

Annotating our Environs with the Sound and Sight of Numbers: The DataScapes Project

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Abstract

The DataScapes Project is an exploration of how Augmented Reality objects can be used as constituents for Landscape Architecture. Using Stephen Ramsay's Screwmeneutics and Harold Innis' Oral Tradition as our theoretical points of departure, the project integrated the products of Data Art – the visualisation and sonification of data – as the constituents for our two works: *The Five Senses and Emergence*. *The Five Senses* was the product of protein data, while *Emergence* was generated using text from the King James version of the Holy Bible. In this exploratory treatment, we present the methods used to generate and display our two pieces. We further present anecdotal, qualitative evidence of viewer feedback, and use that as a basis to consider the ethics, challenges and opportunities that a future AR Landscape Architecture will present for scholars in the Digital Humanities.

Our Aim: A new form of landscape architecture

There is a singular privilege that accompanies living in this first century of digital computation: the opportunity to discern what it means. The task is nowhere near complete. We know, or think we know, that computation is having a bearing on our capacities to locate pattern, create and replicate pattern, and disseminate pattern. There are even some who believe its advent will ultimately impinge on the trajectories of natural and human history. Welcome to the Noosphere [Teilhard de Chardin 1959]^[1]. The ambition of this exercise in meaning-making is relatively more modest. We seek to explore how computation can be used to support the human penchant to adorn one's surrounds. More specifically, our purpose here is to explore how Augmented Reality (AR) Objects can be used as constituents for Landscape Architecture. In the aftermath of Ivan Sutherland's foundational work in the late 1960s establishing the field of computer graphics, the prospect that users might seek to integrate computer-generated form with their surrounds became a plausible one, one realized in the decades since via the medium of Augmented, and now Mixed, Reality [ACM 1988]. In the ensuing decades, AR has emerged as an actual or potential support for multiple fields, including education, construction, engineering, computer gaming and firefighting. In this contribution, we present the efforts of *The DataScapes Project* to explore how AR's capacity to situate and register digital content might be leveraged for artistic purposes: Augmented Reality content, combined with constituents from Data Art, can be leveraged as raw materials for Landscape Architecture.

Previous Work

The first challenge faced by members of the project was the fundamental one of determining how to proceed. We were presented with a blank canvass and had to select the location and method that, so to speak, would constitute our

"paint." Choosing a location proved to be the more straightforward of the two decisions. We were looking for a readily accessible space at one of our two universities, a locale that at once presented a sense of grand scale and a sense of enclosure. We were looking for a tract of land that would serve as a frame and a complement for our AR artwork. Based on that criteria, we selected the traffic circle at Brock University in St. Catharines, Ontario Canada. The circle is 140 metres in diameter, is centrally located on campus, and until recently was bounded by willow trees.

Selecting the method and content that would constitute the matter of our creation, by contrast, proved more difficult. To be sure, there were multiple domains of art that anticipated – in part – what we were seeking to do. The fields of Landscape Art, Earthworks, and Digital Art, through their creation of anamorph and *trompe l'oeil* artworks, for example, were suggestive of what an AR-based Landscape Architecture might accomplish. But the three fields also differed significantly in their practice from what we were aiming to accomplish. To start, while Landscape Art and Earthworks both make location a central constituent of artistic production, artists in both fields sculpt material objects – constituents from a local landscape – to generate artistic form, not digital content [Thompson 2014] [Herrington 2017]. In the domain of Digital Art, artists such as Joe Crossley have sought to conflate the digital with the material by transforming static empty spaces – generally building surfaces – into multi-media surfaces using projection mapping. The content that is disseminated, however, is 2D, not 3D [Crossley 2017].

Landscape Architecture, the primary field to which we sought to contribute, also did not present an obvious theoretical frame of reference, method or aesthetic to assist our efforts. One dimension of the problem here is that practitioners still tend to view digital tools and content as instruments to support the design of physical landscapes. A second problem is that the field's ontology of place is not sufficiently broad to encompass the fusion of digital and physical that we sought to construct. Since the Renaissance, landscape designers and gardeners, historian John Dixon Hunt argues, have typically divided space into three constructs or "natures," with first nature referring to wilderness, second nature to cultivated land, and third nature to landscapes shaped with aesthetic intent [Thompson 2014, 38]. Some designers suggest that Landscape Architects should consider adding a fourth nature to the list, one encompassing reclaimed landscapes and restored habitats, while we in turn wondered if we had stumbled on a fifth: landscapes containing digital annotations, objects or complements.

A third issue centered on the field's self-definition. While Landscape Architecture traces its origins to Landscape Gardening, the profession has maintained a complicated relationship with the arts over the course of the 20th century. Then, many designers, particularly in the wake of the profession's 1966 *Declaration of Concern* [2], suggested the focus of landscape architects should be on environmental conservation, not the translation of artistic or philosophical trends, be it transcendentalism or post-modernism, into landscape form. Other practitioners have taken the stance that the primary focus of the field should be on design, here understood as landscape construction that is optimized for the needs of a site's visitors and users. The artistic ambitions of the architect are deemed to be a secondary concern, if they are considered at all. On the 50th anniversary of the 1966 statement, however, the Landscape Architecture Foundation published a *New Landscape Declaration*, one in which architects called for a renewed emphasis on aesthetics [Landscape Architecture Foundation 2017]. One reason for the call was the realization that aesthetic concerns are not a luxury: poor design of buildings and cityscapes – here understood as the mindless prioritization of utility over beauty or meaning – has had a deleterious social impact. Landscape architects have also stressed artistic concerns because of a widespread sense that the field has never been a site of aesthetic innovation, and that it has missed important opportunities, such as the emergence of avant-garde art in the early 20th century [Corner 2017] [Fajardo 2017] [Jellicoe 1995] [Thompson 2014]. While the field has not been oblivious to important trends such as Modernism and Post-Modernism, "there is surprisingly little discussion," Richard Weller writes, "of what contemporary landscape aesthetics are and what they might yet become" [Weller 2017, 10].

Given this lack of definition, our team opted for an exploratory approach to inform the design of our project, one akin in the Digital Humanities to Stephen Ramsay's Screwmeneutics and Kevin Ferguson's Digital Surrealism. In his seminal essay, Ramsay proposes a method of scholarly activity that eschews the conduct of what he refers to as the "search." The "search" in this context is the practice of identifying a canon – the state-of-the-field for a given domain of research – and then identifying a gap in that same canon. As scholars, we contribute to our respective fields by conducting research to fill that gap. But there are times, Ramsay writes, when this formulaic approach does not work, particularly

when the researcher is attempting something new. How can the "search" "help me find what I'm looking for," he writes, "when (a) I don't know what's here and (b) I don't know what I'm looking for?" [Ramsay 2014, 115]. For Ramsay, the answer to this dilemma is to engage in what he refers to as "browsing." Drawing on the ideas of Roland Barthes, Ramsay proposes that we engage in the construction of the *writerly text*. In contrast to the *readerly text*, which involves a passive form of reading, engagement with a *writerly text* presupposes a process of composition, an immersion of the reader into the flux of existence, and initiation of a process of discovery and systematization: the connection by the reader of the content from the given text with a context, be it another item of content, a person, or a compelling idea. The theory of the *writerly text*, Barthes writes, "is a practice (that of the writer), not a science, a method, a research ... this theory can produce only theoreticians or practitioners, not specialists (critics, researchers, professors, students)" [Ramsay 2014, 119].

Via this process, Ramsay argues, the humanist defines a path through culture, thereby providing the Humanist – or, if you will, the Screwmeneuticist – with perspective, the platform necessary to support discovery, desire and questioning. One useful first step in defining such a pathway was undertaken by David Ferguson in his recent visual analysis of Disney animations, where he brings his artistic artefact of interest – the film – into relation with the concept of complex. Any artefact of interest, he suggests, can be dissected and its components re-articulated into new combinations. However, while useful, Ferguson's method for applying Screwmeneutics is not appropriate for our purposes for two reasons. First, its aim is ultimately analytic, not generative. It seeks, like all Structuralist methodologies, to locate the intrinsic properties – the hidden archetypal structures – of a given art-form. Its purpose is not scenario exploration. It does not seek to conduct an exercise exploring the potential ways an art-form *might* exist. It seeks instead to define the way a given form *already* exists. Second, and by extension, Ferguson's methodology, and structuralist methodologies in general, are ones that collapse the dimension of time. They presuppose objects of analysis that operate in a synchronic fashion [Ferguson 2017] [Merrell 1975]. We, by contrast, were seeking to create Augmented Reality, multi-media landscape complexes that could incorporate the dimension of time, and more specifically would incorporate temporal art forms such as music. Our purpose, in the end, was to generate an artwork that would serve, in Seymour Papert's words, as an object-to-think-with, and in Barthes' words, as a *writerly text* [Papert 1980]. Given that we were aiming to create something that was new, we sought to construct an artefact that would provide definition, suggest potential, and present questions and connections for future artists and humanists to explore.

Our Theory: The Oral Tradition of Harold Innis

For these reasons, we opted to employ a different Screwmeneutic method to conceive and develop our landscape complex, namely Harold Innis' concept of the Oral Tradition. For those unfamiliar with his work, Harold Innis was a media theorist and one of the founders of the Toronto School of Communication. Between 1940 and 1952 he produced a set of works, including *Empire and Communications* and *The Bias of Communication* that were dedicated to exploring the physical, formal and cognitive effects of communication media. A political economist by training, Innis turned to the study of communications in 1940 because he perceived, not surprisingly, that the world was falling apart. How was it possible, he asked in the final decade of his life, that the world, after enduring the insanity and carnage of the First World War, should so readily plunge itself into a Second? The answer, he believed, was to be found in the grand sweep of global history. What factors, he wondered, enabled societies to thrive? And what, by contrast, led to their dysfunction and eventual collapse? His lived experience, combined with his studies of the past, convinced him that human collectives functioned much like biological organisms. The vitality, adaptability, indeed the sanity, of institutions, nations and empires were dependent on the environmental circumstances in which they found themselves. Since the inputs and outputs of human-environmental interaction were largely mediated by communication devices, Innis set high store on their importance in global history. The political and cultural periodization of history, Innis believed, could be correlated with the invention or adoption of new communication technologies. So could the pathologies that afflicted cultures. There was a price to be paid for the unthinking use of technology, and in his writings Innis pointed to two: cognitive rigidity and cognitive flux [Innis 1946] [Bonnett 2017]. Technology historically had produced pathological forms of groupthink in which cultures either focused on the wrong thing (due to cognitive rigidity, or bias), or no thing at all (due to cognitive flux). With its judgment impaired by one of the two pathologies, a given culture would lose its ability to discern the opportunities and threats latent in its environment, fail to innovate, fail to compete and as a result fall prey to its

competitors [Bonnett 2013, 191–198].

It was a pessimistic construction of history, but it was not fatalist. While most regimes inevitably went the way of Nineveh and Tyre [3], Innis believed it was possible to construct a culture that retained its vitality and resilience via an ethic he referred to as the Oral Tradition. The Oral Tradition, as Innis conceived it, was not a call to forsake writing and adopt pre-literate Greek communication practices that relied on memory and voice. Instead, like Barthes, Innis called on his readers to adopt an *active stance* toward knowledge, a willingness to alter constructs and formalisms to meet the needs and experience of the present. Such a stance, Innis argued, had enabled the Greeks to make their innovations in theology, philosophy, science, politics and art. The Oral Tradition was also distinguished by its reliance on linguistic and aesthetic formalisms that were characterized by internal complexity and hierarchy. The power of such formalisms lay in their latent potential. They contained multiple constituents that could be arranged and re-arranged at will, enabling artists to explore new aesthetic constructs, and philosophers new intellectual possibilities, through the separation, interpolation and translation of content. In its essence, it was a serio-comic method, one that enabled Greece to shift its conception of nature from one based on myth to one shaped by science [Bonnett 2013, 209–217].^[4]

A third feature of the Oral Tradition, one deriving from its commitment to active manipulation of knowledge, was its use of multi-modal forms of expression. The reason Innis named his communication ethic the Oral Tradition in the first place was due to the influence of linguist Edward Sapir, who noted the "formal richness" of ancient communication practices, practices that contained "a latent luxuriance of expression that eclipses anything known to modern civilization" [Innis 1950, 8–9]. Such luxuriance of expression, and with it enhanced expressive potential, could be purchased in the present by creating formalisms that combined written, vocal and visual forms of representation. Such forms in principle presented possibilities for information visualization – which would assist in the location of significant environmental patterns – and information translation – which would enhance viewer understanding of the construct's content [Bonnett 2013, 166–181] [Innis 1946]. Referring to Italian artistic practice in the 15th and 16th centuries, for example, Innis noted Andrea Alciati's invention of the emblem book, a construct in which poetry, "one of the oldest arts, was combined with engraving, one of the newest" [Innis 2015, 101] The rationale for so doing was provided by Francis Bacon, who argued that emblems "reduce intellectual conceptions to sensible images and that which is sensible strikes the memory and is more easily imprinted on it than that which is intellectual" [Innis 2015, 101] [Bacon 1654].

The commitment to multi-modality in turn presented a fourth characteristic of the Oral Tradition: a commitment to integrate both spatial and temporal forms of representation. Because of its present and historic relationship with the art of poetry, Innis argued, the Oral Tradition "implied a concern with time and religion. 'The artist represents *coexistence in space*, the poet *succession in time*' (Lessing at the University of Berlin, 1810)" [Innis 1951, 102]. In his own economic work, Innis would apply this characteristic of the Oral Tradition by interpolating time series of price data with maps to track the emergent patterns of North American economic history, years before the practice became common via Geographic Information Systems [Bonnett 2013]. The Oral Tradition was finally characterized by what in modern parlance can be characterized as an open-source ethic, one in which content and form was routinely lifted from one work and integrated into another. "The great epics," Innis writes, "were probably developed out of lays constantly retold and amplified. Old ballads were replaced by combinations of a number of episodes into a unity of action. The epic was characterized by extreme complexity and unity" [Innis 1950, 72].

Our Mode and Matter: Data Art, Protein and Text

In its essence then, the Innis' Oral Tradition is a method for intellectual inquiry and aesthetic innovation that rests on a willingness to explore the possibility spaces afforded by complex, spatio-temporal, multi-modal form, and to reconstitute that form through the integration of content brought in from the outside. To assist our exploration of the possibility space associated with digital Landscape Architecture, we opted to use the methods and modes associated with Data Art. Also referred to as Information Art, Data Art rests on the premise that the world is replete with forms that can be harvested for artistic purposes. It chiefly emerged from scientific efforts to use sight and sound analogues as a method to locate significant patterns and relationships in large data sets. From that effort, multiple intriguing genres of art have emerged, particularly in the field of music, such as DNA music [Gena and Strom 1995], protein music [Dunn and Clark 1999], microbial and meteorological music [Larsen and Gilbert 2013], and even a music of the spheres, music compositions

derived from astronomical data [Ballora and Smoot 2013]. With Data Art, we were presented in principle with a method that would enable us to translate a given data set at once into visual and sonic form.

Once we had a mode for our AR landscape, the next, more difficult step was determining its matter, the data that would provide the pattern, the source of serial distinctions for our artworks. The team's decision-making here was determined by the following factors: our decision to produce two works, contingent circumstance, and the intellectual interest of project team members. The contingent circumstance centered on our need to locate sonification software. While Bill Ralph, a mathematician, and Mark Anderson, a computer scientist, respectively possessed the skills required to visualize our data, we had no one with the requisite ability to translate raw data into musical form. After a fairly protracted search (there is not a lot of proprietary or open-source software dedicated to supporting the generation of Data Art) we were able to locate *MusicWorK*, an application developed by John Dunn, a pioneer in computer music and art since the 1970s. While *MusicWorK* is purportedly able to work with any data set, the software specializes in supporting the creation of Genetic Music from DNA and Protein Data. The application's website provides tutorials and links to multiple libraries of genetic sequences, including the one we used: the U.S. National Institutes of Health GenBank [Algorithmic 2015]. Based on this specialization, we opted to use protein data and to create an artwork called *The Five Senses*, a composition of five movements which would respectively be constructed from protein data supporting Sight, Smell, Touch, Taste and Hearing in humans.

Our data selection was also prompted by the team's interest in the construct of change known as self-organization or emergent change, a ubiquitous phenomenon in the natural and social sciences studied by the Science of Complexity [Waldrop 1992] [Gell 1994]. It was also prompted by the observation of scholars such as Werner Jaeger and Harold Innis that different domains of human activity – such as science, philosophy and theology – often produce constructs of change that are very similar [Innis 1950, 93]. It was finally prompted by the observation of John Bonnett that a number of parallels could be found between the core concepts of emergent change – such as positive feedback, the governance of formal cause, and the teleological governance of system attractors – and the philosophy of history associated with the Christian Bible. Economists, for example, often characterize positive feedback as the Matthew Effect, given that the process of cumulative change it describes matches the dynamic Jesus describes in the Parable of the Talents, where the rich became richer and poor poorer [Rigney 2010]. Given these parallels, we opted to create a second work simply titled *Emergence* based on source text from the Bible. Like *The Five Senses*, we planned a composition featuring five movements, with each piece named after a constituent concept of self-organization, respectively "Emergence," "Differentiation," "Regulation," "Selection" and "Attractor." Each piece, in turn, would rest on data taken from the King James version of the Bible, text that provided narrative or mythic analogues to the concepts of positive feedback, formal cause, and so on.

With the terms of composition settled, the team's next step was to identify the specific data sets we wanted to use for each composition and then begin the process of sonification. The proteins selected for *The Five Senses* are shown in Figure 1, while the biblical texts selected for *Emergence* are shown in Figure 2. The process of sonification for *The Five Senses* began by harvesting the letter data associated with each protein record, such as that shown in Figure 3. In many ways, NIH protein records resemble what any researcher might find in a library catalogue for a book listing, with metadata describing authors, key words, versions and the like. However, NIH records also feature a sequence of letters where one typically would find Library of Congress or equivalent subject headings describing a book's contents. Those letters collectively constitute the protein described in the given record. In Figure 3, the highlighted letter sequence refers to the amino acids making Medium Wave sensitive opsin 1 (*Homo sapiens*), a protein contained in green cone photopigment that we used to generate the work *Sight*. These letter sequences provided the patterned sequences that would be translated into notes for *Sight*. Similar letter sequences generated the notation for the four remaining movements of *The Five Senses*, while the biblical passages provided the initial basis for *Emergence*.

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Movement

Protein

Hear
Sight
Smell
Taste
Touch

TMC 1: Transmembrane cochlear-expressed protein 1
Medium Wave sensitive opsin 1 (Green cone photopigment)
Putative Olfactory Receptor 212
Sweet taste receptor TIR2
POU domain, class 4, transcription factor 2

Figure 1. Proteins selected for *The Five Senses*

Movement

Emergence
Differentiation
Regulation
Selection
Attractor

Text Source
John 1: 1-18
Genesis 1:1-Genesis 2:3
I Corinthians 12:12-31
Matthew 25:14-30
Revelation 22:12-31

Figure 2. Biblical texts selected for *Emergence*

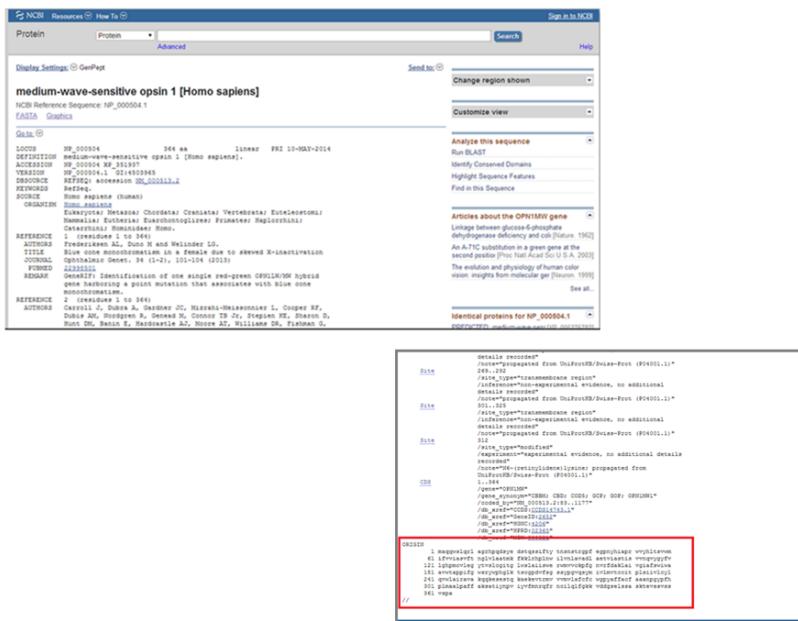


Figure 3. The screenshots show the NIH record for medium-wave-sensitive opsin 1, a protein affiliated with the sense of sight in human beings. The small boxed section of letters on the lower right refers to the protein's constituent amino acids. These letters were the source data for the movement *Sight* in *The Five Senses*.

Our Method of Sonification

The process of sonification for both compositions was initiated in *MusicWorK* first by converting every letter from every dataset into a counterpart number, with A equaling 1, B equaling 2, Z equaling 26, and so on. Once an entire letter set from a given dataset had been translated, the software then aligned the numeric series with a specified music scale,

producing a raw music string, as shown in Figure 4. From that point, the project's two music composers – Erin MacAfee and Amy Legault – had two methods of composition and two modes of operating with their source data open to them. The first method of composition – selected by neither – was to use the algorithmic method of music composition supported by *MusicWorK*. There, the raw music string is transformed by feeding it through a set of components that control features such as tempo, chords, instrumentation and the like. The process, shown in Figure 5, is akin to creating an algorithm using a visual programming language, or creating an electronic circuit.

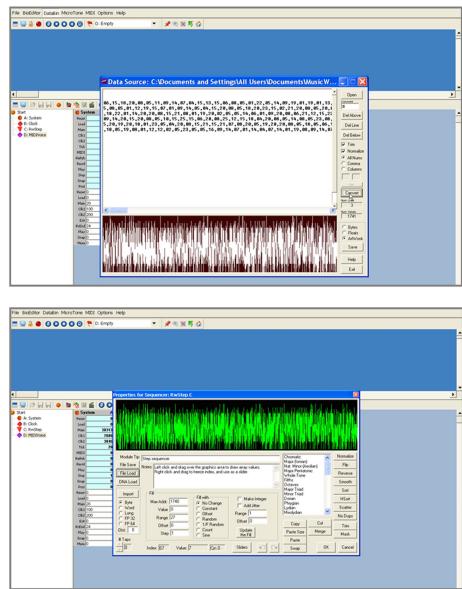


Figure 4. MusicWorK is shown here generating raw music string from protein data



Figure 5. MusicWorK interface for algorithmic composition of protein music

The second method – selected by both – required the two to export the raw music string to a *.midi file, and then open the exported file in *Finale*, a music composition software package. The appeal of *Finale* for Legault and MacAfee is that it presented methods for music notation that were familiar to them, most notably by featuring an interface and tools that supported viewing and direct manipulation of music string notation. With *Finale*, the two were able to alter note duration,

inscribe chords of their own devising, and repair aberrations in pitch.

Finale also enabled each composer to determine how she wanted to use the musical sequences inherited from her source data. MacAfee's approach in *The Five Senses* was minimalist. While she was willing to alter select attributes in her file, such as rhythm, instrumentation and the duration of individual notes, she was not inclined to alter the tonal sequence inherited from her datasets. Legault's approach, by contrast, was more interventionist. Instead of viewing her inherited notation series as a fixed object, she opted to view her raw music strings as libraries from which she could splice identified musical components. The appropriated sections were – much like the lays in Innis' Oral Tradition – placed in new sequences and were integrated into established musical genres selected by Legault, such as the fugue.

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Our Methods for Visualization

While Legault and MacAfee were generating their respective sonifications, team members Bill Ralph, a mathematician, and Mark Anderson, a computer scientist, were working on their visual correlates. Ralph is also an algorithmic artist, one who describes his work as "an attempt to make a visual connection with the enormous complexity and unity that lies within the rich mathematical objects that inspire my images" [Ralph 2018]. He is particularly interested in mathematical objects that can generate chaotic, dynamic systems, and has used them to generate dynamic and static works distinguished by their complex topologies and colour. From the standpoint of this project, Ralph's approach was ideal because it often relied on source data to drive the generation of a given work. For *The Five Senses*, he used proprietary algorithms driven by two inputs. The first source of pattern was the set of distinctions obtained via a sequential progression through the data. The second source was the set of relationships detected by the algorithm between different, non-proximate strings contained in the data. Both were leveraged to provide a visual focus to our landscape composition. For *Emergence*, Mark Anderson used a different approach. Instead of deriving his images from the data, he selected Screen Vector Graphic images that related conceptually with concepts such as *Differentiation* and *Attractor*, and then used project data and the application *NodeBox* to animate each image and prompt transformations in colour.

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The DataScapes Project AR Set

With the sonification and visualization of our two works complete, two further tasks remained, the first being the construction and overlay of a digital set to display *The Five Senses* and *Emergence*. Given that we conceived our two works as Landscape Architecture, and that the Brock Traffic Circle – our selected first venue – was 140 metres in diameter, the parameters of our project mandated that the components of our digital set be relatively large in size for the visualizations to be observable and for them in turn to serve as artistic complements to the surrounding landscape. That need was further compounded by the presence of the physical statue, known as She-Wolf, situated in the midst of the circle, and the scaffolding and the four 4.6 metre-high QR code signs we installed to activate and situate our digital works. All three objects are shown in Figure 6, and all three required effacing by the digital set to prevent their disruption of the impact of our AR Landscape works. Accordingly, the set shown in Figure 7 was designed by John Bonnett using *SketchUp* to display *The Five Senses* and *Emergence*. The set is bounded by eight 9-metre-high monoliths, with the front of each monolith displaying a graphic representing the title of the movement currently under display. Figure 8, for example, shows the graphics for the movement *Touch* on the left and *Differentiation* on the right. The centre of the set is composed of two components. The cylinder at the base is used to cover the statue, scaffold and QR code signs mentioned above. Floating above it is a 9 metre object used to display the given movement's visualization. For *The Five Senses*, a cube was used to display the artwork, while a sphere was used for *Emergence*.

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The DataScapes Project Android App

Our final task was the creation of an Android app to support user viewing of the two works via a tablet or phone. Our requirements for the *DataScapes* app were straightforward. We wanted to simultaneously see and hear the respective visualizations and sonifications associated with each movement. We further wanted multiple users to the site to experience the performance in sync. If one viewer was viewing and hearing the movement *Taste*, we wanted their counterparts to see and hear the same thing at the same time. We also wanted user entry into the experience to be

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simple, involving little more than user activation of the app, and direction of his



Figure 6. Brock University She-Wolf Statue, surrounded by scaffolding and 4.6 meter QR code signs used to situate *DataScapes*' AR content.



Figure 7. The *DataScapes* AR set, shown as it was featured at Brock University's Traffic Circle.

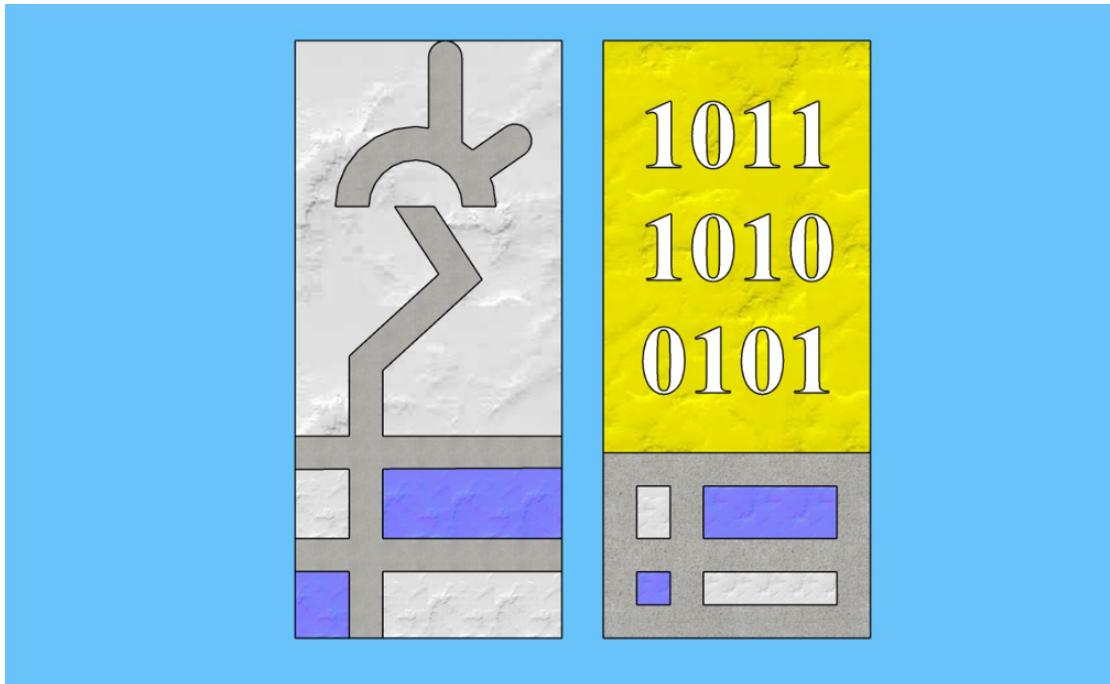


Figure 8. Graphics for the movement *Touch* on the left and *Differentiation* on the right

or her device camera at the QR signs situated in the middle of the traffic circle. The app only worked at a distance of 6 metres or less from the QR code signs, to prevent unsafe viewing of the exhibit by, for example, drivers circumnavigating the circle. The *DataScapes* application was developed using *Vuforia*, an SDK (Software Development Kit) designed to facilitate the development of AR applications on mobile devices. Leveraging 3D objects, planar surfaces and patterns situated in the environment, *Vuforia* is able to determine the user's position and camera orientation relative to objects such as the project's QR Code signs, and in turn to situate and register computer-generated 3D objects. These capabilities enabled team programmers Joe Bolton and Mark Anderson to fulfill another requirement for the *DataScapes* app: the capacity to move around and within the artwork. *Vuforia*'s capabilities, combined with GPS and gyroscopic data, enabled the *DataScapes* app to track the movement of viewers, and in response to change the orientation and rendering of displayed objects in real-time, to make our digital objects seem as if they were integrated and locked into the natural landscape. 22

Results

The final results of our efforts are shown in Figure 9 and Figure 10, along with a video showing the operation of the app in Figure 11 (For an earlier treatment of *The DataScapes Project*, see Bonnett et al. 2018). The first version of the *DataScapes* app in our estimation was a partial success, both technically, and with respect to audience reception. With respect to the app's functionality, our initial trials of the two works were hindered by two difficulties. The first and perhaps most disappointing setback was the inadequate processing power of the two Asus 12" tablets we had on hand for viewing the display. The tablets did not have the capacity to simultaneously render and register our set while simultaneously displaying our data visualizations in dynamic form. Despite our best efforts to find work-around solutions on site, we had to settle for the necessary compromise of presenting Bill Ralph's and Mark Anderson's respective visualizations in static form. A second difficulty centered on the stability of the set. While the first version of the app adequately anchored our set to the Brock traffic circle, several of its constituents, most notably its monoliths, tended to vibrate or jitter in a way that was at once distracting and unpleasant. These deficiencies have been partially remedied in the second and third versions of our app. Our intention in these two iterations was to develop portable versions that would display *The Five Senses* and *Emergence* indoors, while remedying some of the performance failures identified in the first. Version two, shown in the animation featured in Figure 12, was designed to support Mark Anderson for an Edge Hill University lecture dedicated to the Art of Computing, and presents the project as a wall display. Version three, shown in Figure 13, transformed the orientation and scale of the project yet again, by adapting it for display as a table- 23

top installation. In both, we were able to better stabilize the display of our set. And in both, we were able to add some dynamism to the display, albeit by introducing movement into the set rather than our visualizations. Both iterations required changes to the application, most notably by changing the way *Vuforia* searched for targets and changing the orientation of the 3D content it displayed in relation to those targets. In addition, we also removed the initial application's use of GPS tracking code, as that functionality was specifically designed to support the geo-location of 3D content on the Brock traffic circle, and further designed to hinder the display of content to users not on campus. Finally, we reduced the size of QR code displays used with versions 2 and 3 of the *DataScapes* app and designed each version to generate displays proportional in size to the QR code target. Via this step, the user can print a code on a piece of paper and generate a display proportional in size to the underlying table.



Figure 9. Screenshot of *Emergence*, as it appeared using an ASUS tablet.



Figure 10. Screenshots of *The Five Senses*, as it appeared using an ASUS tablet.



Annotating our Environs with the Sound and Sight of Numbers: The DataScapes Project (figure 11)

from [Digital Humanities Quarterly](#)



Figure 11. Video showing the performances of the movements *Emergence* and *Differentiation* from the piece *Emergence*.



Annotating our Environs with the Sound and Sight of Numbers: The DataScapes Project (figure 12)

from [Digital Humanities Quarterly](#)



Figure 12. Animation showing version 2 of *The DataScapes Project*, as it was displayed at Edge Hill University. Version 2 featured the project as a wall display rather than as a component of landscape architecture.

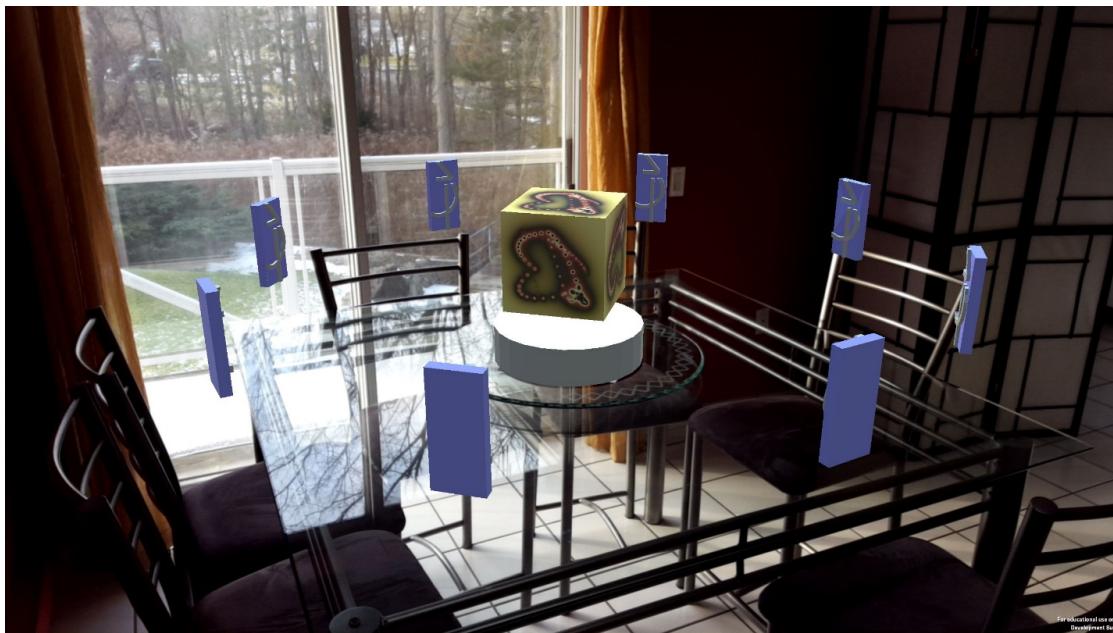


Figure 13. Version 3 of *The DataScapes* project, here configured for table-top display.

As for audience assessment, we report here anecdotal evidence gathered during our first trial. Our rationale for this approach as opposed to more extensive and expensive methods used in Human Computer Interaction (HCI) and elsewhere is due, in part, to concerns regarding the reliability of user assessment methods pioneered in cognitive psychology and HCI. These methods have been drawn into question due to, on a general level, the replicability crisis in the social sciences and, more specifically, widespread criticisms of the two fields pointing to errors in statistical method, small sample sizes and large confidence intervals [Lundh 2019] [Greenberg and Thimbleby 1992] [Cairns 2007] [Gigerenzer 2004] [Cohen 1994]. Putting the matter simply, user assessment via this route seemed to impose a good deal of effort for results that did not necessarily convince. 24

For the type of exploratory exercise that we were pursuing, it seemed more useful to take a craft-based approach to user assessment. In fields such as web design, argues Gerd Waloszek, a former interface designer with SAP, the metric for success for a given design is not its authentication via an HCI analysis of design *consumers*. The real metric rests on whether other design *producers* copy the design, making it a convention [Waloszek 2003]. In a different design context, Elizabeth Eisenstein and Hellmut Lehmann-Haupt note a similar process in the history of the print book. Through experimentation and appropriation of designs from competitors, printers such as Peter Schoeffer collectively generated the conventions of the modern book, such as tables of contents, title pages, running heads and footnotes [Eisenstein 1979] [Lehmann 1950]. A craft-based approach, then, suggests that the "success" of our effort will depend on whether other artists, landscape architects and digital humanists choose to emulate our approach to landscape design, because they like it, and because they believe it will induce a favorable reaction from their respective audiences. The best we can do is report what we learned from our viewers and suggest the questions and implications that stem from those observations. We will be "successful" if colleagues choose to mimic those efforts and address the questions we have raised. 25

Based on that framework, we noted two classes of respondents – general viewers and artists – and important questions that arose from each. General viewers for the most part found our various pieces engaging, reporting an intrinsic fascination with the fact that data, particularly protein data, could be translated into art forms, particularly music. That feedback raised an important question for us, however. Is Data Art intrinsically compelling on its own? Is it capable of generating an intellectual or affective response from viewers without annotation, or must it be presented with an accompanying spoken or written context to maintain viewer interest? This is, of course, not a new question in the history of art and Landscape Architecture, where practitioners continue to argue whether art should attempt to communicate a concept or message – such as the need for environmental sustainability – or instead focus on generating an emotional 26

response from viewers [Thompson 2014]. A related question is whether artists and Landscape Architects can generate the sensory "languages," be it visual, sonic, olfactory or something else, required to successfully communicate the artist's message to an audience without textual assistance.

The response of artists was, perhaps not surprisingly, more searching and more critical. While most viewers found the project's content and approach very interesting, some took exception to our temporary appropriation of the Brock traffic circle (we used it for one week), particularly since it already contained a physical statue that was surrounded by the project's scaffolding and QR codes. One artist deemed the metal framing and the statue's digital effacement problematic. Another deemed it a violation. This feedback raised fascinating ethical and political questions for us. To be sure, the infrastructure we constructed around the physical *She-Wolf* statue did hinder proper viewing of the statue. Whether it constituted a violation depends on your point of view. Until artists raised the issue with us, the construction of the scaffolding and QR codes prompted no concern from project participants, nor did it for the university officials who granted us permission to use the space. We meant no disrespect. It was not our intention to make a comment on the statue, nor to damage it. But some artists did see our temporary occupation of the space as an unacceptable abridgement on the statue's integrity and the sculptor Ilan Averbuch's rights.

One response to these concerns would be to note that the scaffolding and QR codes will not be a permanent component of AR Land Architecture, or more generally, AR-based artforms in future. We used them because current technology requires their use to situate and register content. In future, artists will be able to use RTK GPS (Real-time Kinematic Geographic Positioning System) data to position content with centimetre and even millimetre level accuracy. That expedient will resolve the issue of the art form's physical intrusion into a given space, but not its digital annotation. Is it ethical for one artist to use digital methods to efface, comment upon, add to, mock, or alter the context of a physical artwork created by another, even if the digital annotation is not visible to the naked eye? To that ethical question we can add a political one: who gets to add that annotation? The complexity and sensitivity of this question was anticipated in 2017 in New York when the statue *Fearless Girl* (sculpted by Kristen Visbal) was placed in proximity to the statue *Charging Bull*, a work situated on Broadway and long associated with Wall Street and the city's financial district. To many, *Fearless Girl* presented an important message of female empowerment. *Charging Bull*'s sculptor Arturo Di Modica, however, was outraged, arguing that *Fearless Girl*'s proximity and positioning transformed the meaning of his statue, from one symbolizing prosperity and strength, to that of villain [Dobnik 2017] [Mettler 2017]. The controversy raised multiple questions, ones that we now face with our project. When an artist makes an intrusion into a space, does that space become sacrosanct? Artists have long made interventions into spaces that they deem to be playful, even provocative. Are those intrusions to be exempted from three-dimensional annotations that some will label as legitimate super-positions or rejoinders, others as graffiti, and others as outrageous violations? Who gets to decide the issue? These issues will become increasingly central as AR becomes a ubiquitous communication medium.

Discussion and Conclusion

In addition to the questions posed above, what other observations and questions might we offer to conclude this exercise in Screwmeneutics via the Oral Tradition? In our view, the best way to finish would be to explicitly address the questions that constitute the heart of this issue of DHQ.

1. What are digital and computational approaches to sound, images and time-based media?

For this project, the answer is simple: data translation. Data translation via computation can be used to generate sound (via sonification), images (via visualization), and time-based media (music via sonification). Further, this project is significant in the context of the digital humanities because of its use of approaches typically used for analysis to generate art. In the last 10 to 15 years, visualization has become an integral component of text analysis, while tentative steps are also being taken to leverage sonification [Sinclair and Rockwell 2016] [Graham 2016]. The project also makes a contribution by leveraging text data, typically the grist for DH analysis, as the raw material for art. It finally contributes by using a non-traditional DH data source, protein, as a constituent for art.

2. How do these methods and approaches produce new knowledge and shift scholarship in a particular scholarly domain?

In the domain of Landscape Architecture, as indicated above, digital objects have typically been seen as instruments for planning, the basis for the physical transformation of a given landscape. This project suggests that Landscape Architecture – and, by extension, the Digital Humanities – should integrate the digital with the physical when producing new landscape designs, and in so doing should generate a new domain of Landscape Architecture. The reason for so doing rests on a long-standing ambition of the field: to use landscapes as a visual way to say something about the nature of the cosmos in which we find ourselves. For example, pioneers such as Frederick Law Olmsted, the designer of New York's Central Park, were Transcendentalists. They used landscapes to express their sense that there was a latent reality underlying nature, that it was suffused with the divine [Thompson 2014].

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Landscapes populated by latent, invisible without instrument, AR objects could be used to extend a similar, but different, message. In this context, the construction disseminated would not be *transcendence*, but *ubiquitous sentience*. In the past 20 years, biologists have made numerous remarkable discoveries that suggest many supposedly human distinctives are not unique to our species at all. Trees, for example, form familial and friendship networks, and communicate via something akin to a fungal Internet [Wohlleben 2015]. Cetaceans have been shown to use artificial languages and form cultures while musical biologists suggest birds compose music equal in complexity to symphonies [Conway 2003]. Perhaps most surprisingly, recent work in molecular biology suggest that cells use molecules in a fashion akin to words, that their communication is possibly akin to language, with a semantics, syntax and pragmatics, that they communicate in more than one "language," and that they vote (biologists refer to it as quorum sensing) [Ahmed 2008] [Bassler 2009] [Ben et al. 2004] [Ji 1999]. Landscape Architects have long had a commitment to design that reflects an ethic of ecological sustainability and highlighting plant life, stone and other constituents of their local regions. To our knowledge, those same architects have not produced designs that in humanist terminology reflect an *Animal Turn*, a commitment to highlighting the agency embedded in environments that individuals in modern, European-derived cultures have traditionally ignored, largely because they – and we – were ignorant of their existence. It would be a worthy challenge for Landscape Architects to derive an AR-based visual language to focus viewer attention on our neighbours. DNA, molecular and Protein Data – the "words" used by single cell organisms to communicate – would be particularly worthy material upon which to build that language.

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For the Digital Humanities, our exercise in Screwmeneutics via the Oral Tradition suggests that scholars have the potential to translate their traditional focus – text data – into visual and sonic forms of art. They also can join their colleagues in the arts and sciences in translating other forms of data for the same purpose. The exercise also suggests that so long as the intrinsic structure of source data is retained, there is no correct, preferred or consistent method for generating Data Art. The source data can be divided into its components, and, again, provided the internal structures of those components are retained, the appropriated sections can be placed in new sequences and contexts. Further, the components of a given data source can be situated with whatever form, medium or context that is consistent with the needs, aspirations and capabilities of the artist. To be sure, most artists in domains such as Protein Music and other forms of Data Music choose to retain the sequential structures of their source data in their entirety. But the insights of the Oral Tradition and the inherent structure of our protein and text source data suggest that this preference need not be so, and our experience, combined with the past behavior of some Data Artists, suggests that some will do so.

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With respect to the nature of our data, Douglas Hofstadter notes that proteins like music are composed of smaller components: "Music is not a mere linear sequence of notes. Our minds perceive pieces of music on a level far higher than that. We chunk notes into phrases, phrases into melodies, melodies into movements, and movements into full pieces. Similarly, proteins only make sense when they act as chunked units" [Hofstadter 1979, 525] Biologist Mary Anne Clark similarly notes that "I was struck by the parallels between musical structure and the structure of proteins and the genes that encode them. Proteins also seemed to be composed of phrases organized into themes. For years I was haunted by the image, and tried occasionally to interest musicians in making the transformation for me ..." [Dunn and Clark 1999, 25]. Similar observations can and have been made about the complex nature of linguistic and textual data, not the least, as we saw, by Harold Innis in his descriptions of the Oral Tradition.

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Our stance that some Data Artists, particularly digital humanist Data Artists, will opt to leverage the "phrases" and "themes" of data for artistic purposes, and connect them to the instrumentation, media or objects that suit their purpose, is indicated by the choices made by the artists who collaborated on *The Five Senses* and *Emergence*. In the first work, Erin MacAfee and Bill Ralph chose to work within the sequential confines of the data presented to them. In the second, Amy Legault and Mark Anderson did not, collectively producing a work that confined the Data Art to the sonic level, based on selections of phrases detected by Legault in the source data, and the selection by Anderson of non-data images derived from an on-line library. In each case, the artists subjectively chose the extent to which they would subject themselves to the structures contained in their data, and the objects, media and instrumentation they conflated with their data. That is no different in principle from what previous Data Musicians have done, where they have displayed a remarkable degree of ingenuity and freedom in the artistic choices underlying their compositions. In our work, we played with complexity, arranging and re-arranging units contained on a single level of biological organization. In previous work, sonic composers have played with hierarchy, subjectively conflating structure from different levels of biological organization – such as DNA data, amino acid data, and protein folds – to produce a composition. Our work has been an exercise in juxtaposing retrieved structure with selected visualization. Previous work has juxtaposed identified structure with selected instrumentation. The key point here is that strict adherence to a given method is not necessary for Data Art to retain its integrity. So long as some trace of the data's original structure is retained, one should expect artists, as they must, to exercise their own judgment on what method or array of methods is legitimate to fulfill their purpose.

3. What are the Challenges and Possible Futures for AV in DH?

Our combined use of Screwmeneutics, Harold Innis' Oral Tradition and Digital Art has explored one potential way that AR-based objects can be leveraged as constituents for Landscape Architecture. The Possibility Space for spatial AR art, however, is much larger, and its exploration and realization would constitute a worthy possible future for the Digital Humanities. One obvious way that space could be explored would be to change the digital content that is used to populate selected landscapes. Data Art is and will remain a central constituent of our future work. Indeed, we intend to further refine our app so that future users can incorporate their own visual and sonic constructs from data into it. But we also intend to incorporate other forms of art. We find ourselves, for example, wondering what the surreal imagination of Salvador Dali might have made of AR as a medium. The sky is a constant backdrop in his paintings, as witnessed in masterworks such as *Dream Caused by the Flight of a Bee*, *Christ of Saint John of the Cross*, and *Santiago el Grande*. One only has to survey a few of his works before the question arises if other spaces might be filled by AR objects. We are used to thinking of Landscape Architectures. Dali's work suggests AV digital humanists ought to expand their imagination to consider what a Skyscape Architecture or Seascapes Architecture might look like.

Two factors, one old, one new suggest why they might want to consider the development of such architectures. To start, it is a commonplace to observe that architects and interior designers, since ancient times, have sought to shape a visitor's experience of interior space – a given room inside a building – by importing select features from exterior space, ranging from the physical to the metaphysical. Whether by landscape or *trompe l'oeil* paintings, alignment of windows, doors, and ceiling oculi with the sun and moon, paintings with celestial motifs, or religious paintings such as Michelangelo's *The Creation of Adam*, artists have sought to use exterior space to create a sense of interior place. A second factor that should influence digital humanists is the imminent availability of smart glasses, as well as intelligent glass supported by smart film. Both present the possibility for immersive AR that outstrips the constrained field-of-view presently afforded by tablets and head-mounted displays. While smart glasses – which will be light, easy to wear, and feel like regular glasses – suggest the possibility for user access to AR content anywhere at any time, intelligent glass and smart film – sheets of glass and film that can alter glass opacity and display information – suggest the possibility that digital humanists and interior designers will be able to conceive and construct augmented seascapes and skyscapes.

Consider the following storyboard as a possible example of what might result from an architect's attempt to construct a Skyscape Architecture using intelligent glass. Typically, the night-time sky in a city is a rather dull place. Light pollution effaces many if not most of the stars that might be observed, plus the Milky Way. An architect, say, of a restaurant might choose to exploit this gap by creating an A-Frame structure topped by a roof made with glass and smart film. The

architect or interior designer, in turn, would then be free to fill the evening sky with whatever object, or array of objects is wished. Drawing on ceiling celestial paintings as a source of inspiration, our architect might opt to create a surreal display conflating the earth and moon with the Andromeda Galaxy, as shown in Figure 14. The restaurateur taking possession of the locale, however, would not be constrained by the initial skyscape provided by the architect, and could supplement it with other designs displaying other astronomical objects and other styles. The next evening our restaurateur might choose to populate the evening sky with an enlarged version of Jupiter juxtaposed with part of the Rosette Nebula. The following day, patrons would be treated to a surreal display of objects floating in the sky, as indicated in Figure 15.

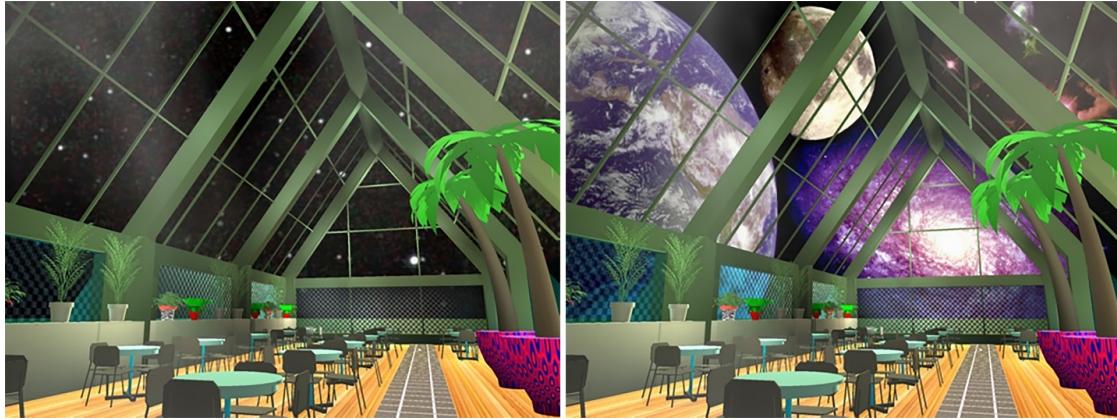


Figure 14. Restaurant configured with smart-film supported rooftop windows for display of AR skyscapes.
(John Bonnett, 2020)



Figure 15. Restaurant configured with smart-film supported rooftop windows for display of AR skyscapes.
(John Bonnett, 2020)

In such a scenario, building architecture would emerge as an interface to a new domain of art. And in such a scenario, sea, land and sky would emerge as platforms for the very sort of meaning-making that we have sought to promote in this study. Nothing is inevitable, but we would be very surprised if artists and digital humanists do not avail themselves of this opportunity to use digital form to enhance their surrounds. Such a step would simply be a continuation of a long history in which humans have used built form and modified topography for more than functional purposes. "From the most immemorial Hindustan pagodas to the Cathedral of Cologne," Victor Hugo writes in *The Hunchback of Notre Dame*, "architecture was the great script of the human race." Landscapes and buildings have been used by humans to express their yearning for beauty; their conception of history; their power over space; and their belief that humans – in the end – live in a cosmos with intrinsic purposes that can be understood. Now, that conversation, and that quest for meaning, can be continued in digital form, in new locales. And now, that conversation – in visual, sonic and topographic form – can express in a powerful way that the planet is replete with agency, creativity and dignity. We have no idea what our peers and our successors will produce. But we expect it will be replete with all the usual adjectives that we

associate with great art: compelling, interesting, at times infuriating, but never boring.

Notes

[1] The *noosphere* is a philosophical concept developed and popularized by the biogeochemist Vladimir Vernadsky, and the French philosopher and Jesuit priest Pierre Teilhard de Chardin. See: <https://en.wikipedia.org/wiki/Noosphere>

[2] <https://www.lafoundation.org/who-we-are/values/declaration-of-concern>

[3] The line is a reference to a famous poem by Rudyard Kipling titled "Recessional," which dwells on the temporary and fleeting nature of empires. The key passage in the poem is this:

Far-called, our navies melt away;

On dune and headland sinks the fire:

Lo, all our pomp of yesterday

Is one with Nineveh and Tyre!

The entire poem can be found at <https://www.poetryfoundation.org/poems/46780/recessional>

[4] <http://podcasts.torontoreviewofbooks.com/2013.02/Bonnet.mp3>

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