longer than 60 minutes. I would greatly appreciate your participation. If you are interested, simply reply to this message and I will send you a list of times in which I will conduct demos.

Thank you for your time.

Aaron Ferrari

Undergraduate students were recruited from classes with a verbal invitation that mirrored the above email transcript. A sign-up sheet for attendance at specific times was available for students to select the time that worked best for them to come to the demonstration.

Each demonstration was composed of between two to seven participants. The group size was selected to facilitate discussion without crowding the CAVE while also accounting for no-shows. When attendance was lower than anticipated, the demonstration continued as planned. In these instances, discussion following the demonstration and questionnaire tended to be limited and this is reflected in the transcripts in the appendix. Once a group assembled at the CAVE, participants were given a consent form (See Appendix A1). Upon their signature of consent, participants were given a written review of the purpose of the study and thanked for their willingness to participate. Although there was minimal risk associated with their participation in this study, participants were provided with optional information regarding resources that were available to them in the event that they should experience any discomfort or emotional stress as a result of their participation in the demonstration. Participants were also given the option to leave the demonstration at any time. After covering the ethical aspects of the study, the group was guided into the CAVE where they were asked to remove their shoes as per CAVE use policy. While preparing for entering the CAVE,

participants were given a brief summary of nineteenth century Wheeling and the work of Rebecca Harding Davis (1861) in order to set the scene for the demonstration. The following is a transcript of what was read to the participants in setting the scene:

“In the mid-1800’s, Wheeling was an industrialized, developing city along the Ohio River in what is the present day Northern Panhandle of WV. Thousands of immigrants lived in the city working its iron and steel mills which gave Wheeling its nickname ‘Nail City’. Rebecca Harding Davis grew up in this manufacturing city and experienced first-hand the effects of the industry. In her book, *Life in the Iron Mills*, she writes about how the emissions from the factories enveloped the city on a daily basis. I will read you a few lines from her book: ‘A cloudy day: do you know what that is in a town of iron works? I want you to hide your disgust, take no heed to your clean clothes, and come right down with me, here, into the thickest of the fog and mud and foul effluvia. I want you to hear this story.... I want to make it a real thing for you.’ Davis often writes from the perspective of looking out the windows of her Main Street home noting ‘I open the window, and, looking out can scarcely see through the rain the grocer’s shop opposite, where a crowd of drunken Irishmen are puffing Lynchburg tobacco in their pipes...Smoke everywhere! A dirty canary chirps desolately in a cage beside me. Its dream of green fields and sunshine is a very old dream,—almost worn out, I think’ (Davis, 1861 p1-2).

Participants were asked to stand in the CAVE and were given a dynamic tour of virtual, historical Wheeling without the addition of any scents. A chronological sequence of sights, sounds, and scents presented to the participants is included in Appendix Figures A10-A11. This demonstration was then repeated with the incorporation of scents at various relevant stages of the virtual tour. “Woodsmoke” scent was added as the tour approached an outdoor fire; whereas grass scent was added when the tour approached Davis’s garden, and barnyard scent was dispensed when near animals in the Main Street and near barns.

Following the presentation, participants were asked to sit at tables near the CAVE and complete a questionnaire regarding their experience. The questionnaire also served as a reference point for participants to use during the subsequent focus group discussion and as an immediate gauge to the effect of adding scent to the scene and the experience of the virtual environment. Responses to the questionnaire provided a source of quantified data regarding the influence of adding scent and feedback on any heightened experience of place in a scented geosensory environment. The questionnaire can be found in Figure 6. Following the

completion of the questionnaire, a focus group discussion began. The discussion was held in the same room as the CAVE so that, if needed, the scene could be accessed as a reference during the discussion.

Figure 6—Questionnaire

Could you identify any of the scents when they were introduced?	Yes	No
If so, how many? _____		
Of the smells you identified, could you relate them to the scenes on display?	Yes	No
Did the scenes evoke any emotions for you during the demonstration?	Yes	No
If so, please list all emotions you experienced as a result of the demonstration.		

Please rank based on how well you dis/agree with the following 2 statements

The scenes WITHOUT scent enhanced my understanding of Wheeling in the 1860's?

Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree
0	0	0	0	0	0	0	0	0

The scenes WITH scents enhanced my understanding of Wheeling in the 1860's?

Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree
0	0	0	0	0	0	0	0	0

On a scale from -5 to +5, with -5 being strongly decreased and +5 being strongly increased, how did *your understanding of 1860 Wheeling* change after the scents were added?

-5	-4	-3	-2	-1	0	1	2	3	4	5
strongly decreased					no difference					strongly increased

Using the same scale as in the previous question, how did the addition of scents *influence your sense of place* in a virtual, historical Wheeling?

-5	-4	-3	-2	-1	0	1	2	3	4	5
strongly decreased					no difference					strongly increased

Each query in the questionnaire was designed to identify specific aspects of the participant's experience of the virtual tour. The first question addressed whether or not the participant could

identify any of the scents during the demonstration. If this question received a “No” response, the remaining responses on that sheet were then moot. The following question asked how many scents the participant could detect. This response yielded information about how many of the four added scents the participant could detect. It also identified any instances in which participants reported more than four scents being present, as the participants were not informed of the number of incorporated scents. The number of detected scents was also used as an independent variable in comparison with the responses to the remaining questions.

The detection of a scent during the demonstration did not imply that all of the scents were necessarily related to the scenes. A follow-up question asked about the potential detection of scents from other sources such as from another group member in the form of perfume, for example. Any “No” responses were expected to exhibit no difference or a negative correlation between their responses relative to the final two pairs of questions. Because the sense of smell is so strongly tied to the limbic system, participants were asked to identify whether or not they experienced any emotions as a result of the tour and to list them.

The before-and-after design questions were aimed at isolating the effects of smell on the understanding of place from other stimuli such as sight and sound. These questions sought to identify whether participants experienced a greater sense of place when scent was introduced into the virtual environment. Although the participants were all familiar with the CAVE, the visual display alone are presented on 300 ft² of screen, which is over 150x more area than the standard monitor present in the Geography computer labs. A strong understanding of place in the before- scent demonstration suggested that scents do not necessarily enhance participant understanding of place in the context of historic Wheeling. Responses to the before-and-after questions were translated into positive or negative values for the statistical analysis of the

Wilcoxon Rank Sum Test. The nine possible choices were converted into values from -4 to +4 respectively. A verbal level of the dis/agreement scale was presented in the questionnaire to avoid confusion with the final two questions which used an ordinal scale with different indicators.

The penultimate question highlighted the ways in which the participant's understanding of Wheeling was changed by the addition of the scents. Although the scents were designed to enhance the experience of place in historic Wheeling, this is also in addition to the other sights and sounds represented in the virtual environment. Stimulating a third sense could yield a discordant or confusing experience for the user which would convolute their understanding of the environment of 1860 Wheeling. The final question was straightforward in its design and asked for a rank of the extent to which adding scent to a scene increased or decreased their sense of place. This question generated a mean of the responses indicating the extent to which scent influenced a person's sense of place. Incorporating this direct question also served as a useful reference point for participants during the focus group discussions when prompted to discuss how their sense of place was changed by the scents. Upon completion of the questionnaire, the focus group discussion began.

Led by the facilitator, the focus group was conducted in accordance with the guidelines set by Hay (2010). Upon starting the discussion, participants were given a brief overview of how a focus group is designed to work with an emphasis on discussion among participants as opposed to simple question and answer. An assistant was present to take notes of the discussion and to complement the subsequent transcription, which was derived from an audio recording of the discussion. The question prompts (which are included at the end of this chapter) were arranged in the order in which they were presented to the participants and served as guidelines

for the facilitator. As the focus groups often had a synergistic effect whereby one response triggered further discussion that overlapped with these prompts, the facilitator had to adjust accordingly so as not to disrupt the flow of the discussion.

FOCUS GROUP DISCUSSION PROMPTS AND SUB-PROMPTS:

- How did the scene compare to your expectations of historic Wheeling based on extracts from the book?
- How did the introduction of scent contribute to your experience of virtual wheeling?
 - Did it reinforce or detract from your sense of place? And Why?
 - How did the scents increase or decrease your being immersed within the scene?
- What parts of the virtual tour reminded you of a previous experience or memory?
- Do you feel as if any parts of the virtual scene made you feel any emotions? If so, explain what emotions you felt and when they occurred?
- Why do you think your sense of place in virtual Wheeling changed by the addition of scents?
- Please discuss any specific components, such as images, sounds and smells, in the demonstration that you felt were the most powerful in effecting your sense of place?
 - If you were to rank the most significant factors between visual, sound, smell, how would you place them?
 - Why?
- Were there times the experience of smell dominated your immersive experience of place?
- In what ways would you suggest the virtual tour of Wheeling could be enhanced or improved to provide an even greater sense of place?

After conducting several rounds of demonstrations and discussions for different groups, the questionnaire responses were tabulated and analyzed. A Wilcoxon Rank Sum Test was performed on the ordinal questionnaire data. Verbal discussions were recorded and transcribed into a password-protected document. A text analysis was then performed to identify patterns or trends in the responses.

CHAPTER 4—RESULTS, ANALYSIS, EVALUATION

QUESTIONNAIRE RESULTS

The numerical responses to the questionnaire were designed to complement the discussion component of the focus group. Twenty-two questionnaires were completed and returned. Because every participant was able to detect at least one of the four scents, no responses were removed from the analysis. The mean number of the four scents that were detected by the respondents was an impressive 3.1. However, only 27% correctly identified all four smells. All participants indicated that they were able to relate certain scents they identified to the scenes on display during the virtual tour.

Wilcoxon Rank Sum Test

H_0 = Smell and the use of scents does not create a greater sense of place.

H_1 = Smell and the use of scents does create a greater sense of place.

Table 1—The table below shows the difference between the scenes with and without scent. Differences are ranked from smallest to largest difference. Three difference values of 0 were omitted.

Diff.	1	1	1	1	1	1	1	2	2	2	2	2	3	4	4	5	5	6	7
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Sign	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

A Wilcoxon Rank Sum Test was used to identify the difference value between the responses of respondents who experienced 1860's Wheeling with scent added and also their experience with no scent added. Each with scent value was subtracted by its corresponding without scent value to yield a difference value (Table 1). Because the response range was from - 4 to +4, the difference values could range from -8 to +8. Having received only three values where no difference was noted ($dv=0$), these values were removed from the test. The remaining values were ordered from lowest to highest and assigned a rank based on their distance from 0 with positive values receiving positive ranks and negative values receiving negative ranks (Table 1). Strikingly, all values were positive indicating that scent made a difference.

Table 2—Responses to the question of “The scenes WITHOUT scent enhanced my understanding of Wheeling in the 1860’s?” where ± 4 represents strongly dis/agree; ± 2 represents dis/agree; 0 represents neither agree nor disagree; remaining values fall in between.

Respondent #	Without Scent	With Scent	Respondent #	Without Scent	With Scent
1	2	3	12	2	2
2	2	3	13	2	2
3	2	4	14	1	2
4	1	3	15	-3	2
5	-4	3	16	1	3
6	3	4	17	2	2
7	-2	2	18	2	4
8	2	4	19	-1	2
9	3	4	20	2	3
10	2	3	21	0	4
11	-3	3	22	-1	4

A complete matrix of questionnaire responses is shown in Table 2. Each response to ranking the statement “The scenes WITHOUT scent enhanced my understanding of Wheeling in the 1860’s” is recorded in the Without Scent column, while each response to rank the statement “The scenes WITH scent enhanced my understanding of Wheeling in the 1860’s” is recorded in the With Scent column. Thus, respondent #7 indicated s/he disagreed with the first statement regarding having an enhanced understanding of place during the virtual tour without scent. Subsequently, the respondent indicated s/he agreed with the second statement regarding having an enhanced understanding of place during the tour with scent. The resulting difference value for respondent #7 would be +4.

The results of the Wilcoxon Rank Sum Test yield a mean difference of +2.32 between without scent and with scent responses regarding participant response to smell being added to the scene. The resulting z-score value is -3.823 with a p-value of 0.00014. Therefore, the result is significant at $p \leq 0.01$. This refutes the null hypothesis that smell and the addition of scents do not create a greater sense of place.

Even though the unscented segment of the virtual demonstration was conducted in an advanced, geo-virtual CAVE, nearly one third (32%) of the participants did not gain an enhanced understanding of historic Wheeling as a place. The majority (68%), however, stated that their understanding of Wheeling was enhanced by the virtual tour without scents. Of those who did not report an enhanced sense of place without scents, one response was neutral while the remaining 27% indicated that their sense of place was not enhanced by the unscented tour. This lack of an enhanced experience of place by one third is perhaps surprising and could be attributed to some participants having previous experience with Wheeling or the CAVE or a lack of affinity for visual learning. However, and importantly, those who identified a neutral experience of place in the CAVE without the scents then demonstrated the greatest difference in response to the addition of smell with all values being three or higher. When asked about their greater understanding of place with scents, every response indicated an enhanced understanding that was equal to, or greater than, their understanding of Wheeling from the unscented tour alone.

As for the final question concerning the influence of scents on gaining a sense of place in the virtual, historical Wheeling, on a scale from 0 (no difference) to 5 (strongly increased), the mean response was 3.64 with 95% reporting ≥ 2 out of 5. Only one response indicated no difference. The questionnaire results support the hypothesis that the respondents sense of place in Wheeling in the mid-nineteenth century was enhanced with the addition of olfactory stimulation.

RESPONDENTS QUALITATIVE EVALUATION

In addition to the questionnaire, a qualitative analysis of verbal and written feedback from the focus group discussions was pursued. These discussions were analyzed around some

common themes and selected quotes derived from the analysis are included to elaborate on certain points made by the respondents.

GROUP DISCUSSION RESULTS

Table 3—Themes (in bold) and select quotes derived from the focus group discussions.

Visuals received very little discussion
Stimulating an additional sense through smell enhanced participant understanding of the place
“The more senses you can get out of it, the more connection you have with it”
“When I smell something, I get more out of it”
“You can try to imagine it in your head but once you walk into a GIS, there is just so much more; you’re able to feel it”
“When I heard the sound, I felt like I was more into the scene”
“When I smelled the smell, I felt more into the scene.”
The contrast between the positive nature of the garden area and the negative nature of the rest of the town strengthened the experience of place through affect and emotions
“When we were starting to get away from the garden, I almost felt tense”
“The garden scene, that’s where I felt the biggest contrast, that’s where I felt where I was”
“You understood that it was like her place to get away”
“Especially the bright greens, [the garden] was good!”
“99% of the place was dark, there was an attitude of it being gloomy, not happy, and there was that one area that was so small, but [the garden] had such an effect on everything else”
“Because the garden looked so different from everything else in the scene so when the smell came out that was very different, I got that”
“I smiled when I smelled it...I was happier”
Sounds and smells gave better understanding than visuals of what was taking place in the scenes.
“Sometimes I closed my eyes and I was really into the scene...Because when I open my eyes, I know that it is something like fake space.”
“When I closed my eyes, I felt the emotion, but when I looked with my eyes I didn’t realize those things.”
“The animal sounds like the cows and the birds I felt like I was walking in a village”
“The sound of the blacksmith. That helped me realize okay someone is actually hammering
Scents facilitated feeling of being immersed—outdoors
“You know you are inside when you’re looking at it, but when you get the smells, you feel like you’re not standing in a room, you’re actually on the screens”
“You get a sense of what the people in that place were experiencing”
“It really, put you on the street”
“It made me a feel the feeling of you’re outdoors”
“I imagined myself like I was walking outside”
The dynamic, virtual tour incited physical and emotional responses from participants
“I felt anxious. Like, I want to get out of [the factory area]”
“Claustrophobic. I mean the smog or fog is like too dense, too big. It felt hard”
“[The flowers] made me feel like, it’s spring!”
“It was depressing”
“[The garden] was relaxing”
“The barnyard smell was like similarly sickening to an actual barnyard”

"As we got farther away from her house, I started feeling anxious"
"I actually wanted to cough when I smelled the smoke scent"
"I was like not breathing fully because I was like, I didn't want a huge breath about all these things"
The demonstration evoked memories
"[The barn smell] brought that back like as soon as I smelled it, driving down a country road"
"With smells...I started remembering things from back home"
"I spent a few days in Tuscany in the fall, and they had a lot of wood smoke, and it brought that back"
"It kind of reminds me of home"
Sounds helped enhance spatial awareness
"Sounds and the smells...really helped you understand, you were by a barn and by the animals"
"The church bells were good. Because you could tell where you were"
"You could tell how close you were to the church"
"You knew which direction you were...the sound plays a role in knowing place as far as relative to something else"

Upon examination of the focus group discussion (see Table 3), there is a striking absence of conversation about the visual aspects of the geo-virtual scene. The very low frame rate, which was below 5 fps for extended portions of the demonstration and which contributed to a somewhat staccato like movement, did not elicit one comment or critique. Even when prompted to comment on, or critique, the virtual representation of historic Wheeling, the group discussion immediately shifted toward a dialogue of performance and embodiment. With no tactile experience or actual locomotion, there were still 19 mentions of respondents "walking" through the town in the responses. Even without taking a single step, the groups discussed their experience as though they had experienced walking through the virtual environment and the representation of a place that predated them by over a century.

When asked about smell in the context of the immersive experience, multiple participants said that closing their eyes made them feel as if they were walking outside. Some felt the scents were what they expected from such a representation, while others had a changed experience because of the memories that the scene and smell evoked. Participants explained their

experience in the form of numerous, often vivid memories of going “back home” or being in another place and time. For example, one person stated that the street scene reminded them of a music festival. Another chimed in by way of agreement saying that it reminded them of standing in line for the portable toilets while tailgating at an outdoor music festival. In another group, one participant mentioned how s/he was reminded of walking around outside in Tuscany.

Of the six principal areas of the Wheeling scene (see Appendix Figures A4-A11 for overview), the garden area behind Davis’s house was the most common place mentioned in group discussions. The garden frequently came up as a response to prompts about the specific components that affected their sense of place and prompts asking about the places where emotions were evoked. Participants felt as if they could breathe freely while they were in the garden and experiencing the smell of grass. Respondents repeatedly mentioned how the floral scent of the garden was the only desirable scent of all the scents used citing a calming, happy feeling and smiling when they experienced the garden area scent.

When asked about the point at which participants felt most immersed in the virtual scenes, the consensus was the garden area. Even though the garden area occupied a very small space in all the virtual scenes, it significantly enhanced the experience of place in the virtual tour by highlighting the contrast to the surrounding, industrial areas and associated noxious smells. Many participants experienced the garden as a place in the same manner that Davis described her experiences in the garden as being one of peace and tranquility. Not only did arriving at the garden site provide a respite from the virtual smoke and street smells, but leaving the garden to return to the industrial scenes created contrasting and negative emotional responses as well.

Table 4—Emotions most commonly reported on the questionnaire.

Negative Emotions			Positive Emotions	
depression	fear	terror	calm	pleasure
anxiety	disgust	tense	tranquil	close to nature
sketchy	nervous	disturbed	happy	nostalgic
uncomfortable	gloomy	claustrophobic	peaceful	

Participants who experienced an emotional response as a result of the demonstration were asked to expand upon those feelings and perceptions (see Table 4). The majority of the responses included at least one positive emotional reaction; however, each response with a positive emotion included at least one negative emotion as well. This aligns well with the focus groups who highlighted how the contrast between the positive and the negatively perceived places in the scenes helped shape the overall experience of multiple, unique places within the virtual scenes.

The most common negative emotive responses were those where terms such as anxious, depressed, and fearful were recorded. Many of the responses were quite elaborate and included information as to when the participant felt such feelings. Several felt fearful when they left the garden area near Davis’s home and entered the darker, industrial areas which were denoted by the sound of a faster heartbeat. Feelings of anxiety were also most common near the factory which made respondents “want to leave” that area. In contrast, the most common positive emotional responses were recorded by terms such as peace, happiness and nostalgia, which were experienced most often in the garden area. Nostalgia varied between respondents with some stating that they felt nostalgic with the animals roaming about the street, while others described feeling nostalgic when experiencing the smell of wood smoke. Two other responses to the emotion question were unique because they dealt with a physical experience rather than a strictly mental, emotional response. One answer stated that s/he “felt

like I was about to have a panic attack.” Another response included feeling claustrophobic.

Further analysis of the group discussions suggests that participants were less impacted by the visual stimuli and much more so by the smells. Even while surrounded by three, 10’x10’ projection screens, participants appeared to give only marginal thought to the visual aspects of the virtual place. Although unexpected technical glitches caused the frame rate to remain below 5 fps throughout most of the demonstrations, strikingly, this had minimal impact on the participant’s experience of place. Through the suspension of belief stimulated by the immersive experience and the addition of smell and sound, participants clearly experienced a place in time. Even though the virtual environment resembled a time and place that no participant had ever experienced, according to the respondents, the evocative nature of the scents afforded a marked and enhanced experience of place. Much like the perceived experience of walking, some sensory stimuli worked against another, as in the case of the garden. On three, separate occasions, the garden was mentioned as being a positive area specifically because the iron mill was not audible in that area. However, upon review of the scene, that statement about sound was found to be incorrect. When closest to the factory, the

Figure 7—The volume of the iron mill (95%) when the listener/camera was closest to the factory

Figure 8—The volume of the iron mill (55%) when the listener/camera was in the garden area.

sound was only 40% louder than it was when in the area of the garden, as shown in the sound graphs in Figures 7-8. The garden area with the fresh cut, floral scent in this case provided a particularly strong, geosensory experience.

Embodied aspects of experience were marked by the emotional responses that participants disclosed both in the focus groups and in the questionnaires. The power of emotion can be seen by the statements surrounding the physical and mental responses to various scents in the virtual tour. The mention of wanting to cough, of not breathing fully, and feeling sickened show how olfaction affected the experience of place in a geo-virtual environment that certainly transcends the response evoked by a traditional GIS presentation. Even with increased familiarity with first- person style media, such as video games and virtual reality headpieces, the participants in this study had no embodied sense of agency, yet they still experienced the space and place as if they were there. A lack of agency was observed in the participants' wanting to leave and wanting to get out of certain places in the scene. Even though everyone was given the option to leave the demonstration at any time, some went as far as reporting that they wouldn't take a full breath until they reached the virtual garden.

Throughout all the participant feedback, the sparse focus on visual representations was surprising and suggests strong support and validity of the research and use of a non-representational approach to enhance one's sense of place in a sensuous GIS environment. In reality, it may be that the focus groups reacted more to the emphasis of my research into smell. Nonetheless, examining the discussion feedback from these groups, alongside the statistical results, shows that an understanding of place would indeed seem to be enhanced when olfactory stimuli are added.

CHAPTER 5—CONCLUSION

The incorporation of olfactory stimulation into an immersive, geosensory environment enhanced the experience and sense of place. Although a traditional GIS presentation is central to understanding and representing space, it does not capture or recreate the embodied experience of place. Through a virtual demonstration, participants in this study experienced perceptual and emotional responses to the presentation. The scents provided an evocative, intangible experience of historic Wheeling, WV which could not be achieved by visuals alone. Utilizing the intimate, local scale at which human olfaction occurs, each participant was afforded his/her own unique experience of the place that was Wheeling.

Although there was a consensus among most participants that the scents and visuals were congruent, each person seemingly had a unique and personal experience of embodiment within the virtual space. A sense of embodiment was evidenced by people's responses to differing perceptions upon the introduction of scent. The ways in which scent in certain areas of the scene sparked emotions indicate how the participants felt embodied experiences of place. Even though there was no risk associated with going down a virtual, dark alleyway of nineteenth century Wheeling, the perceived danger and shared experiences of the person in that environment demonstrates the power of olfactory stimulation on a person's experience of place.

Focusing on the experiential phenomena, future research will benefit from an informed understanding of how place is experienced in a virtual setting that is increasingly accessible through virtual reality devices, such as the Gear VR by Samsung. This would afford researchers the ability to provide a personalized visual experience to a large group of participants simultaneously (Buonincontri and Marasco, 2017). Utilizing the capabilities of the smartphone,

which serves as the screen in a Gear VR device, a study could be set up in which scent devices were automatically activated as a person approaches an area within the scene. Although this comes at the cumbersome expense of requiring a person to strap a phone adjacent to their face, real-time location data collected by the phone could be used to better understand a person's behavior in response to various scents by allowing the researcher to tailor prompts during the focus group toward addressing that behavior.

The ability to better incorporate a sense of place into spatial analysis will facilitate new inquiries into how place is experienced and the sense of place that is created. Emerging fields of geographic study that emphasize experience, such as deep mapping (Harris, 2015), are poised to incorporate olfaction into their studies. The way in which the individuality of each participant's experience was most evident in the interactions with the olfactory components exemplifies how scent can transform one's sense of place. Intangible aspects of place, such as emotion, memory, and perception, align with the ways in which deep maps seek to engage people in a spatial narrative (Bodenhamer, Corrigan, and Harris, 2015). Additional research should employ a multicomponent measure of sense of place which incorporates both qualitative and quantitative responses.

Monitoring participants' physiological responses, such as heart rate and respiratory rate, to different smells could have enhanced this study. Because emotions, such as fear, typically evoke involuntary, biological changes, these variables could be quite valuable when analyzing a person's physiological immersive experience. Supplementary participant characteristics such as ethnicity, sex, and age are also desirable criteria as they may correlate to olfactory performance and immersive experience. Due to the sensitive nature of these data, restrictions are in place that require exponentially increased IRB coordination and health professional

supervision and are beyond the focus of this study. In addition, a deeper discussion into the psychological processes at play in this study could bolster an explanation of the drivers behind each participant's reaction(s) during the demonstration. Reviewing the specific neurological processes involved in this type of demonstration could yield a better understanding of the concept of agency and its role in the participant experience (Haggard and Chambon, 2012).

The expansion of olfactory stimulation in geography has the potential to develop further beyond theoretical research and into daily practice. As technology progresses, scents will become increasingly valuable in geographic applications. In urban planning, developers could provide scents to complement their proposals of a new greenspace or street market. Multisensory displays would allow policy makers to personally gauge whether or not a proposed development creates the desired sense of place for their constituents. Inclusion of olfactory stimulation could transform the way in which people consume spatial data and contribute to an evocative experience of place.

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APPENDIX

Figure A1—IRB Consent form completed by participant and co-investigator at time of testing

West Virginia University OFFICE OF RESEARCH INTEGRITY & COMPLIANCE	Human Research Protocol Only Minimal Risk Consent Form Without HIPAA
Only Minimal Risk Consent Information Form (without HIPAA)			
Principal Investigator	Dr. Trevor Harris		
Department	Geology and Geography		
Protocol Number	1502602800		
Study Title	How smells impact a person's sense of place in a virtual environment		
Co-Investigator(s)	Mr. Aaron Ferrari		
Sponsor (if any)			
Contact Persons			
In the event you experience any side effects or injury related to this research, or if you have any questions, concerns, or complaints about this research you should contact Dr. Trevor Harris at (304) 293-3171.			
For information regarding your rights as a research subject, to discuss problems, concerns, or suggestions related to the research, to obtain information or offer input about the research, contact the Office of Research Integrity & Compliance at (304) 293-7073.			
In addition if you would like to discuss problems, concerns, have suggestions related to research, or would like to offer input about the research, contact the Office of Research Integrity and Compliance at 304-293-7073.			
Introduction			
You, _____, have been asked to participate in this research study, which has been explained to you by Aaron Ferrari. This study is being conducted by Aaron Ferrari in the Department of Geology and Geography at West Virginia University with funding provided by Dr. Trevor Harris.			
Purpose(s) of the Study			
The purpose of this study is to explore the influence of olfactory stimulation on a person's understanding and experience of place in an immersive, geosensory environment.			
Phone: 304-293-7073 Fax: 304-293-3098 http://oric.research.wvu.edu		Chestnut Ridge Research Building 886 Chestnut Ridge Road PO Box 6845 Morgantown, WV 26506-6845	Page 1 Subject's Initials _____ Date _____

Description of Procedures

This study involves you experiencing a 3D virtual representation of a historic town and will take approximately 10 minutes for you to complete. You will be asked to fill out a questionnaire and participate in a brief focus group discussion regarding your experience and perception of the virtual place. This will take approximately 30 minutes. You do not have to answer all the questions. You will have the opportunity to see the questionnaire before signing this consent form.

Discomforts

There are no known or expected risks from participating in this study, except for the mild frustration associated with answering the questions.

Alternatives

You do not have to participate in this study.

Benefits

You may not receive any direct benefit from this study. The knowledge gained from this study may eventually benefit others.

Financial Considerations

There are no special fees for participating in this study.

Confidentiality

Any information about you that is obtained as a result of your participation in this research will be kept as confidential as legally possible. Your research records and test results, just like hospital records, may be subpoenaed by court order or may be inspected by the study sponsor or federal regulatory authorities (including the FDA if applicable) without your additional consent.

In addition, there are certain instances where the researcher is legally required to give information to the appropriate authorities. These would include mandatory reporting of infectious diseases, mandatory reporting of information about behavior that is imminently dangerous to your child or to others, such as suicide, child abuse, etc.

Audiotapes or videotapes will be kept locked up and will be destroyed as soon as possible after the research is finished. In any publications that result from this research, neither your name nor any information from which you might be identified will be published without your consent.

Voluntary Participation

In the event new information becomes available that may affect your willingness to participate in this study, this information will be given to you so that you can make an informed decision about whether or not to continue your participation.

You have been given the opportunity to ask questions about the research, and you have received answers concerning areas you did not understand.

Upon signing this form, you will receive a copy.

I willingly consent to participate in this research.

Signatures

Signature of Subject

Printed Name

Date

Time

The participant has had the opportunity to have questions addressed. The participant willingly agrees to be in the study.

Signature of Investigator or Co-Investigator

Printed Name

Date

Time

Figure A2—Document of counseling services available outside of the University operated counseling services available to those who may experience negative mental effects

COUNSELING COMMUNITY REFERRALS

<p>ATN = Aetna AWW = Access WV BCBS = Blue Cross Blue Shield CHC = Coventry Health Care</p>	<p>GS = Geisinger PM = Primark P/SP/ON = Private/Self Pay/Out of Network</p>	<p>THP = The Health Plan TRIC = TRICARE UHC = United HealthCare ** = not handicap accessib</p>
<p><u>APO Counseling **</u> (304) 284-8438 1553 Stewartstown Road, Morgantown Accepts: ATN, BCBS, CIGNA, PEIA, THP Accessible by bus from campus</p>		<p><u>Fremouw-Sigley Psychological Associates</u> (304) 598-2300 1224B Pineview Drive, Morgantown Accepts: ATN, BCBS, CHIP, CIGNA, GS, Medicare, PEIA, THP, UHC Accessible by bus from campus</p>
<p><u>Bruceton Medical Center</u> (304) 379-7600 198 Morgantown Street Suite B, Bruceton Mills Accepts: ATN, BCBS, CHIP, PEIA, P/SP/ON, PM, AWW Accessible by car from campus</p>		<p><u>Holly Thomas, PLLC</u> (304) 362-6647 235 High Street Suite 701, Morgantown Accepts: BCBS, GS, PEIA Accessible by walking, bus, or PRT from campus</p>
<p><u>Caitlin's Counseling Services **</u> (304) 276-0601 3461 University Ave Suite 6, Morgantown Accepts: BCBS, GS, PEIA, TRIC Accessible by car from campus</p>		<p><u>Impact Therapy Institute **</u> (304) 599-0109 457 Broadway Ave., Morgantown Accepts: P/SP/ON Accessible by bus from campus</p>
<p><u>Chestnut Ridge Center</u> (304) 590-6400 930 Chestnut Ridge Road, Morgantown Accepts: most insurance Accessible by bus or PRT from campus</p>		<p><u>Intuitive Wellness LLC</u> (304) 534-9355 300 Second Street Suite 1, Fairmont Accepts: ATN, BCBS, CHIP, CHC, Medicare, PEIA, P/SP/ON, THP, TRIC, MHNNet Accessible by car from campus</p>
<p><u>Christian Counseling Services of Morgantown</u> (304) 594-3473 2223 Cheat Road, Morgantown Accepts: ATN, BCBS, CHIP, CIGNA, CHC, GS, Humana, MultiPlan, PEIA, P/SP/ON, THP, UHC Accessible by bus from campus</p>		<p><u>Jamie Downs **</u> (304) 680-7003 3461 University Ave. Suite 102, Morgantown Accepts: BCBS, CHIPS, GS, PEIA, P/SP/ON Accessible by walking, bus, or PRT from campus</p>
<p><u>Chrysalis Integrative Healing and Wellness</u> (304) 249-3335 235 High Street Suite 808, Morgantown Accepts: ATN, BCBS, GS, PEIA Accessible by walking, bus, or PRT from campus</p>		<p><u>Jonathan Pishner **</u> (304) 685-4103 160 Fayette St. Suite 206, Morgantown Accepts: BCBS, PEIA, TRIC, P/SP/ON Accessible by walking, bus, or PRT from campus</p>
<p><u>Cynthia Hite</u> (304) 296-3111 235 High Street Suite 821, Morgantown Accepts: ATN, BCBS, PEIA, TRIC Accessible by walking, bus, or PRT from campus</p>		<p><u>Kostka Associates</u> (304) 296-4512 1553 Stewartstown Road, Morgantown Accepts: BCBS, Humana, TRIC, Health Smart Accessible by bus from campus</p>
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Morgantown Counseling

(304) 519-4030

874 Fairmont Avenue Suite C, Morgantown

Accepts: BCBS, GS, MultiPlan, PEIA, P/SP/ON, THP, UHC

Accessible by bus from campus

Morgantown Mental Health

(304) 599-1816

1193 Pineview Drive, Morgantown

Accepts: ATN, BCBS, CIGNA, CHC, GS, Humana, PEIA, THP

Accessible by bus or PRT from campus

Morgantown Pastoral Counseling

(304) 599-5751

1062 Maple Drive Suite 1, Morgantown

Accepts: ATN, BCBS, CIGNA, Humana, Medicare

Accessible by bus from campus

Positive Impact Counseling Services, PLLC **

(304) 777-6262

3000 Hampton Center Suite C, Morgantown

Accepts: BCBS, GS, PEIA, THP, Stratos/Foremost

PSIMED Morgantown

(304) 470-4284

3040 University Avenue Suite 3308, Morgantown

Accepts: ATN, BCBS, GS, PEIA, THP

Accessible by walking, bus, or PRT from campus

Psychology Associates, PLLC

(304) 681-4168

1286 Suncrest Towne Center West Entrance, 2nd Floor, Morgantown

Accepts: BCBS, PEIA

Accessible by car from campus

Psychotherapy Services of Morgantown, PLLC

(304) 685-4631

1286 Suncrest Town Center Drive West Entrance, 2nd Floor, Morgantown

Accepts: BCBS, GS, Medicare, MultiPlan, PEIA, P/SP/ON, TRIC

Accessible by car from campus

Sandra Perine **

(304) 292-3575

370 Scott Avenue, Morgantown

Accepts: BCBS, GS, PEIA, UHC

Accessible by bus from campus

Terry Chapman & Shannon Waliser **

(304) 363-4265

207 Fairmont Avenue Suite 2/Suite 3, Fairmont

Accepts: BCBS, CHIP, PEIA, THP, TRIC

Accessible by car from campus

Theresa Williams

(304) 216-1160

816 Somerset Street, Morgantown

Accepts: ATN, BCBS, GS, PEIA, THP

Accessible by bus from campus

TIMKO Counseling Services, LLC

(304) 841-0108

300 2nd Street Suite 1, Fairmont

Accepts: ATN, BCBS, ComPsych, CHC, GS, PEIA, P/SP/ON, UHC, Optum Health

Accessible by car from campus

United Summit Center

(304) 241-1708

40 Commerce Drive Suite B, Westover

Accepts: ATN, BCBS, SHIP, CIGNA, CHC, GS, Humana, PEIA, THP, TRIC, UHC, WV Medicaid, Value Options, Champus, Mental Health Network, Stratos/Foremost, AARP, Mutual of Omaha

Accessible by bus from campus

Valerie Stansberry **

(304) 290-0333 or (304) 291-9491

709 Beechurst Avenue Suite 14-B, Morgantown

Accepts: ATN, BCBS, CIGNA, GS, PEIA, UHC

Accessible by walking, bus, or PRT from campus

Valley HealthCare System

(304) 296-1731

301 Scott Avenue, Morgantown

Accepts: Most insurance

Accessible by bus from campus

Wedgewood Family Practice

(304) 599-1975

613 Burroughs Street, Morgantown

Accepts: BCBS, CHIP, ComPsych, GS, PEIA, P/SP/ON, THP, UHC

Accessible by bus or PRT from campus

West Virginia Family Grief Center

(304) 282-4935

361 Scott Avenue, Morgantown

Accessible by bus from campus

Women in Balance, Counseling & Life Coaching

(304) 241-1097

3000 Coombs Farm Drive Suite 102, Morgantown

Accepts: ATN, BCBS, CIGNA, GS, PEIA, P/SP/ON, THP, UHC

Accessible by bus from campus

Figure A3—Document of health services available to students who experience negative, emotional or psychological effects as a result of the demonstration

List of health services available to students

WELLWVU Carruth Center for Psychological and Psychiatric Services

Phone: 304-293-4431

Email: vvucccps@mail.wvu.edu

Web: <http://well.wvu.edu/ccpps>

Drop-In Hours (Monday-Friday 9:00am-4:00pm)

Location: Health and Education Building

390 Birch Street

PO Box 6422

Morgantown, WV 26506-6422

Directions to CCPPS from here:

PRT: Take PRT from Beechurst to Towers. After exiting PRT platform, turn left. CCPPS is located in the CPASS building 500 ft ahead on the right.

Mountainline Bus: Take bus 38 from Grant & 1st St to WVU Rec Center. Cross the street. CCPPS is located in the CPASS building 750 ft ahead on the right.

Driving: Head north on Beechurst Ave (US 19/WV 7) toward the Coliseum. Turn right at light at top of hill onto Patteson Dr. Turn right at next light. Follow signs to Health and Education Building Parking.

**Figure A4—
Looking down
Main Street
away from
the factory
and church**

**Figure A5—
The barn
below Main
Street**

**Figure A6—
The
blacksmith
shop located
behind
buildings on
Main Street**

**Figure A7—
Garden area
behind
Davis's home**

**Figure A8—
Ancillary
buildings that
surround
Main Street**

**Figure A9—
Approach to
the factory**

Figure A10—
The tour began at the green dot in the center of the image and goes down along the central street. At the end of the street, the tour turns and approaches the barn. After the barn, the tour turns again behind the main street buildings and passes by the blacksmith shop before crossing the main street and arriving at the garden respite. From there, the group is taken into the dark buildings on the outskirts before passing along the large, black iron mill structures. The tour ends upon its return past the church to the starting point.

Figure A11—
Sensory stimuli
experienced
during the tour.

A4—(Begin) The tour starts with several sounds of people talking and laughing, animal sounds, church bells, and the iron mill. The iron mill and church bells fade over time. A5—The barn includes mooing, clucking and bleating, while street noises become faint. A6—The blacksmith loudly hammers as the lumber mill, street sounds and iron mill grow. A7—Street noise is replaced with quiet, bird chirps and church bells. The iron mill continues to increase in sound. A8—A heart beats loudly as iron mill looms. A9—The iron mill sound plateaus for a while until it begins to decline as the church bells and main street sounds rebound.

The transcription of each focus group discussion is included in the following section of the Appendix. Comments by the facilitator (PI or Co-I) are *italicized*.

Group 1

What did you think of the wheeling scene first of all in unity?

Did you get a feel for the place?

It's kind of depressing.

Did the scene reinforce the reading?

Yeah

Like even regarding the garden I guess that's supposed to be nice?

Did you sense a better understanding of wheeling?

most nod in agreement

You can reference the questionnaire it may help in the discussion.

Based on the reading, how did the scene look like compared to what you expected by hearing the reading alone?

Anything you expected to see that you didn't see.

You mentioned how it was a clear day, but I could still see clouds. Was a little offsetting. I noticed that.

Oh yeah! It was depressing

Anyone else feel different emotional responses

When you were reading I couldn't really visualize it being so dark even when the sun was out. Actually seeing it helped me understand that better.

When the heartbeat started going up, I started feeling stressed out.

With the heartbeat going the first time without any scents, I was terrified. The garden made it worse! But once I could smell the tree scents idk it was like a freshly cut kind of scent. I felt okay then. But was terrified without that smell.

Also the rumblings of the iron mill was pretty intense.

So, based on your answer to the dis/agree questions, why do you think your sense of place in virtual wheeling was changed by the addition of the scents?

It was more realistic.

You get to smell like walking around the town. You get a sense of what [the people in that place] were experiencing. The iron mill was also...like the chimneys over the town and the livestock and everything.

Do you feel like the scents matched what you were seeing?

Oh yeah!

I actually wanted to cough when I smelled the smoke scent.

Was there ever a time that you felt like the scents did not match up?

I thought maybe in the beginning there was a more plastic type of scent from the machine. During some of the transitions, the previous scent would linger for a bit. *Could you explain any specific components aspects that were the most powerful in giving you a sense of place?*

There was a visual looming iron mills over the town.

The heartbeat helped me feel what you're supposed to feel. Like otherwise you wouldn't really know if that was a dangerous place or not.

So it helped you realize it was an unsafe place?

Yeah

It gave me a sense of place when you got close to the iron mills the sound getting louder and the smell of the actual mills enhanced what I was feeling.

And the sound of the blacksmith. That helped me realize okay someone is actually hammering so yeah that is a blacksmith!

Are there any ways you would suggest this geosensory scene could be enhanced or improved to enhance sense of place?

Is there a way to do two scents at once? Like when we were going into the garden it went from smelling like iron furnace straight to smelling like a garden. A better transition or a mixing of the smells would better represent the real place.

And the fact that like we knew the changes in scents were coming. It would be better if we weren't expecting the changes.

Maybe we could do it from behind so you wouldn't see that?

If you do it from behind or a higher angle pointing down?

You could even have a ladder in the back. That would work because we were staring at the screens. We weren't paying attention to the surroundings.

If everyone were inside the CAVE it would help.

So, how many scents did you identify?

three concurrent responses 4, 3, 4

I thought the first was livestock, the garden was one, distinct smell. Then it smelled like woodfire. The last one smelled like a coal or iron furnace.

It is actually called oily chemical.

Yeah!

The 5th one wasn't used. It's wrapped up pretty tight.

I was waiting for that bad one.

So some people said 3 some said 4.

Overall did the scents enhance your sense of immersion?

I got 3.

Yeah I think so

Definitely.

Yeah.

Significantly?

Yeah I think they did.

Which did you think was most significant. Visual. sound. smell. Rank them.

I think sound was a big factor.

I would put sound, smell, visual.

Sound. Smell. Visual.

Visual was last?

It's there, but the sound was like the first thing that you got. Then you bring in the sense of smell and it was more so than the eyes.

What smell immersed you the most?

Livestock for sure.

I thought the last one. The oily chemicals.

I thought the garden because it was the only one that smelled good. The rest of them were kinda unpleasant.

Which sound was the most effective for you?

The beating heart was good. And the clanking of the iron mills. I feel like I can still hear it in my head.

concurrent with previous comment I could still hear it!

Even when it ended, I could still kinda hear it ringing.

I think the church bells were a little bit too much. Maybe they were too loud. Like when we were by the livestock, the church was a little louder than the animals.

A lot of the places were close to the church though in Davis's description.

Having smells get stronger or weaker with distance may help some.

Our hesitance is due to our not knowing when the smell has been detected by you all when at a distance.

On a scale from -5 to +5 how much did the smell increase your sense of immersion?

I gave it a +3.

Yeah I gave it a +4.

I said +3.

I gave a +4.

Okay this is good and supports further testing.

Are there any ways you can think to improve this?

So you definitely felt an improvement in your sense of place?

Oh yeah!

all nod in agreement

Group 2

How did the scene compare to your expectations of historic Wheeling based on extracts from the book?

It was pretty much exact.

Yeah.

What I was picturing when you were reading it.

I expected things to be even a little bit more compact. I expected the streets wouldn't be as open.

But in general it was what you expected.

How do you think introduction of scents contributed to your experience of the virtual wheeling tour?

I think it felt kinda realistic?

It felt very realistic. I think it helped.

I think before they were introduced like I felt like I was there but then as soon as you brought out the smell it was even more. Absolutely. Like it was just another experience added to it. Like, you could see it but as soon as you could smell it, it really like put you on the street. You get a better understanding of what was really around you.

It definitely made me feel like...It made me a feel the feeling of you're outdoors. You know what I mean.

Which I think is kinda difficult in these types of virtual reality situations.

So would you say it reinforced or detracted from your sense of place?

All—Reinforced

Why do you think that?

Just giving you another aspect of it, back to what I was saying earlier, like you know you are inside when you're looking at it, but when you get the smells, you feel like you're not standing in a room, like you're actually on the screens

It puts you there rather than the 1st floor of brooks hall?
Right.

So, basically what you're saying is the scents increased your sense of being immersed within the scene?

Yeah

Definitely

Were there any parts of the virtual tour that reminded you of a previous experience or maybe a memory from your past?

Um, I spent a few days in Tuscany in the fall, and they had a lot of woodsmoke, and it brought that back in a sense, the woodsmoke.

Like being over by the barn and the animals, it brought that back like as soon as I smelled it. Like, driving down a country road, you're just, that's a smell that just hits you no matter where you are.

Did you feel like...any emotions associated with that memory or...?

When we were in over by the garden, it was like that nice smell, it almost like...I smiled when I smelled it. It was almost like you were happy cause you walk through and everything was dark, everything, but when we got to that place and you introduced the smell, it was like, okay there is a nice place here somewhere. The smell really made it...I was happier.

Especially like the bright greens, it was good!

It was relaxing.

It was the contrast for me that really made it so strong.

Which is what she was trying to get at in the book. Any other times you felt different emotions or the transition between the garden, did you feel different?

You could definitely tell why she felt more fear the further she went from where she lived. And adding the heartbeat really helped portray that

When we were starting to get away from the garden, I almost felt tense, like as we were walking through, it just didn't feel comfortable, walking through the streets.

Yeah

The dark alleys, yeah

So, why do you think your sense of place changed when we added the scents?

I think we as humans define place by all of our senses.

Yeah, so it's just kind of there.

The more senses you can get out of it, the more connection you have with it.

Are there any ways you would suggest the virtual tour of wheeling could be enhanced or improved to give an even greater sense of place?

I have no clue if it is possible or not, but like, with the mills and everything rumbling, if there was a vibration or something out there that would let you feel it, you can kind of get a sense of it with the noise like with the bass.

Climate control? Cause it was nice and comfortable in the room. But like if it were autumn or something, im not sure, but like if it were colder, or warmer? Or like wind!

I could increase the volume and bass?

Yeah

We have looked into additional senses, but the tactile force feedback that really merited getting that for the purpose of this study.

Could you discuss any components specific images or sounds or smells in the tour that really made you, you felt were the most powerful in effecting your sense of place.

The people's faces were more realistic than I was anticipating.

The fact that as you got closer to a group of people you could hear them muttering things and as you got closer to them you could hear more clearly what they were talking about.

Right

The garden scene, that's where I felt the biggest contrast, that's where I felt where I was.

I think the smoke, and the way it moves, it seems to move accurately physically.

I don't know if you have tried to model that type of thing in a GIS, it doesn't give the same effect that it does here.

You mentioned the contrast is what made it so powerful. Because it was so different

Because the garden compared to everything else was such a small area, that really helps. Everything else, Because 99% of the place was dark, there was an attitude of it being gloomy, not happy, and there was that one area that was so small, but it had such an effect on everything else.

If you were to rank the most significant factors between the visual sound and smell, how would you place them and why?

That's tough,

Yeah that's okay.

Even if there were any particular sounds or smells that came out stronger that you would put first in some cases?

I would say the visual in some places was the prime thing,

Yeah, it definitely was more...

Then I would go smell after that. Just because it gave you more.

I think part of it might be because we are used to hearing sounds that are more artificial you know we are less likely to interact with them. I don't know if artificial is the right word, but mimicked I guess, smells were better.

I would suggest the visual is the typical interface you use for interacting with data.

Right. Typically it is just something that is right in front of you. But this is in front of you and beside you. It totally wraps you around.

So you said sound in general would be at the end...?

Yeah.

Anything else as to why you felt that way?

I think there are other sounds in the room that are masked out. It is hard to separate the experience sounds from the room sounds.

Right.

Which we cannot change unfortunately.

I think smell is just more of a.....a.....sensitive sense.

Uh-huh.

When I smell something, I get more out of it, I almost, ALMOST more than seeing it. If I smell something, I can picture it, if I have my eyes closed and I smell something, I can picture it. It is different for sounds.

My research has shown that smell is the most intimate sense as we have to take air into our bodies in order to detect anything.

So, we discussed when smell dominated the immersive experience.

Anything else?

Group 3

What did you guys think? How did the scene compare to your expectations of historic wheeling based on what I read from the book?

I thought that what she said about the foul effluvia and stuff. It was hard to get a sense of what it would be like to be walking around because the ground was just brown and it is hard to feel walking through the mud.

Right. So the terrain didn't match what you expected?
Yeah or her description of the terrain being messy and dirty, I didn't get that from the virtual scene.

Okay.

I really think you could tell about the fog, dust, soot feeling,

The dirty?

When I heard the sound, I felt like I was more into the scene.

When I smelled the smell, I felt more into the scene. It was the second stage for me. Rather than just seeing the screen, like, I watched videos, but I always don't get into the scene.

Right

Here when I see the moving landscape and the sound like the meadow sound or the animal sound. It gets me more close to the scene.

The dynamic aspect gets it?

Yeah

I didn't get a sense of the smoke until we stood in the alley.

When we stood in place?

Yeah. Yeah. because when we were moving through the street I didn't see it moving at all.

Right.

But when we stood in the alley, the reference of the wall, you could see it rolling across. And the sound like *NAME* said, when you go from the church to the barn to the blacksmith to the iron mill, all those sound changes made you feel like you actually went somewhere.

So you would say the sound helped define the different places within the tour?

Yeah. Yes.

Sometimes I closed my eyes and I was really into the scene.

Without looking?

Yeah. Because when I open my eyes, I know that it is something like fake space.

Yeah. Yeah

You know you're in Brooks Hall and not there?

Yeah.

I closed my eyes for the heartbeat portion too and I thought that was interesting too. I don't know if you

noticed but the floor had like a haptic heartbeat feeling of her heartbeat.

Huh?

I didn't have shoes on and I could feel it like it was my own heartbeat.

Interesting.

Yeah I took my shoes off and that was a new experience for me.

Was there anything in the scene that made you think of a previous experience or memory?

Yeah.

Do you care to elaborate?

Yeah, especially the animal sounds like the cows and the birds I felt like I was walking in a village. I had some experience when I remembered those sounds.

I smelled the flowers were good.

Yeah that was good.

The flowers were the best one. That's the one that made me feel like, Ahhh its spring!

The barnyard smell was like similarly sickening to an actual barnyard smell so I was really ready for it to be over by the time it was gone.

Right.

Which works because that's how it is when you first arrive to a big pigpen or something you can hardly handle it once you're there.

I didn't even notice, I could smell that one but I didn't even notice it as much. But maybe that's because I grew up around those kinds of animals. But I did notice the last one, the um, oily chemical one. Yeah I was ready for that to be over.

So, for those of you who it did remind you of something else, did you experience any type of emotions with that?

Did it make you feel different?

Yeah. When I closed my eyes, I felt the emotion, but when I looked with my eyes I didn't realize those things. Were you like nostalgic about being in a village?

Yeah.

Yeah so it kind of really took you there.

So I really closed my eyes for a while.

Yeah that's cool.

So basically you're saying the visual detracted from your experience?

Yeah. for me.

I would say the same for me too. The sounds and the smells were much stronger than the visuals.

So, how would you say the introduction of scents contributed to your experience of the virtual tour of wheeling and how did it enhance or detract from your sense of place?

It enhanced it.

Why do you think it did that?

It helps show how hard it would be to breathe with all of the smells and all of the fog, it was like it could be suffocating if you didn't like the smells.

Were you getting that too? Where you didn't want to take a full breath?

Yeah I was like ehhhhhhh

Yeah! I was like not breathing fully because I was like, I didn't want a huge breath about all these things.

And then you took us to the window scene with the flowers and that was good

That was a good break.

Yeah!

All chuckle

It was like, yeah you can breathe here.

Uh huh.

So, the contrast between the garden and the other areas. What do you think about that, was it strong or maybe it helped?

It was very strong.

Yeah for me it was very strong!

I also thought the blacksmith. I did like what [a participant] did when the blacksmith was pounding. And as soon as I smelled like that campfire smell, it totally brought like a different sense.

Right.

I don't know if it was like more place or less place but it just kind of brought it all together when I smelled the wood burning

The smell was just really significant in changing your experience?

Yeah I and I think the smell changed too. Cause before that I didn't have any of that then all I had was that wood smoke and that really got it.

Okay that's good.

So how would you say, to what extent did the smells increase or decrease your being immersed within the scene?

Well, I have a terrible sense of smell so I couldn't differentiate between a lot of them. But they made a difference. I think the garden one was too artificial and it didn't do anything for me.

Okay.

But the other just walking through the town, they made a difference for me.

In the immersive aspect?

Yeah.

They all made a difference for me. I think just smelling something. Just hearing something.

They all made a positive impact?

Well...

On being immersed?

On being immersed, yes. On enjoying them, not as much.

Right.

I had a feeling like, my brain is always trying with the visual things like, seeing a scene or reading a book, what definitely, when I'm exposed to different senses when I'm hearing something and then, especially the background words, briefing the scene?

Yes.

It was like relating your mind. It's not like the audio is added to this video. That was really helpful to get into the scene. It really increased my immersiveness in the scene.

So having more context helped?

Yeah.

Other than the smell, what it reminded me of was the old old classic Disney cartoons with like the sounds and the smells. That's what it seemed like for me.

So, if you don't mind, try to discuss any specific components, certain images, sounds or smells, that you felt were the most effective in changing or influencing your sense of place?

I would say for me the number one was the heartbeat sounds. Then we walked into these things with like strange black boxes.

Right.

Everything else was kind of colorful with signs on it or windows but we were in sort of a dark alley.

That was when that nasty last smell came.

Right! That was when the machine oil smell came.

Yeah that was really, I was like, I need to get out of here.

So you felt sort of unsafe?

I felt anxious. Like, I want to get out of here.

Any other places within the scene or sounds that made you, made you remember or change your sense of place.

The further you got away from the people, the scarier it got. When no one was around and it was dark, it was pretty scary.

So fewer people made you feel more?

Yes. I paid attention at least to them more.

Even though they were just standing, they still were powerful.

Yes.

So, if you were to rank the most significant things in the virtual scene between the visual the sound and the smell, how would you rank them?

So like which is 1st 2nd 3rd?

Yes. For most influential in your experience.

For me it would go, sound 1st. I was fixated on the sounds in the scene.

Yeah you don't have to choose all three.

For it me it would be the smells. Because I am really familiar with sounds.

For me also sound, because it was so clear and loud. So it really hits my brain. You're walking through some trees and some villages and some garden, then it comes smell.

Also you can kind of avoid the sights and smells a little bit, you could close your eyes or you could not inhale directly where the things are. But I still think you could feel it. But you can't completely cover your ears.

Right.

I still think you would feel it.

Sound, scene, and smell.

I would say sound and smell are tied for #1. Scene would be last.

Okay.

For me, like scent first, as well as the smoky skies, I feel like they were in there next.

Okay.

Even if maybe the sound in general was the most powerful, you could pick out any sounds that weren't as strong or more effective? Same thing for sights or smells?

I felt like some of the animal sounds weren't as good as they could've been. They just seemed a little off.

There was one moment though where the cow made a really loud noise, then there was a background cow. I really felt like I was around a bunch of cows.

Yeah.

Like there was a subtle bunch of cows then there was a really loud one that is close to you.

Right.

Even the background rumble sound, it fit in well with the dark, to me that was more outstanding than the particulars.

The ominous looming factory?

Yes.

I think the blacksmith sound worked best for me. But when you look at the visuals it's hard because the guy is just standing there not moving.

Right.

That was a little off-putting to me. But the smell was good!

How could we make the people move? Could we do that?

If we had more time or funding, or if I were an expert at animation, we would've gone into that, but it was beyond the scope of what we were able to do.

Yeah.

I think in that scene the smell was the strongest for the blacksmith.

So, you somewhat touched on this but, were there any particular times during the demo that smell dominated the immersive experience.

I think I felt like in the garden. The smell was very dominant there. I could sense it quickly compared to the others. Maybe I was standing on the other side but.

I agree with him. The garden smelled dominant. Because the garden looked so different from everything else in the scene so when the smell came out that was very different, it was like, I got that.

So, again the contrast really helped.

Yeah the garden was the most pleasant smell.

I picked up on the manure smell more and I don't think I smelled the flowers.

Okay.

I think another reason for the flower smell because over there there's no other sound over there I guess so there is nothing else to distract us only the smell I think. Compared to all the other sounds like animals and things.

Oily chemicals was very strong to me.

Yeah maybe if we had stayed in the oily chemicals longer there at the end. But I was really glad it was the end.

Right.

Because I didn't want to be in the oily chemicals any longer. It kind of smelled like chain saw bar oil.

I didn't smell barnyard.

It doesn't really smell like a real barnyard. It isn't like you just passed a bunch of cows in the country smell. It's more like ammonia and earthy. It's not quite the same thing.

Right.

So if you've smelled real barnyard before you may be thrown off by the smell.

The previous experience could have come into that.

Okay. So, were there any ways you would suggest that this virtual tour of wheeling could be enhanced or changed or improved to make an even greater sense of place?

I think maybe some temperature like maybe some hot wind or some cold. And maybe some moisture based on the temperature.

To represent the seasons maybe?

Yeah

I also think maybe being able to move around and go into the buildings maybe that would good.

Entering and exiting a building would be interesting.

Also some labels for the buildings or something like, shop or mall or something, so you don't have to explain them.

Do you have sound for a person walking like footsteps?

There could've been.

I didn't hear it that's why I was asking.

Oh okay.

I think that we considered that but it may be disjointed since we are just standing in here. So you mentioned the rumbling or pressure?

Yeah for the heartbeat you could totally hear it in the floor. Maybe the surround sound system was moving through the frame here.

Yeah there is no woofer underneath.

Right.

Based on your expectation of the reading itself, was there anything you expected but didn't get out of it?

Maybe some more people or moving people.

Anything else about the experience? General comments?

Group 4

Just, how did the scene compare to what you expected historic wheeling to be like?

I thought it would be a little bit more fresh. Better smelling

I think that it was comparable to what I expected the scene to be, I thought the scene would have more distance between objects maybe?

How do you think the introduction of smells changed your experience of the virtual wheeling?

I think that there's probably, more, I thought that the sound was a better sense of the scene sometimes than the smell. The sound overrode sometimes the smell.

But on certain scenes, the walking between is when the sound overrode it. There were certain smells that were more powerful than others. So like the flower one was more powerful. And the...I would say the manure smell was more powerful than something like the smoke was less apparent. Or more subtle?

Why do think that was it the intensity?

I thought the sounds were a little bit better than the smells because they were stronger.

Are there any particular sounds that you thought were better?

I liked when the blacksmith was working was good.

I agree the blacksmith was good. Also the church bells were good. Because you could tell where you were.

You could tell you were near a church. You could tell how close you were to the church. Because the church was in the center of the town, you could tell how far you were from the center of town because of the church bells.

As far as sounds, the blacksmith was good. And evoking...

Were the trees along the edge near a river?

Yes they were near a river.

Maybe adding the river would help.

I was thinking like the music for the scary part. The black buildings away from her house. You know it from movies so well. You automatically feel that emotion. Even though what I was watching was not scary for me, but it evokes that emotion just because that music is so....sort of a percussion sound of building, you hear it so much in movies, like the sound in jaws, that buildup, it made you feel like you're...

Were there any parts of the tour that reminded you of a previous experience or a memory of a place you had been before?

I just think the blacksmithing, but that's because I have personally watched a blacksmith work, even though I hate the smoke, but I love watching them work. I love watching that process, but I don't like the smoke and I always have to move away from the smoke to constantly watch them but avoiding the smoke.

Did you feel any physical changes based on the smoke?

Ummm....no, more just the desire to like *inaudible* where you could rotate yourself within the scene to where you...you like observing them work but you don't want to have the smoke. Like at a campfire. Nobody wants to be on the smoke side of the campfire.

Were there any times that you felt any emotions during the demo?

I felt peaceful in the park. You tend to...even though you're...you hear the birds in that time period, even though there are still sounds, it doesn't feel like you're inundated, with the noise, the machinery, you need the smells you aren't as assaulted. All the other things feel like your senses are assaulted. For some reason the park seems like it's not as either constant, like yeah the birds chirping was not constantly assaulting you're senses therefore you feel more peaceful by the time you get there you're, like oh this isn't so bad! It gives your brain, your senses a break.

Even though I think earlier you said that one of the garden smells was a strong one, that part was okay?

Yes.

Were there any other specific sights, sounds, or smells that you felt were the most powerful in affecting your sense of place?

I would say like the manure one maybe, but that's even though I know yes it makes sense in some ways, but I felt like it wasn't timed to where I thought it should've been. So I smelled it more by the pig than I did by the barn which is where you would think you would smell it. There was a disconnect.

Okay.

When you're smelling it in the street, your mind immediately goes to a barn.

Yeah the barn.

But I also think it is appropriate in the street scene, that would've been a smell of the time period.

I thought it would smell more like a barn at the barn.
If you had to rank from most powerful to least powerful the sights sounds and smells, how would you rank them and why?

I would give sound a 5 star but maybe like a 2 star for smell because I couldn't smell them as strong.

What about the sights?

Well, you knew where you were going and you knew where things were because you could see them.

You knew the sights were the primary one because you knew which direction you were observing them. The sound was maybe equal to smell in some ways. But the sound you could put more to a place sometimes. You could put where you were in relationship to the town in some ways. It's not like the sound was knowing....you could tell you were on the opposite side away from the factory

Okay.

You knew you were on the other side of the town because you could hear where you are. Versus, if you were next to them, like, you knew which direction you were with the church sound. So it's like, the sound plays a role in knowing place as far as relative to something else, but it's not equal like to smell if you were like it smelled like smoke near the blacksmith.

So it's more like your spatial location rather than place?
Yeah.

I was expecting the models to be moving.

We would have if we had more time and funding.

Then maybe they would've added some cigar smoke and maybe the woman with flowers would have almost the same smells as the places.

The one thing I was more impressed with was that it was knowing that...it was more apparent that how many smells there actually were at that time. WE have this romantic notion of some time periods but you don't actually realize what an assault on your senses that time period actually was as far as smells. Like it was more so than it is now in some ways because now we have air filters and things.

So the contrast?

Yes. That's actually why I think when we got to the park it was so *expression of relief* that's why I thought maybe the smells should have been even stronger because they really were so strong in that time period. Maybe they weren't strong enough.

I was thinking that some, during the streets, there was no sanitation. Everything was just THERE! Going into town would've overwhelmed you with smells. I think they could've been stronger because they probably would've been stronger.

Okay.

I don't know if that's anything you can control.

Right. That kinda gets at the last question here: are there any ways the virtual experience could be enhanced or any changes that could make it better?

I think that really being overwhelmed sensory-wise, being like they were. That constant industrial sound near the factories. The constant, even, you didn't necessarily get air circulation unless there was wind blowing through. Which might have actually been, like maybe having wind blowing the trees a little bit and some breeze in here.

Right.

Actually being able to feel the wind but have the constant smell, we kinda take our current situation for granted.

True.

We don't realize that about history. That it wasn't a good time to be around

Yeah

I thought about making the people move even like maybe doing background smells versus just the specific instances where it puffs out in front of you.

So like the smoke smell just always being there because it was everywhere?

Right and how that would affect the rest of the smells and how you experience them

So you would add another scent machine basically? Yes.
Something.....the best way I can explain it is like the 3d 4d movie things where it is right in front of you?

Right.

Like the rides at Disney world.

Something that is right in front of you.

That individual device, stronger intensity or taking the smell away like the sound where you hear the sound when you're up close it might give you a stronger sense of a place. Maybe more intensity or stronger gradient.

Okay.

So like having the gradient of sound but equivalent with smell?

Yeah like the coming up close would give you a better intensity.

So, the last question here, were there any times that the smell dominated your immersive experience?

No.

Not really no.

Group 5

So, how's the scene compare to your expectations of historic wheeling based on what I read from the book?

You get a sense of what it was like. You really can't know what it's like without going through it.

Right and you can try to imagine it in your head but once you walk into a GIS, there is just so much more; you're able to feel it basically.

What do you think it was, sounds, sights, or smells that really got at that?

The sounds really helped it out. Like the church bells and the factory.

I think the sounds and the smells when they were together, it really helped you understand, you could tell you were by a barn and by the animals and everything. You could smell the barn.

Like the sound of it, when we were at the fire and the iron worker

You could hear the crackling of the iron and the striking.

How much do you think the scent contributed to your virtual experience?

You can only get so much from looking at something. It gives you a better understanding of the literature, the book. Its good walking through the streets like with google street view, but it doesn't really give you a big sense of what you can learn from having the smells.

I think it is having the scents and the sounds together that is really good.

If you were in like a city where the restaurants are and walking around all the restaurants, it would give you a much better picture of what is going in if you can smell the things around you instead of just seeing the restaurant.

Yeah, when we were in the garden, it just felt more peaceful because of the smells.

Exactly.

The sounds it was like tranquil. You couldn't hear the factory.

You understood that it was like her place to get away.

That leads into the next question really well...Do you think that any parts of the virtual tour made you feel any emotions? If so, explain.

Well, emotions like, sense of tranquility, but then whenever you go to the factory, it's kinda like, negative, it's a negative feeling because it's all dirty.

When the heartbeat started as we got farther away from her house, I started feeling anxious like, I don't know what's going to happen.

Yeah

What was the heartbeat?

They made a fear map based on places where she felt uncomfortable in town.

Oh okay so more heartbeat, where she's more scared?

Yeah

She didn't like getting farther away.

It seemed like the farm was pretty tranquil too. Because everyone was like, the animals were just calm.

Honestly, not making the factory, like, you couldn't see the individual parts of the building, made it more, you could understand what she felt better, how it loomed over everything. How it was just a black space there.

As soon as it comes to your eye, it's over everything.

So, even though it wasn't modeled or detailed...

Right. It actually was better because it wasn't detailed.

I feel like the one scene of 4 or 5 set points gave you a pretty good understanding of what wheeling was like.

So, do you think, the contrast between different areas helped define different places?

Sure! You could even close your eyes and could tell where you were, you could smell and hear everything around you. So definitely it helped you get a better sense of place.

I agree with that as well.

Were there any certain times that maybe you did try to close your eyes?

The one part where you were walking down the street, that's like the only part that you couldn't understand, yeah you could hear the conversations of the people, but that was really it.

You still had to see what was going on to understand it.

Okay, so the visual was required to understand the street.

Yeah, especially in the garden part and the farm, you could really tell. Like even, what else is going to smell like flowers in 1860?

Right.

Okay.

So if you were to rank the most significant factors in the demo between visual, sound and smell, how would you rank them and why?

I think sound and smell are really close.

Yeah I feel like sound and smell are tied into each other almost.

I think sound is more for me because there were more sounds. That and it is gonna be harder to get exact smells. Smell obviously does help too...

I would still put it as visual, sound and smell, but I feel like the sounds and the smells go together. I would put them on the same height.

It makes the map so much better. I would rather do that than look at a big map for hours. It gets you a better understanding of what's going on for sure.

Were there any certain times that the experience of smell dominated your immersive experience?

Maybe walking through the street for me.

It smelled a little like garbage but it was

It was garbage, but it was like, foul, like I don't know

It smelled like a music festival to me.

Okay.

It smelled like when you're standing in the port-a-potty line at a music festival.

Yeah when you're tailgating.

Or the blue lot?

Or it could be both ways, it could be, that smell could be a that smell could be like a bad experience in life, but when you're talking about the flowers; it is a good experience. It's still the same but it still makes you understand it the same but they are different.

The contrast?

Yeah.

Were there any ways you would suggest the virtual tour could be enhanced or improved to provide an even greater sense of place.

Temperature.

Temperature would have been one, like when we were by the fire if it got hot.

Yeah and like the factory, in the shadows it would have been colder.

This is gonna sound ridiculous but it would be sweet if you had like a treadmill so you really felt like you were walking.

There is a grad student working on doing something like that actually where the walking would correspond to the surrounding images.

How long have you worked on this?
More than a year ago we started.

How much farther do you have to go?

This is the end for me for now at least.

Well there is always more that could be added on.

But this is one of the coolest things I've ever seen in my life.

Especially in geography you wouldn't imagine it.

Yeah, exactly. It seems more like video games than geography almost!

They do use it for video game development.

Really?

Yeah

It's like you took something that would be hard to understand and you made it easy for everybody
You made a book come to life essentially.

Right. That's kinda the goal essentially.

So, what were the smells?

1st barnyard livestock, 2 woodfire, 3 fresh cut grass, 4 oily chemicals

Fresh cut grass seemed more like flowers.

It definitely smelled like the outside.

Anything else?

Group 6—Only 1 participant took part in this group which resulted in limited discussion which began during his/her completion of the questionnaire.

I'm not sure what emotions means? Are you talking about if you feel like foul or disgusted or something?

Just like, happy, anxious, sad, anything like that.

Disgusted would be one, yeah.

Oh okay.

It reminded me of something definitely. Cause I live in, like, it used to be the biggest city in North Africa. So it kinda reminds me of home. Somehow, one of the smells. It this mainly asking about the smells or the whole experience.

It varies. Some ask about the scene others ask about the smell in particular.

I'm not sure how to say it felt like home, is there a word for that like nostalgia?

Yeah that's nostalgic.

Claustrophobic. I mean the smog or fog is like too dense, too big. It felt hard.

Almost physically?

Yeah it did.

It was effective without the scents, but with the scent it was much much better.

So yeah this would work best with a whole group to discuss, but I could at least ask you about the stuff you did mention. So, what parts of the virtual tour reminded you of a previous experience or memory so maybe if you could just talk about that a little bit?

We actually have a thermal plant in the city, it's not really polluting the city, i didn't feel, it's just one, not a lot of them, but some people say it's bad but like,
It reminded you of that?

Not that part of my city, some parts are different.

Which aspect made you feel that way?

The sound was good, but I think the smell was really good.

Okay.

You know, I'm kind of used to just the scene alone. Like the 3D. I'm used to that. But the sound was really good. Like a game.

Yeah.

I'm used to like the game, like with the sound. But I'm also used to the 3D modeling by itself. Adding the sound is a different thing. It changed my perspective.

It changed your experience?

Yeah I think it was a very rich experience.

Good.

I think the scents really changed it. I didn't know it would be like this. This is really cool.

Thank you.

But people don't talk a lot about the smells. It's in writing but like, once you smell a smell it takes you back like instantly. It's evocative.

Yeah. So was there anything you would suggest could be used to make the scene better or maybe give a stronger sense of place?

Well, like, with smells, I remembered one time like, we went to a farm or something here in the US. Then I started remembering things from back home. Here I mainly don't see many farms.

Right.

But when you get to a farm, you remember when you last went to a farm.

Right

The only thing is, these smells are not entirely authentic.

Yeah but they are better than air fresheners.

They are better, but maybe they could be stronger I would say, but then, you know, I imagined myself like I was walking outside.

Right?

Yeah. I thought it was effective.

Great. Thank you