Facilitating Community Engagement for The University of Toronto's Landmark Geoexchange Project

By: Sabrina Poinen, Tanvi Khurmi, Hayley Vlcek and Marko Berrak-Tinaz

UNIVERSITY OF
TORONTO

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1. Introduction

1.1 Introduction

The University of Toronto (U of T) educates more than 88,000 students making it the largest university in North America.[1] Unfortunately, the university's great population ranks them as the third largest greenhouse gas emitter among institutions within Ontario's Broader Public Sector. In recognizing this undesired standing, U of T aims to reduce its greenhouse gas emissions by 37 percent from 1990 levels by the year 2030.[2] Although this is an ambitious climate change goal, the Landmark Project is a significant step forward that will help meet U of T's target. This project envisions an open-concept downtown campus that invites pedestrians to occupy these greener and more accessible spaces. More importantly, a Geoexchange system will be installed beneath King's College Circle that will save 15,000 tonnes of carbon dioxide equivalent per year (Figure 1). This system will be Canada's largest known ground source heat pump in an urban setting that will provide a sustainable, low-carbon source of heating and cooling.[3]
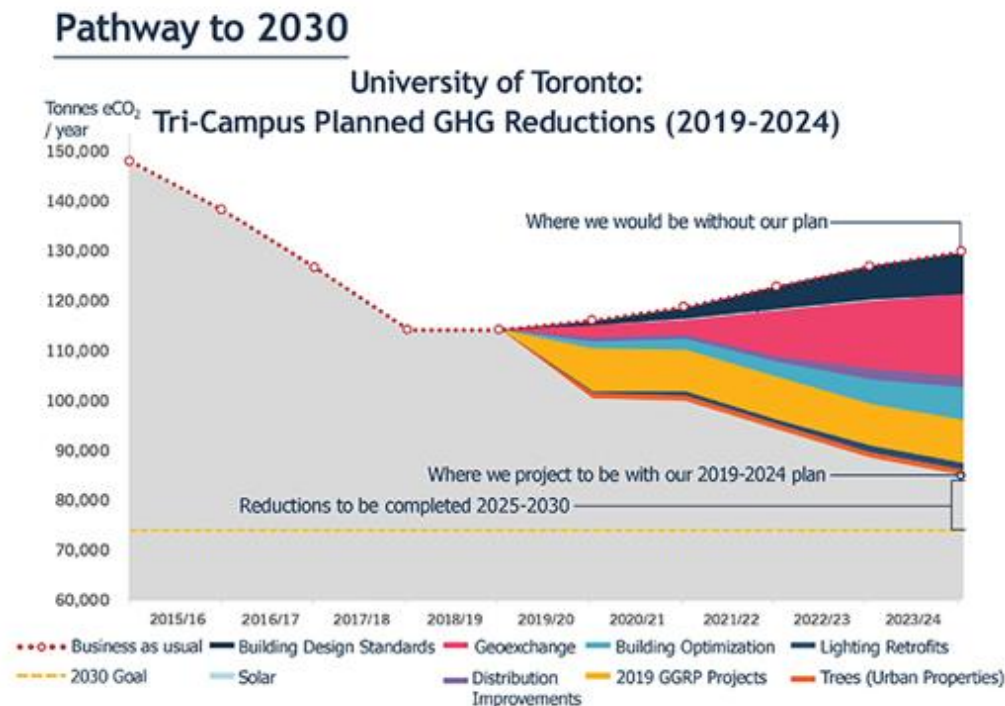
Figure 1: University of Toronto: Tri-Campus Planned GHG Reductions from 2019 to 2024.[3]

1.2 Geoexchange System

A Geoexchange system is a type of geothermal system that uses the Earth to generate and/or store energy for later use. This system will use the Earth as a thermal battery that allows surplus heat to be collected and sent to campus buildings during the colder months of the year. Since the temperature of the Earth is stable, the Geoexchange system is able to utilize the thermal properties of the soil to retain energy. Through this heating and cooling system, we are able to store and extract heat as needed to serve the following seven U of T, St. George buildings [4]:

Table 1: The seven buildings that will utilize heat from the Geoexchange system.

Geoexchange University of Toronto, St. George Buildings	
1	Medical Science Building
2	FitzGerald Building
3	Terrence Donnelly Centre for Cellular & Biomolecular Research (CCBR)
4	Leslie Dan Faculty of Pharmacy
5	Galbraith Building
6	Wallberg Memorial Building (WB)
7	D.L Pratt Building

Due to the U of T's location, the university greatly benefits from "…the access to large amounts of heating and cooling loads on campus".[5] [(p6)] By digging 374 boreholes 800 feet deep into the ground, vertical ground-coupled heat pumps will be installed in order to store and extract energy from the Earth. In other words, holes are drilled vertically into the ground and are filled with loops of pipe with a U-bend at the bottom (Figure 2). The ground heat will be transferred to buildings by fluid circulating in the vertical pipes. Vertical ground-coupled heat pumps are the most common type of installation done in downtown Toronto because it has a small footprint and lower operation costs.
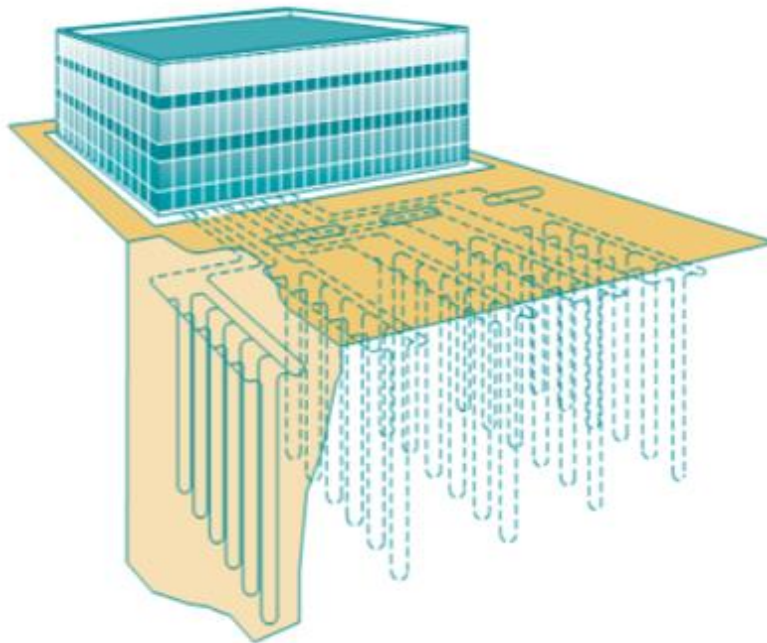
Figure 2: Vertical Ground-Coupled Heat Pumps [5]

1.3 Scope of Research

Since the Geoexchange system is a renewable energy source, U of T is able to generate energy while making sustainable choices. This system is energy-efficient, cost-effective, and environmentally sound; however, its benefits are not well known by the U of T community nor the general public. Since the Geoexchange project is hidden and developed underground, public awareness and involvement become a challenge. Thus, our scope of research is to analyze how to facilitate internal and external engagement with the Landmark Geoexchange project through the development of physical structures (e.g. pavilion, art installation) and digital signage.

2. Goals and Objectives

Our goal is to find ways to inform the surrounding community of the Geoexchange system and its benefits. Our target audience includes U of T students and faculty as well as campus visitors. Through a series of community engagement models, we aim to accomplish two main objectives:

1. Simplify and successfully communicate complex scientific information related to the Geoexchange project, and
2. Contribute to the overall branding of U of T as an institution known for sustainable development. We aim to employ two types of models to achieve these goals.

We have employed two types of models to achieve these goals: physical structures (e.g. pavilion, art installation) and digital signage. For each we have prepared 3 potential design concepts.

3. Methods

3.1 Initial Methods and Literature Review

To accomplish our objectives of communicating information about the Geoexchange project as well as branding U of T as an institution that is known for sustainable development, a literature search was conducted looking at both academic and grey (e.g. conference proceedings, project reports) literature. To conduct our initial research, a list of key search words, (e.g. sustainability, sustainable development, energy project, geoexchange, community engagement, public engagement, data visualization, visualization) were searched using *Google Scholar* and the *University of Toronto Libraries database,* and cited references from reviewed papers were used. After an initial screening of the literature, four key concepts related to our original broad search topics were identified: (1) eco-revelatory design, (2) eco-visualization, (3) landscape 'messaging' and landscape visualization and (4) community-based social marketing. Literature for our secondary review was solely focused on peer-reviewed academic sources, and we conducted a synthesis of our research findings from this review. We identified the primary principles and approaches related to community engagement and our study objectives that were emphasized or overlapped between the four research topics. These ideas were then blended together to create our own framework for engagement, in order to develop compelling physical structure and digital signage models.

3.2 Model Mock-up Designs

For this project, we developed a total of 6 models: 3 physical structures and 3 digital signage models (Table 2), using our engagement framework developed from our research synthesis. Mock-ups of these models were created using mainly *Adobe Photoshop* and *Adobe Illustrator,* other software used included *Sketchup*, *Canva* and *Pixaloop.*

Table 2: Lists each mock-up design created for our two model types.

Model Type	Mock-up Designs
Physical Structures	Heated Seating
	St. George Campus Mural
	Building Plaques & Stickers
Digital Signage	Unearthed
	Digital Marketing Posters
	GHG and Me: Interactive Webpage

4. Main Findings

4.1 Eco-Revelatory Design

By using aesthetics to invoke critical thought, eco-revelatory design seeks to connect individuals and communities with their environment.[6] The term can encompass a variety of different systems and scales related to the environment. For instance, designs can mimic natural functions, use nature as a tool to create visually appealing scenes, or actively work to preserve ecosystems. Two examples that illustrate this notion are *Testing the Waters* and the *Blur Building*. Located in an area historically known for poor water quality, *Testing the Waters* seeks to expose the water purification process. The project pushes polluted water through a series of open-air basins and limestone spillways until it is clean enough to return to a creek.[6] The landscaping surrounding this infrastructure slowly changes from reds to greens to represent the cleansing process. The exhibition of this process not only serves as a beautiful landscape but also functions as an educational tool for the community and visitors.

Figure 3: *The Blur Building* Before Fog Production.[7]

The second example is only one building. The *Blur Building* by DS+R architects utilizes natural processes that are enhanced by manmade infrastructure to envelop a structure in fog. The designers describe water as not only the site of the building but also its primary material. The pavilion does not have a roof to enclose the fog but is rather made up of a sequence of intersecting metal rods (Figure 3). It sits upon large pilotis like infrastructure that give it the illusion of floating. All of these elements in combination create a white out sensation. Its design combined with the fog allows the *Blur Building* to effectively provide a unique visual and physical experience for visitors. "By appealing to both the emotional and cognitive parts of human consciousness, it (eco-revelatory design) hopes to instill in people knowledge of, and affection for landscapes that demonstrate a sustainable relationship between people and nature".[8] [(p97)]

4.2 Eco-visualization

Eco-visualization combines artistic and scientific information through data-driven animations to display real-time environmental information that is made public, available and easily understandable to everyone. By linking scientific data analysis, community engagement and public education, ecological data is reinterpreted to create meaningful yet attractive narratives that are desirable to engage with. The field of eco-visualization can "…increase our ability to conserve valuable resources like electricity, [heat] and water".[9] [(p274)]

For example, Figure 4 shows *7000 oaks and counting* which is a real-time visualization of electricity loads in the National Center for Supercomputing Applications (NCSA) building at the University of Illinois. The custom software collects electricity demand data and converts it to reveal the building's carbon footprint.[9] The sequence of animated clips uses trees to represent the number of carbon loads. When electricity usage increases, oak trees turn into electronic appliances and vice-versa. Not only does the animation include tree imagery and a colourful background to give visual interest, but it also incorporates subtle sounds to engage the audience's auditory senses. When energy loads are high, the building sounds are loud and when loads are low, the sound is replaced with a birdsong.[10] This scientific visualization engages individuals by inviting them to make public commitments to reduce their carbon footprint which is then incorporated into the animation sequence.
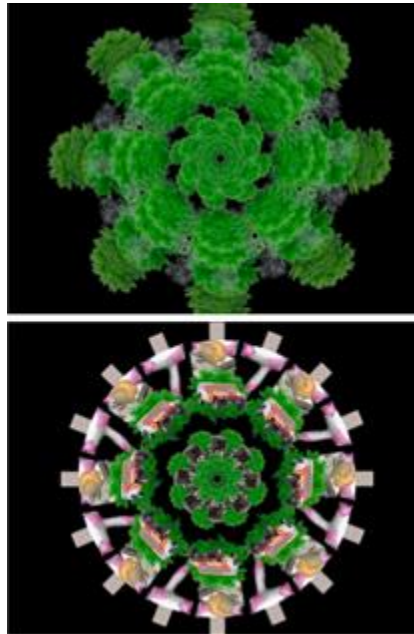

Figure 4: 7000 oaks and counting.[10]

The easily accessible visuals of *7000 oaks and counting* prove its value as it raises awareness of the building's carbon footprint by making hidden information (i.e.: carbon loads) available to its residents.[10] The public art piece visualizes energy consumption through oak trees rather than numbers to provide a sense of positivity (as most individuals maintain positive feelings towards trees) and a sense of familiarity (because the oak tree is the state tree of Illinois).[9] The public art piece invites participants to engage in the discussion about resource consumption and reflect on reducing their personal carbon footprint through self-defined offsets. In the case of U of T, we can leverage existing information hidden within digital control systems to encourage conservation of energy as the Geoexchange system serves the heating, ventilation and air-conditioning (HVAC) needs of campus buildings.

4.3 Landscape 'Messaging' and Visualization

Landscape 'messaging' is a concept coined by Stephen Sheppard, who sought to communicate ideas of environmental protection and sustainability to the public through the use of dynamic landscapes.[11] It involves exposure of large-scale phenomena and their impact (e.g. climate change) through the modification of local landscapes.[12] Landscape visualization is one strategy that can influence public perception through the use of 2-D or 3-D models that alter existing landscapes and everyday surroundings (Figure 5).[12, 13] Visualizations are composed of a combination of landscape elements (e.g. water, vegetation, infrastructure, animals, atmosphere) and varying levels of abstraction (i.e. level of detail or style of the illustration).[13]

To bring attention to complex and often abstract issues, landscape visualizations convey information in a way that strongly appeals to both logic and emotion.[11, 14] This practice influences people's perceptions of environmental concerns and stimulates cognitive (i.e. knowledge and understanding), affective (i.e. feelings, attitudes and emotions) and behavioural functioning of viewers.[11, 14] Visibility is another principle utilized that can serve to rapidly advance people's awareness of environmental issues.[11] Intrigue is also established by making invisible environments visible, scarcely visible environments more prominent and/or what is already visible, comprehensible to the public.[12] The core mechanisms behind landscape visualization act to develop deeper connections between participants, the land and environmental concern to establish a greater sense of appreciation and understanding.[11]
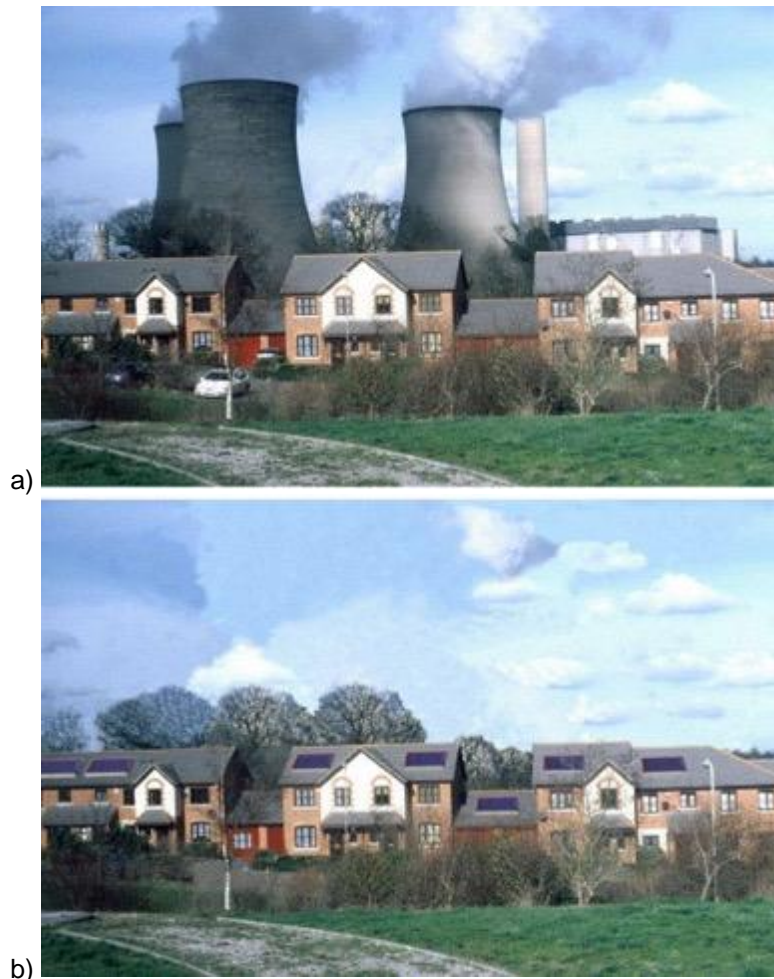

a)

b)

Figure 5: A visualization of an existing neighbourhood in South England (a) vs. what a low-carbon future could potentially look like (b).[11]

4.4 Community-based Social Marketing

Community-based social marketing (CBSM) blends both psychology and social marketing in a rigorous four stage framework to make well informed and desirable behaviour change.[15] This framework initially identifies barriers in promoting certain behaviours and then, after that has been identified, a selected behaviour is chosen to be promoted; next a program is designed to overcome the barriers to the selected behavior; and then piloted to be evaluated once it has been broadly implemented. This marketing technique is most commonly used in sustainability promotion to make well informed and desirable behaviour change.[15] Examples of CBSM tools are prompts that remind people to engage in sustainable behaviour and vivid communication tools with engaging messages and images.[16]

Examples of signage campaigns include New Zealand's *Govt3* campaign encouraging waste reduction (Figure 6a). The campaign concluded a 66% waste reduction in respect to their Wellington and Christchurch offices.[17] There was also the *Target 10%* campaign which aimed to encourage residents to reduce their energy consumption (Figure 6b). The campaign reached success within six weeks as there was an increase in audience reach and awareness regarding issues of over energy consumption. The signage used humour making messaging more accessible and not too confrontational.[17] This further reinforces the importance of eliciting appropriate emotional responses in creating effective and engaging signage.

Figure 6: New Zealand's campaigns Govt3 (a) and Target 10% (b). [17]

Although the New Zealand campaigns are examples of social marketing, it still serves as a powerful example of effective signage. One notable difference between community-based social marketing and social marketing is scale. Social marketing is much broader in scale and audience reach whereas CBSM is much more localized. We recommend community-based social marketing for this reason. Taking a more localized approach reflects the data found in the literature that supports the notion that one approach does not apply to all circumstances. When taking the community-based approach you curate a more appropriate, well-informed and tailored program for the specific community that needs engaging. It supports a nothing about us without us approach which largely informed our rationale for pursuing this method. For the purpose of this project and its limitations comparing and contrasting these two approaches allowed us to explore and experiment with a variety of concepts.

5. Data and Analysis

5.1 Data Collection

Data collected for our report looks at primarily peer-reviewed academic literature focusing on the four research concepts: (1) eco-revelatory design, (2) eco-visualization, (3) landscape 'messaging' and visualization and (4) community-based social marketing. The literature we reviewed has a strong emphasis on strategic methods for the communication of both complex, scientific theory and sustainability literacy. We also consulted design precedents in the sphere of eco-revelatory design, approaches and examples of eco-visualization and landscape visualization, along with strategies for compelling community-based social marketing. To supplement these strategies and ideas with credible, scientific information, we have gathered various data related to U of T's Geoexchange system. This includes data regarding the reduction of greenhouse gas (GHG) emissions, thermal energy use and system schematics, as well as information about demographics at the University.

5.2 Research Synthesis

In order to facilitate public awareness and engagement with the Landmark Geoexchange project, we aim to ensure that our physical structures and digital signage prioritize:

1. **Creative thinking**: what participants know.
2. **Eliciting emotional responses**: what participants feel.
3. **Participatory reflective practices**: what participants can do.

5.2.1 Creative Thinking

People are unable to decipher complex environmental data in meaningful ways that can relate to their lives. However, we found that introducing art mediums can attract the attention and engagement of individuals. In other words, "visualization empowers imagination" as people develop their own narratives to their life and the environment around them.[6] This idea was demonstrated in eco-revelatory design as it uses aesthetics to provoke critical thought through connections made between communities and their surroundings. Thus, our designs will build on this idea of art in order to invite individuals to envision and comprehend ecological data that is often misplaced, hidden or forgotten.[18] By combining art and technology, we embrace the concepts of eco-visualization as well as landscape messaging and visualization which can produce new forms of dynamic data representation. Specifically, eco-visualization creates data-driven animations to interact with the public and the latter uses realistic landscape visualizations to build community awareness.[10, 11] Both approaches leverage the power of art to make the invisible visible through new innovative ways of communicating environmental issues that motivate people to conserve resources. In addition, we will incorporate functional or fact-based appeals which reflect advertising methods commonly used in social marketing.[16] Ultimately, we aim to create a space for questioning and dialogue so that individuals become participants in the experience rather than observers. In turn, this would allow for deeper connections to what they value within their environment which may motivate them to sustain it.[19]

5.2.2 Emotional Responses

Not only does art have the ability to convey hidden ecological data to get the audience thinking, but it also has the capacity to stimulate feelings. Therefore, effective public engagement involves the combination of both informative and emotionally evoking visuals.[10] By touching peoples' emotions, people tend to pay more attention to the narrative which taps into their long-term memory.[20] Capitalizing on human memory and feelings is imperative to effectively communicate environmental issues thus, these two aspects will be reflected in our recommendations. The theme of emotive responses carries significance in ecological design as this practice uses nature by replicating or mimicking existing landscapes and natural functions to create visually appealing scenes.[6] This concept ties to landscape messaging and visualization that alters existing landscapes and everyday surroundings to promote awareness of environmental issues as well as influence behaviour and policy. In using nature imagery, we are able to evoke affective responses that positively influence the formation of brand attitudes. As community-based social marketing highlights the engagement between psychology and social marketing, a selected behaviour is chosen to be promoted.[15] By influencing people's perceptions and stimulating cognitive, affective and behavioural functioning, art collaborations provoke feelings and attitudes which change behaviour in a positive way.[11, 14] With all that said, we will gain the interest of an audience through the use of capitative and memorable imagery that elicits emotional responses to maintain interest with the ecological data being conveyed.

5.2.3 Participatory Reflective Practices

While creative thinking involved seeing and understanding and emotional responses involved feeling, participatory reflective practices focus on doing. By providing an experience that puts participants in touch with their environment, two practices unfold: dialogue and reflection. A space that uses data visualization to generate reflective conversations around complex environmental issues can empower a community to create change. The best projects are those that bring "participants as close as possible to evolving processes," even better are those that provide different vantage points.[6 (p116)] Therefore, we

aim to create innovative art pieces that invite social conversations as "individuals hone their values and sense of responsibility by watching and interacting with others".[19] [(p507)] To reiterate, visualizations of environmental data have the power to influence an audience to act and behave differently. Through the strategies used in community-based social marketing, we can promote positive and sustainable behaviours. By promoting participation and empowerment through design, we can inform the public about sustainable development and advocate an environmentally responsible lifestyle at U of T.

6. Recommendations

6.1 Physical Structures

6.1.1 Heated Seating

To garner appreciation and interest for U of T's Geoexchange project, we recommend utilizing principles from the four research concepts to create a unique experience for students, faculty, and visitors to the campus. The best way to reveal the existence and functions of the Geoexchange system is to utilize its heating properties in ways that will be both beneficial and intriguing. We suggest heated seating areas and snow melt designs powered by heat from the Geoexchange system surrounding King's College Circle. The heated seating we have devised consists of circular step seating that is dug into the Earth (Figure 7). The below-grade construction will likely be easier to heat and also serves as a metaphor for the geothermal infrastructure that will be placed deep within the Earth. Seating is much needed in the area and will complement the overall goal of the Landmark Project to make King's College Circle into an inviting space to gather. Signage indicating that it is heated by U of T's Geoexchange system will inform visitors of the project's existence and processes. A QR code nearby will link individuals to an interactive webpage which is discussed in Section 6.2.3. The refuge that heated seating will provide in the colder months will likely create a great amount of gratitude for the Geoexchange system because it will directly benefit individuals.

Figure 7: Heated Seating placed into the ground.

In addition to the heated seating, we recommend snow melts that will also use the Geoexchange system. Heated tubes that prevent snow from settling on the surface can be placed strategically to create decorative and provocative designs. We have created a mock-up consisting of snow melt that creates the U of T logo and an array of rings (Figure 8). These designs will likely gather a substantial amount of attention from passersby creating a sense of wonder as to why they're occurring. If U of T chooses not to reveal the processes behind the snow melt designs right away, it is probable that the mystery and discussion surrounding them will increase. Once individuals discover that it is in fact a Geoexchange system that is the source of these designs, they will likely remember it. Both the heated seating and snow melt designs can be implemented separately or together. They are both likely to gather attention, intrigue and appreciation.

Figure 8: Snow Melt creating the U of T logo on King's College Circle and an array of rings.

6.1.2 St. George Campus Mural

To make people aware of how impactful the Geoexchange system will be, we recommend a mural of the St. George campus (Figure 9) that highlights the seven buildings that will be using geothermal heat as an energy source. This display will enable the interface of the hidden Geoexchange system to be visible to the U of T community and the general public.
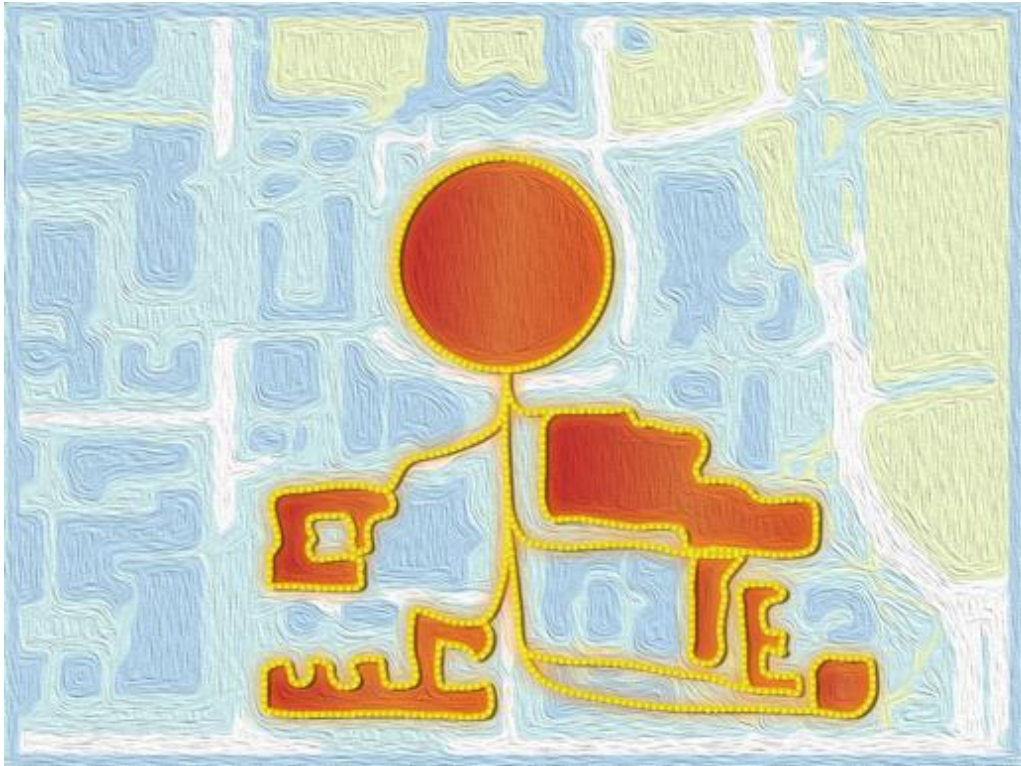
Figure 9: St. George Campus Mural.

The campus map will be made out of Power Aware Cords which are translucent cables that represent energy consumption through glowing pulses, colour and intensity of light (Figure 10).[21] Rather than indicating energy in Watts on a numerical display, the cords use dynamic glowing patterns to reflect the level of energy being used by the Geoexchange at a given time. These electroluminescent wires make energy consumption easier to visualize and comprehend. In fact, using light as a symbolic representation creates an association with the real world since it registers as a form of energy.[21] This art medium unfolds aspects of eco-visualization as the power aware cords communicate site-specific data in an aesthetically pleasing way.

Figure 10: Power Aware Cord.[10]

We recommend placing the campus mural on the wall of the Medical Science Building because of the high volume of individuals that pass through this area to get around the campus (Figure 11). The glowing lights from the cables will attract users on an interactive level thereby, opening a space for creative thinking. In placing the campus mural at the site of the Geoexchange system, it allows individuals to visualize the impact of the system and understand the movement of heat throughout the campus. Since the concept of energy flow is simplified to an arrangement of glowing cables, people can decipher complicated data in meaningful ways that relate to their lives. Thus, both an educational and personal connection is created between the community and the campus. In seeing the mural and thinking about energy usage, people may feel a sense of pride knowing that U of T is using renewable energy to heat seven buildings on campus. The dynamic use of light and intensity may also spark an interest and will increase public awareness of energy usage on campus. This will facilitate participatory reflective practices as it urges users to be aware of and reflect upon the energy efficiency of the Geoexchange system.
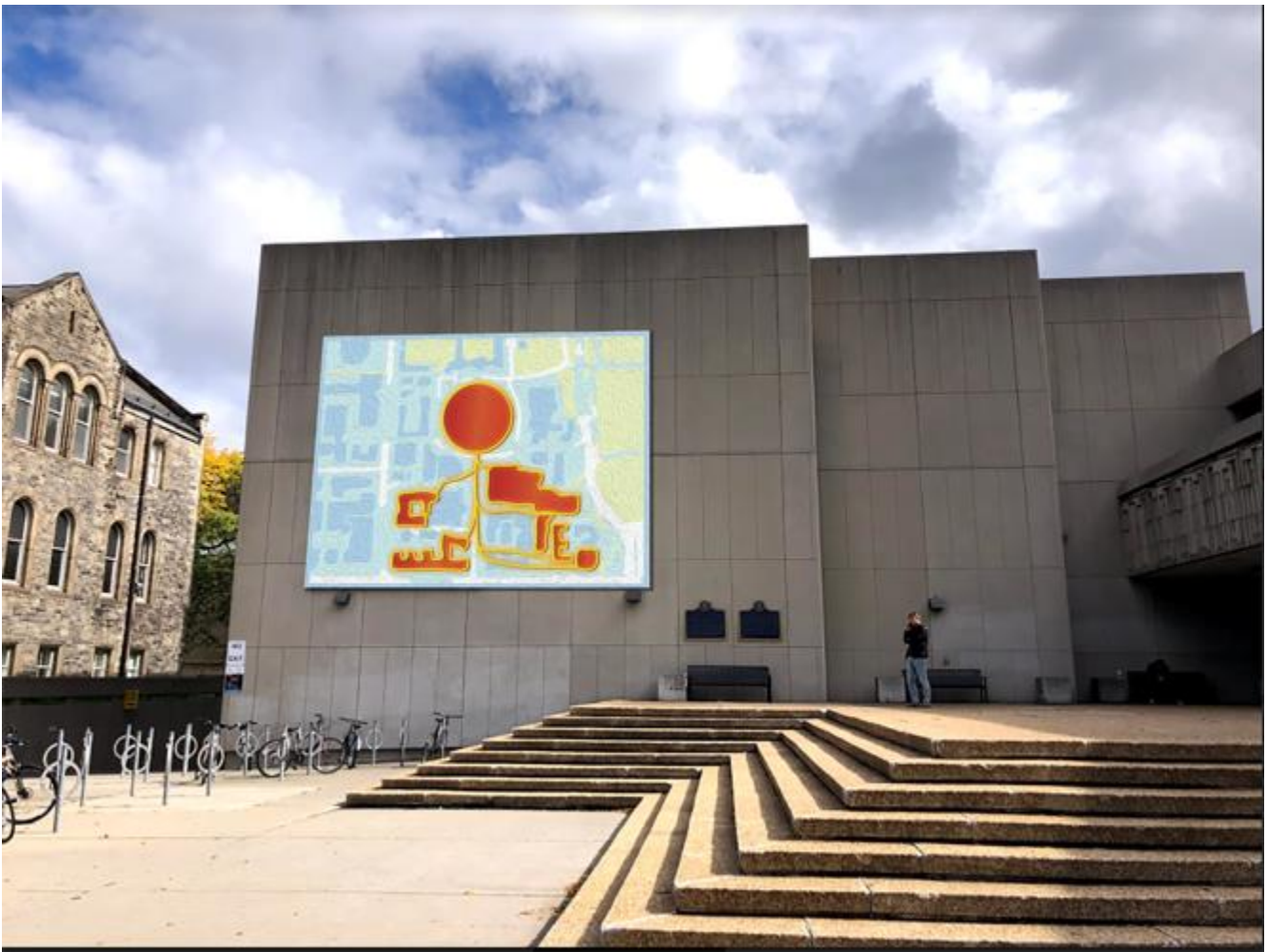

Figure 11: St. George Campus Mural on Medical Science Building.

Since this is a mock-up, we recommend a call for artists who can create a more impactful and artistic campus mural (Appendix A). Not only would promote awareness of the Geoexchange project, but it will also encourage individuals to engage with energy consumption/usage and sustainable development in general.

6.1.3 Building Plaques & Stickers

The addition of plaques and stickers at the building sites will increase awareness for both the Geoexchange project and its scope (i.e. buildings involved; Table 1). The building plaque is modelled after an existing plaque at the Medical Sciences Building, and the sticker design includes a graphic of the heat flows at King's College Circle and a building receiving energy to represent the Geoexchange system. Our mock-ups were designed to remain in-line with current U of T branding as they use both the official font family (i.e. Trade gothic), and colours (i.e. U of T Blue) for the sticker (Figure 12).[22] This was done intentionally to make the models visually appealing, allow them to be seamlessly integrated into U of T's existing brand identity and increase positive reception from the University's community members.[23, 24]

a)   b)
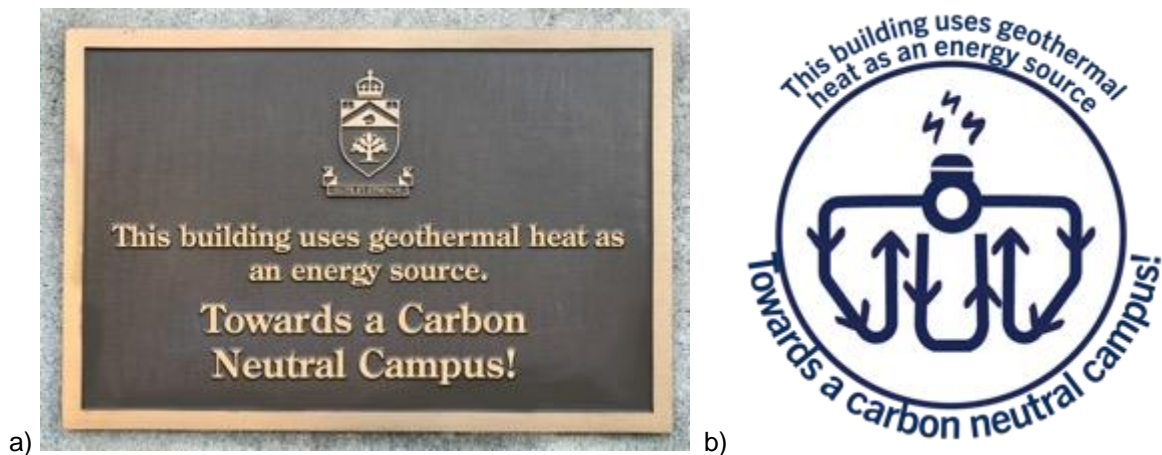
Figure 12: The building plaque mock-up (a) and sticker mock-up (b).

The building plaques are envisioned to be placed at multiple entrances of buildings that will utilize geothermal heat (Appendix B, Figure B1), while the stickers will be placed on existing building signage (Appendix B, Figure B2). This will make them visible to both individuals who frequent these buildings and passersby on campus. Building plaques should also be placed at the St. George Campus Mural (Figure 13) and heated seating structures to establish a clear link between our engagement models.

Figure 13: The building plaque mock-up placed underneath the proposed St. George Campus Mural at the Medical Sciences Building on St. George Campus.

In addition to the phrase regarding geothermal heat, both our plaque and sticker mock-ups include the slogan, "Towards a carbon neutral campus!" (Figure 12). This serves to bring together these prototypes by maintaining an element of consistency amongst the designs which can further build awareness and recognition.[23] It clearly communicates the goal of the Geoexchange system (i.e. reduce the University's carbon emissions) and cements the idea of U of T as a sustainability leader in the minds of community members and others.

Figure 14: The alternative sticker design includes a QR code in its centre.

To increase awareness for the project amongst individuals that do not interact with the seven project buildings, we have created an alternative sticker design that can be placed across campus (Figure 14). We suggest that the alternative stickers be installed campus-wide, in areas near water fountains, around benches and seating, waiting areas outside of lecture halls and in study spaces (Appendix D, Figure D1). This will broaden our audience and increase engagement especially amongst students, who compose a large demographic at U of T.[25] Furthermore, we wanted to create a more participatory experience in these spaces to bridge the disconnect that can be further intensified by distance from the project area at King's College Circle. Thus, we propose connecting our alternative sticker design to our interactive webpage model which also helps to create a more concerted framework for engagement. The alternative design contains a QR code that individuals can scan using a personal device such as a phone or tablet (Figure 14). This will link them to a webpage with more information about the Geoexchange system as well as prompt them to engage with our interactive webpage model discussed in Section 6.2.3. Given their simplistic nature, plaques and stickers can be easily implemented across campus, gaining exposure for the Geoexchange project and connecting our proposed models.

6.2 Digital Signage

6.2.1 Unearthed

The *Unearthed* model involves the illustration of the different environmental layers at King's College Circle to make the hidden Geoexchange system visible to the public. Our mock-up draws heavily from conventions of landscape visualization and illustrates the different layers of the campus environment: the Geoexchange system, the underground parking lot to be constructed and King's College Circle (Figure 15). By divulging the invisible landscape beneath the campus, this model will increase public understanding of the Geoexchange system and its functioning.
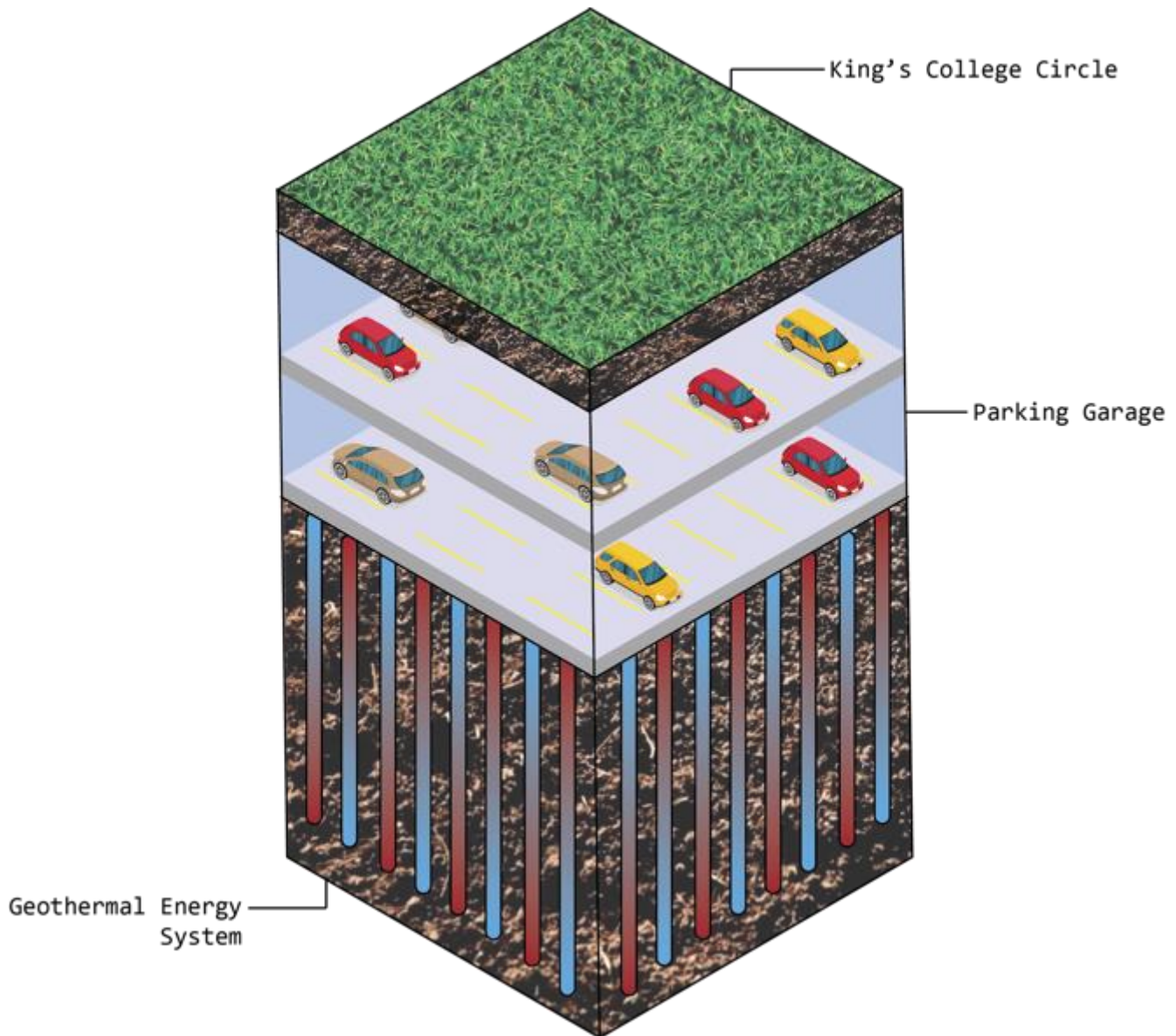
Figure 15: The landscape visualization model is a 2D illustration of the 3 layers of the campus environment: (1) the Geoexchange system, (2) parking lot and (3) King's College Circle.

Our model is a basic, 2-D rendition of the landscape due to our limited technical ability, so instead it serves inspirational purposes. Rather, we recommend a 3-D model which includes animated elements and has a greater level of realism; all of which enhance user experience, increase local salience and foster community identity.[26, 27] The more realistic the visualization is, the more individuals will be able to readily conceptualize the Geoexchange system and its functioning, as well as the changes to be made to campus. 3-D visualizations can increase both enthusiasm and engagement, and most notably, can improve the learning of its complex functioning as it clearly displays processes such as the heat pumping of the Geoexchange system.[12] The implementation of animated elements (i.e. heat flows, people walking, etc.) can enhance user experience and engagement as demonstrated by past studies.[11, 28] Specifically, animated heat flows will work to further exemplify the functioning of the Geoexchange system which, in turn, increases public understanding of the system.[27] Developing a model with a greater degree of realism will result in a more compelling visualization and is essential to instigate emotional reactions and social learning amongst participants.[12]

We propose that the model include more detailed landscape elements in the underground parking lot (e.g. cars, bikes, people) and King's College Circle layer (e.g. people walking, sitting, cycling; vegetation; infrastructure) (Appendix C, Figures C1 and C2). Additional details can produce more holistic imagery, concretize abstract concepts and involve individuals in a collaborative learning process.[11] The models detailed familiarity will also incite strong, positive affective responses (i.e. feeling, emotion or mood) in viewers thereby, increasing public reception and engagement.[11, 25]

For placement, we recommend the models be located in high traffic areas due to their attention-grabbing nature and potential to become gathering sites.[12] Models can be displayed on stand-alone structures such as electronic dashboards or large electronic screens like those currently on campus. Potential sites include building atriums, student lounges and open study areas which receive a large number of daily visitors (Appendix D, Table D1). Furthermore, the model should be available through the U of T website, so that the project is accessible to a wider demographic and will contribute towards branding U of T as a sustainability leader.

Overall, *Unearthed* draws from principles of landscape visualization, eco-revelatory design and eco-visualization to exemplify and reveal the processes of the Geoexchange system happening underground. It illustrates this unknown reality by bringing the Geoexchange system to life and highlighting its role within this larger framework of sustainable development at U of T.

6.2.2 Digital Marketing Posters

When designing the digital signage, we tried to stay as true to community-based social marketing as possible or at the very least social marketing given the scope and limitations of this project. The signage aims to engage with the community emotionally and elicit positive emotions like pride and joy and to avoid negative emotional confrontation and blaming. It was designed to be informative without being excessive. It stays true to the traditional U of T brand as it utilizes the official *U of T Style Guide* and *Boundless* guide from February 2012. This concept is fairly easy to implement and feasible as the digital signage can easily be uploaded to a variety of online and digital platforms such as mobile devices, laptops and digital screens in public places (Appendix D, Table D1). We designed marketing poster 1 to follow the landscape visualization method bringing solutions into conversation with each other (Figure 16a). Marketing poster 2 displays a per person marketing strategy to yield impactful emotional responses and make information easy to digest (Figure 16b). These designs work as vivid communication tools and powerful imagery.

a)   b)

Figure 16: Two digital marketing poster prototypes (a) and (b).

6.2.3 *GHG and Me*: Interactive Webpage

The *People's Garden* is an eco-visualization placed at a Noosa bus transit centre in Australia that asks, "What did you do for the environment today?." Through the use of digital technology, the display requires the participation of the public to send a text message via SMS in order for the vine to grow – if no one engages with the display, then the vine shrinks.[19] New animations are promoted the more people participate. By showcasing people's environmentally supportive messages to the members of their community, it promotes resource conservation and a positive connection to nature.

Utilizing the framework of the *People's Garden*, we have proposed a similar concept with our interactive webpage called *GHG and Me* (Figure 17). The webpage is launched by a QR code where individuals will be prompted to interact with our model through a given question such as, "Do you know about the Geoexchange system?" or "Have you recycled today?." Questions can be related to the Geoexchange project as well as sustainable behaviour in order to promote sustainability competency. Their answers will then contribute to the state of an animated illustration. The animated illustration is smoke in the body representing GHG emissions. The objective is to answer environmentally sustainable yes or no questions, with answers that encourage and demonstrate sustainability competency impacting the visualization positively while answers that lack concern for sustainability impact it negatively. The webpage is designed to promote participatory reflective practices by encouraging participants to be well informed about the Geoexchange system, engage in sustainability initiatives, and support environmentally friendly behaviour. We also recommend *GHG and Me* be placed in high traffic locations to encourage engagement (Appendix D, Table D1).
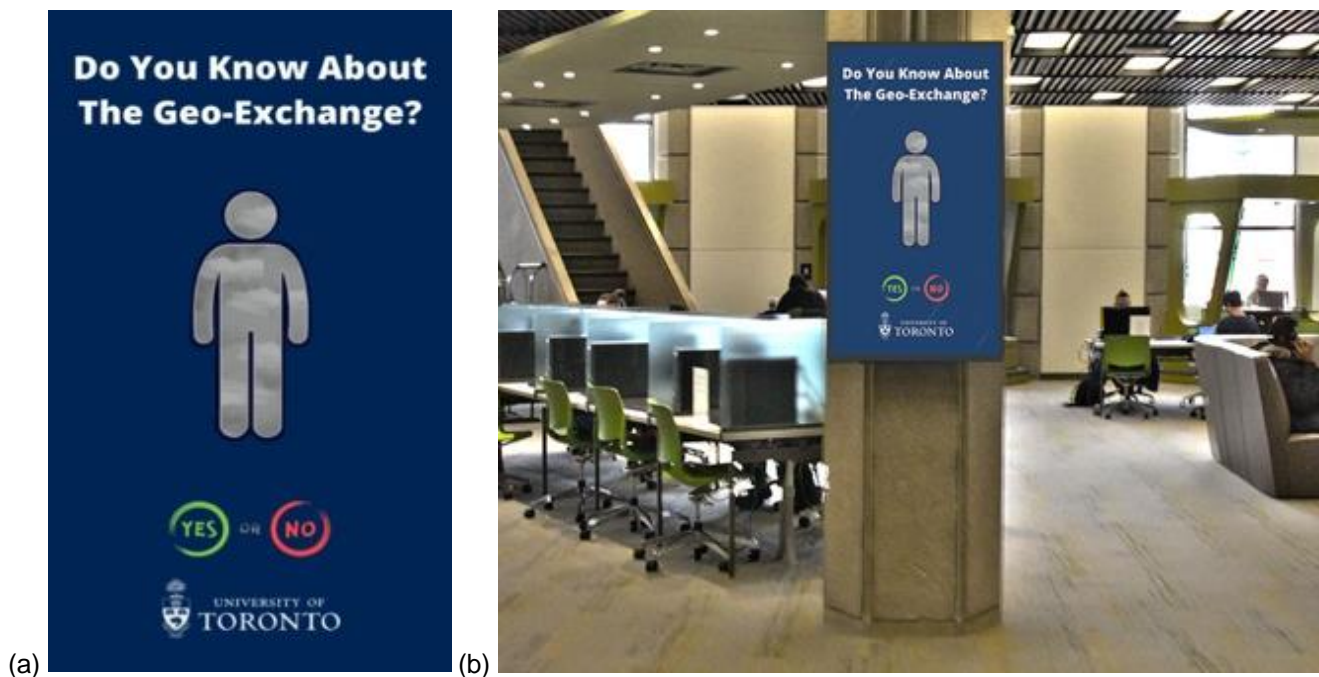

(a)   (b)

Figure 17: GHG and Me (a) and what it would look like on a digital display (b).

6.3 Timeline

Our six recommendations are designed to be implemented at different stages during the development of the Geoexchange system (Figure 18). Before construction, U of T should install the digital marketing signage as well as the Unearthed model at different locations around campus to get the greatest benefit from them. By implementing these recommendations prior to the completion of the project, it will further inform and excite community members to the evolution of an iconic space on campus. The heated seating and snow melt designs should be built during construction to ease implementation and reduce construction time. After completion, the campus mural, plaques and stickers should be added to indicate which buildings are involved and increase public exposure to the project. Dividing implementation in phases, will create a consistent engagement and awareness for the Geoexchange system throughout its lifetime.
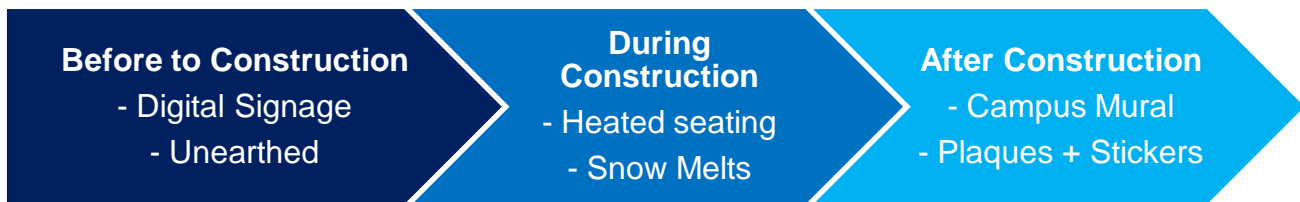
Before to Construction
- Digital Signage
- Unearthed

During Construction
- Heated seating
- Snow Melts

After Construction
- Campus Mural
- Plaques + Stickers

Figure 18: Implementation timeline for the six recommended models.

7. Conclusions

Communicating sustainability is a vast, complex, and fairly unexplored landscape due to the many new and unique ideas. Although eco-revelatory design, eco-visualization, landscape visualization and community-based social marketing are four different concepts, they were easily brought into conversation with each other. We found that the four concepts share an interconnectedness that lies in creative thinking, emotional messaging and participatory reflections. Therefore, it was concluded that effective public awareness and engagement involve the combination of informative yet emotionally-evoking visualizations that connect individuals to their environment. By creating a space for dialogue, deeper connections can be made which can motivate sustainable behavioural change. The key is to clarify environmental issues rather than simplifying them.

When connecting these four strands together, we also came to realize important aspects of facilitating internal and external engagement. In other words, communicating sustainability is a multifaceted task especially, given the University of Toronto's diverse community. Thus, it is apparent that a solution just as complex and diverse is needed. The literature emphasizes the idea of complex solutions for complex problems, stating that not one size fits all when communicating sustainability.

Nonetheless, our six recommendations provide an immense amount of diversity as it draws from the strengths of eco-revelatory design, eco-visualization, landscape visualization and community-based social marketing. They connect individuals to the St. George campus, provoke positive emotions through pride, create spaces for dialogue and participation and most importantly, our recommendations make the hidden Geoexchange project visible to the U of T community and the general public.

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9. Appendices

9.1 Appendix A - Call for Mural Submissions Mock-up

UNIVERSITY OF
TORONTO

CALL FOR SUBMISSIONS

The University of Toronto is seeking an artist to design a mural for their St George campus. U of T has installed a Geoexchange system under King's College Circle that will provide heating and cooling capacity to seven buildings on the St George campus. This system will save 15,000 tonnes of carbon dioxide equivalent per year. The mural will celebrate the Geoexchange system as well as U of T's commitment to reducing greenhouse gas emissions. We ask artists to design a creative rendering of the St George campus map that shows heat flowing from the Geoexchange system to the previously mentioned seven buildings. These are the locations on campus that must be included in the mural:

- King's College Circle
- Medical Science Building
- FitzGerald Building
- Terrence Donnelly Centre for Cellular & Biomolecular Research (CCBR)
- Leslie Dan Faculty of Pharmacy
- Galbraith Building
- Wallberg Memorial Building (WB)
- D.L Pratt Building

9.2 Appendix B - Building Plaques & Stickers Mock-ups Campus Placement

Figure B1: This figure shows a building plaque mock-up placed outside the University Street entrance at the Medical Sciences Building on St. George Campus. It demonstrates potential locations as to where building plaques can be placed at buildings.

Figure B2: This figure shows a sticker mock-up placed on already existing building signage at the Medical Sciences Building on St. George campus. Stickers can be placed on these signs associated with the 7 buildings part of the Geoexchange project.

9.3 Appendix C - *Unearthed* Additional Model Recommendations

Figure C1: Both the top and bottom images represent the improvements to be made to King's College Circle as part of the Landmark project.[31]

Figure C2:. Illustration of the underground parking lot at King's College Circle once completed.[31]

9.4 Appendix D - Potential Model Placement Areas

Figure D1: Potential locations to place stickers or digital signage models. Medical Sciences Building lobby (a)[32], seating outside lecture halls at Lash Miller (b)[33], Bahen Centre main-floor lobby (c)[34], water fountain beside Sid Cafe in Sidney Smith Hall (d)[35].

Table D1: This table has a list of buildings that receive a high volume of daily visitors and areas within the buildings where digital models could be placed.

Building Name	Potential Locations
Gerstein Library	● Main Entrance ● 1st-floor lobby and front desk area ● 1st-floor computer area
Medical Sciences Building	● Main Entrance lobby area (Figure D1a) ● Student lounge and cafeteria area
Bahen Centre for Information Technology	● 1st-floor atrium (Figure D2) ● Cafeteria area ● Hallway study bar-tables ● 3rd-floor seating area (Figure D3)
Robarts Library	● 1st-floor lobby area ● 2nd-floor lobby area (Figure D4) ● Area around the escalator (1st, 2nd, 3rd, 4th floor) ● Cafeteria seating area
Sidney Smith Hall	● Main entrance area ● Seating area in the building hallways ● Sidney Smith Commons (Figure D5)
E.J Pratt Library	● Main floor entrance ● Basement-level student lounge (Figure D6)

Figure D2: The Bahen Centre for Information Technology main-floor atrium.[36]

Figure D3: The Bahen Centre for Information Technology 3rd-floor seating area.[37]

Figure D4: The Robarts Library 2nd-floor lobby and open-seating area.[38]

Figure D5: The Sidney Smith Commons student study and lounge space at Sidney Smith Hall.[39]
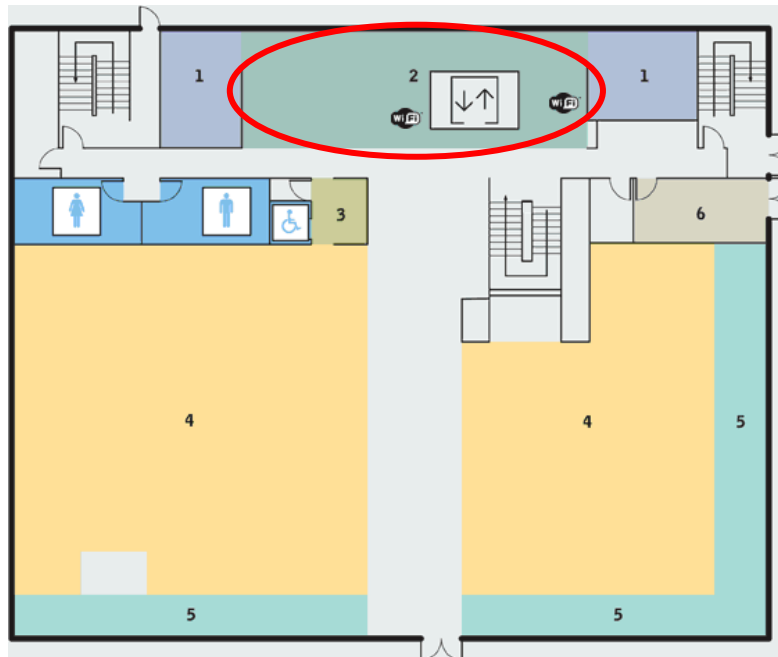

Figure D6: The ground-level layout of E. J. Pratt Library shows the student lounge area coloured green and circled in red.[40]