Expressive Cartography
and the Aesthetics of Public Visualization

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ABSTRACT

Aesthetic visualization projects that incorporate users, community stakeholders, multiple modalities and technologies necessarily emphasize the way that an artistic visualization can be both an artifact and a process — a conceptualization of aesthetic visualization that is useful for thinking about visualization in general. In this paper, the authors propose the concept of expressivity as a move away from the indexical claims of visualization and instead towards an acknowledgement of the entangled nature of social, political, economic, cultural, technological and environmental actants. Through a description of the In The Air, Tonight public visualization project, the authors suggest that by making manifest the connections between these actants, a visualization project, as a form of expressive cartography, can contribute to the visibility of and engagement with important issues (e.g. homelessness) that affect society.

Index Terms: Expression, participation, relational, networks, visualization, social issues, climate.

1 INTRODUCTION

On February 20, 2014 the Ryerson Image Centre became a visualization device that assembled weather data, poverty issues and social media processes for the duration of a month.

We suggest that this project, called In The Air Tonight (ITAT), constitutes a particular form of art, design and visualization practice that attempts to step beyond a concern of formal aesthetics, problem-solving or augmenting cognitive processes. We also posit that this project serves as a modest example of expressive cartography — that is, a form of visualization that acknowledges and fosters a critical understanding of the complex processes of translation, representation and participation involved in any form of visualization.

To understand the use of expressive in this context we must first think about how expression is contrasted with communication. Where communication is focused on the correspondence between a sender and a receiver (e.g. Shannon & Weaver's mathematical model of communication) [31], expression is focussed on the relations between entities (e.g. Deleuze and Guattari's concept of the refrain) [11].

Rather than simply referring to geospatial information visualization we use the term cartography to signal two important aspects of information visualization practice. First, the way that in most, if not all, instances of visualization data is mapped onto the terms or context of other data (see Cox [8] and Manovich [25]). Second, that visualization, in particular the kind that can be termed artistic or aesthetic (see Viegas and Wattenberg [33], Fishwick [14], Sack [30], Ramirez Gaviria [16]), function as maps that arrange information, images, etc. which produce a multitude of subjective readings and connections [11] beyond the original intentions of the designer/artist. Seeking expressive communication over direct representation (Cubitt [9]), artistic data visualizations are manifestations of information flows that are inherently relational, processual, mediatory, involving work (e.g. participation by humans and non-humans) and therefore work beyond a concern for indexicality and towards a concern for instantiating a specific set of connections.

Another important aspect that we would like to note is our emphasis on information visualization as a practice. This subtle yet significant shift is an acknowledgement of the performative dimension of visualization. The use of the term performance, in this context, is meant to highlight the activity of creating visualizations, of the constructed nature of visualization and the use of visualizations — an analysis that has already been made with regards to maps (see Pickles [29]). Rather than focus on the veridical characteristics of a visualization the focus is put on the imbrication of social and technical processes. Visualizations, in other words, are always in a state of becoming. This emphasis is necessary, in our opinion, to understand visualization projects and especially a project like ITAT.

This paper will outline key social, technological and environmental aspects of the ITAT project in the hopes of providing a case of an expressive cartography approach. Above all, ITAT was an attempt to create a space through interaction, event and visualization. The space is created through the animation of the LED façade on a building and thereby creating visual interest and providing opportunities for interaction to pedestrians walking past. The space is also created through the encouragement of participants to post messages on Twitter including the #homelessness hashtag. Furthermore, it is emphasized through the organizing of events that use the building-sized visualization as a starting point for dialogue. This included outreach to local drop-in centres and homeless shelters. These sites were given information about the project and clients were encouraged to participate in the project at internet kiosks.

2 EXPOSITION

The Ryerson Image Centre and the School of Image Arts was a former brick brewery distribution warehouse renovated in 2012 by Diamond Schmitt Architects with a programmable multi-colour LED façade which covers the majority of 3-storey building [10] (Figure 1). Located in downtown Toronto, its geographic position puts it in the middle of various homeless shelters and drop-in centres for the poor, homeless, and chronically under-housed (e.g. Evergreen, University Settlement House).

This project works — as many, if not all, projects do — through an intersection of technical, social and environmental frameworks. Each framework does not exclude the other but rather makes the point of highlighting specific arrangements that are often defined as very separate spheres.

2.1 Technical

The technical arrangement involves four main connected processes: sensing, visualizing, interacting, lighting.

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2.1.1   Sensing and Getting Data

In order to get the data we needed there were several components we used for this project. The only hardware used was the consumer-level weather station (Acu-rite). Software components included the Weather Underground API, Twitter API, Processing/Java applications and web development languages including JavaScript, PHP, CSS and HTML.

Once the weather station was setup, the data was transmitted to an Acu-link server where users could access it through a dashboard interface. However to manipulate the data we needed to feed the data stream into a separate data service provider. In this case it was Weather Underground. Once the connection between Acu-link and Weather Underground was established we extracted the data using the Weather Underground API. In order to constantly poll the data we set up a Processing sketch to execute a php script command every 30 seconds. The data was returned in JSON format and stored in a text file on the server as a buffer. We extracted the data using Java Script and displayed it in HTML format and styled using CSS.

Figure 1: Ryerson Image Centre building with ITAT visualization.

In order to access Twitter we used a third-party PHP library for authentication and to look for tweets that contained #homelessness. The library we used was Twitter-API-PHP written by James Mallison. Again we used Processing to call the PHP script every 30 seconds. The data returned was in JSON format and stored in a text file on the server. We only stored the last ten tweets that contained #homelessness. Much like the weather data, we used JavaScript to extract the day and displayed it in HMTL and styled in CSS.

2.1.2   Visualizing and Interacting

The visual design of the visualization was conceived as a weather beacon. It involved experimenting with different ways of portraying windspeed and wind direction with the Java/Processing-based simulator (i.e. snowfall effect, turbine effect).

A basic sweeping blue animation represented windspeed (i.e. sweep speed equals windspeed). The direction of the sweep represented the direction of the wind (i.e. left and right). The wind direction is derived from a compass on our weather station from which we get data in degrees (i.e. 0 degrees equals north and 180 degrees equals south). If the wind crosses 180 degrees we change the direction of the animation. We chose this number since the main face of the Image Arts building, which faces the pond / ice rink and therefore attracts the majority of pedestrian traffic, runs north to south and would reflect the direction of the wind appropriately. This constant animation is intermittently disrupted

by a pulse of colour that represents a tweet containing the hashtag #homelessness.

The visualization is extremely simple in order to take advantage of the particular characteristics of the physical space and LED façade. More complex layers of information, given the low resolution of the façade, would simply have become confusing and difficult to correlate to a particular datum. This apparent limitation worked to our advantage for it allowed us to simultaneously relate and distinguish the two sides of the nature/culture split, namely windspeed and social communication, via the colour blue (wind) and red (#homelessness).

The choice of colours also helped reinforce the legibility and presence of the project. For instance, the blue gradient acted as a symbol of the project by connecting the building with the mobile website (Figure 2) and desktop website as well as all the other visual elements (e.g. collateral material) involved. Blue became a visual extension of the building to create an external/dispersed network of screens for the installation — beyond the physical building and onto mobile/desktop devices. The colour was reserved for intermittent use. The red pulse was designed to act as a warning or signal of concern — activated on the dispersed screens.
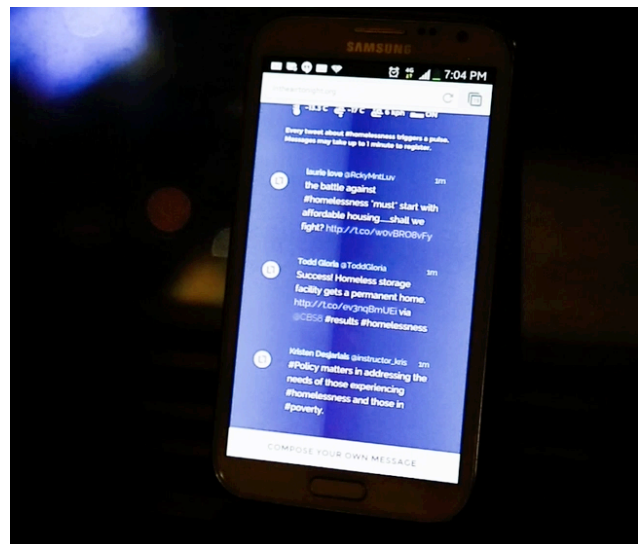

Figure 2: ITAT mobile web interface displaying tweets and current visualization on building facade.

The visualization of windspeed, direction and Twitter activity took place on the building as well as on the mobile devices of viewers on-site and web users off-site. This meant that visitors experienced the scale of the building's animation, the immensity of the warning signal combined with smaller, scattered experiences of red signals on smaller screens in the immediate vicinity. An embodied experience emerged of the large scale LED light installation with reflections off the environment (e.g. windows, ice, snow, concrete) to create an overwhelming aesthetic and specular experience.

The building acted as central beacon both physically in the city and visually in a set of interfaces offered to participants — the blue and red animation tied together the visuals as displayed on the building and the mobile/desktop website. The interaction exists both onsite, where users directly respond to the physical experience of affecting the animations on the building, and also in a dispersed manner, where users can browse, tweet and retweet across the city, and especially in drop-in centres.

Apart from creating cohesion between the different media that the project existed on, the visual language was kept intentionally minimal in order to emphasize certain aspects of the project:

- The design of the online website and application was focused on representing the flow of tweets that contained the hashtag and visually emphasized the activity and energy surrounding the topic — visualizing the global concern and abstract twitter conversations.
- The design of the website also encouraged users to compose their own message about homelessness as well as retweet any especially salient tweets that already existed in the stream.
- The information bar on the top of the website also is a visual representation (iconic and textual) that gives situational information and significance to the felt experience of the state of being homeless at the site of the Ryerson Image Center, visualizing live weather data and implying the experience one might feel being exposed to the hardship of cold and weather conditions.

One of the challenges we faced was to animate the background of the site according to the wind speed given by the weather station. We used Processing JS (a variant of Processing) to achieve the animation. We first wrote the animation code in Processing and then ported it over to Processing JS using the weather data that was extracted from the text file.

After establishing the weather data, twitter and background animation components we coded the site using the HMTL5 Boilerplate template. We chose this template because it was already responsive (mobile and desktop compatible) using CSS. For certain UI components we used JQueryUI. This includes the Tweet composer at the bottom of the screen, and the list of tweets with #homelessness.

2.1.3   Lighting

This last process, lighting, is comprised of a DMX-controlled RGB linear LED lighting system installed by GVA Lighting on the Ryerson School of Image Arts [3]. The lights, capable of emitting a wide range of colours, are controlled by a lighting management system (e:cue) which runs preprogrammed lighting sequences. David Bouchard, new media artist and faculty member at Ryerson University, developed custom software that allows artists and designers to create programmatic visualizations using Processing and dynamically control the lights [3]. Using vvvv software's ability to interface with DMX controls and its ability to send and receive OSC (Open Sound Control) messages, Bouchard created a bridge between the proprietary lighting system and an open and widely used authoring platform.

2.2   Environmental

While those who experience homeless come from all walks of life, and may be young, old, male, female, LGBTQ, sober, or addicted (and so on), what all people experiencing homelessness suffer from is overexposure to the elements. This is the underlying danger that threatens a life that has been stripped bare of its most basic supporting element: shelter. It is because of this underlying and crucial fact that we decided to stage ITAT in the middle of the winter, a time in Toronto, and in many places around the world, where shelter becomes even more important for those who find themselves without it. The interface of the LED façade, and by extension the web interface, reflects this focus on the elementary fact of the threat from the elements by visualizing a sweeping blue wave. The icy blue colour alludes to the frigid temperatures

(typically in the -5 to -20 range in Toronto, plus wind chill) while the speed of the blue wave aimed to amplify the invisible yet chilling effect of the wind.

As it tuned out, this happened to be one of the coldest winters Toronto has experienced in over 30 years. In the period between November 2013 and April 2014 there were 36 days that warranted Extreme Cold Weather Alerts [7]. This is a significant jump from previous winters where the average number of alerts was 13.6 per winter. Although climate scientist observe that there is very likely a trend towards fewer cold days and more warm days [13] there is also climate research that suggests that more extreme cold weather could result from a reduction in sea ice [28] and Arctic warming [15].

Somewhat tangentially, ITAT also refers to something else that is environmental, or 'in the air', so to speak. That is, it refers to wireless telecommunication, essentially visualizing and concretizing and otherwise amorphous, distributed process. While traces of this conversation are created and sensed on a disparate subset of all screens (and a relatively miniscule one at that), the sheer volume of the architectural façade and the bleeding of light into its surroundings created a data environment, making telecommunication, and this specific subset of it, spatially focused and apparent.

2.3   Social

Homelessness can be broken down into a series of general categories which outline issues that are particular to certain groups such as youth, women, indigenous peoples, the elderly, people with addictions, and people with mental health issues. Often times, someone experiencing homelessness will fit within more than one of these categories. For this reason, special care is required to treat this complex problem, and both in Canada and in countries around the world, groups of social workers, researchers, activists, politicians, and volunteers are involved in the ongoing struggle to understand, treat, and reduce homelessness. Pairing the detailed, rich data available through the twitter feeds of these experts with the haptic and symbolic impact of a glowing building allowed us to maintain a balance between description and expression.

Figure 3: User with ITAT web interface at homeless shelter.
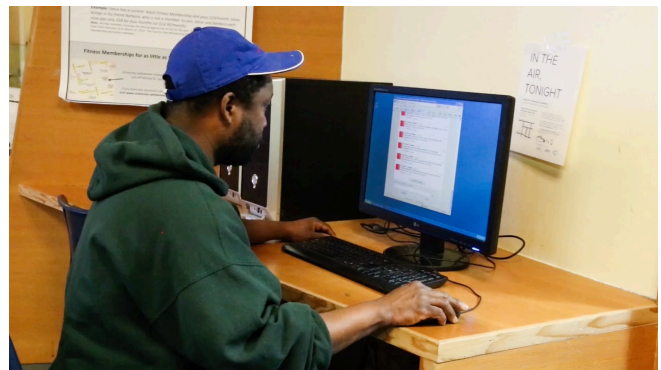
With ITAT, we identified some key players early on in our research and discovered that information dissemination and sharing by this group of experts and practitioners was occurring online in the form of an ongoing twitter conversation organized under the hashtag #homelessness. Leading up to the launch of ITAT's month-long run, we reached out to this community, informed them of our project, and asked them to help us amplify this issue and their ongoing efforts by continuing to spread

information about the project. Reaching out to this community had two major effects: it created an increase in the frequency of the hashtag in online discourse, creating a small but important change in the online media diet of some twitter users, and it encouraged connections to be made between these experts and practitioners, helping them to deepen connections between countries and sites across the mostly English-speaking world (i.e. UK, Australia, USA, Canada). The English-centric impact was a limitation of using an English hashtag, and for future iterations we will endeavour to include equivalents in other languages.

We also made efforts to reach out to the local community by distributing information about the project to drop-in centres and homeless shelters around the city. In our research, we discovered that the Ryerson Image Arts building was at the centre of the highest concentration of these facilities in Toronto, if not in Canada and North America. Each of these centres has internet-enabled computers, and by the end of the project we did see some participation from clients and staff at these centres (Figure 3). It was important for us to find a way to include not only the voices of experts and the participation of viewers at the site, but also provide the means by which those actually experiencing homelessness could contribute to the project or critique it. It is clear that in future iterations, a purpose built kiosk for the project will create greater engagement at homeless shelters and drop-in centres as computers at the sites were generally used by clients for personal communication and information gathering in the limited time available to them.

Another social outcome of this project is the media attention that it generated. This was one of our goals with this project: to create a compelling and spectacular interface to draw attention to and illustrate a not-so-spectacular reality of contemporary urban life. We certainly were successful in high-jacking the media (as advocated by socially-engaged artist Alfredo Jaar [18]), as we were featured on local television broadcasts (CityTV), national radio (CBC), and international blogs such as The Creators Project. Just as we aimed to amplify the importance of this issue in social media, we also managed to insert this discourse into spaces that did not typically cover this topic.

3   DISCUSSION

One possible precedent for this kind of project is relational aesthetics (RA), which itself has precedents in happenings, invisible theatre and performance art. RA, coined by Nicolas Bourriaud [4], is an umbrella term to describe a variety of art practices gaining critical attention during the late 90's (e.g. Rirkrit Tiravanija, Liam Gillick) that aimed at creating spaces in which interaction (social, not digital interactivity according to Bourriaud) was fostered. The artwork required participation and people doing things (e.g. making and eating pad thai) in a given space in the hopes that a sense of conviviality and dialogue would emerge [4]. Bourriaud defines RA as an "aesthetic theory consisting in judging artworks on the basis of the inter-human relations which they represent, produce or prompt" [4].

Although this may seem to have an apparent connection to the practice described in the ITAT project, it is important to note that this project did not intend to create a micro-utopia [4] but rather create a series of asynchronous connections among a variety of participants. Where an artwork that creates a micro-utopic space is attempting to put in action a convivial space, the ITAT project attempts bring into being an agonistic space. ITAT's agonistic space — for its use in political theory and art practice see Mouffe [27], for its use in design and HCI see DiSalvo [12], Binder [1] — allowed users to post tweets regarding the project or current news through the ITAT web application, included regular posts of weather data and available shelter space data, and encouraged users to post to their local politicians.

It is also important to note that the political ambitions of relational aesthetics has been vigorously critiqued to be, at best ineffective, navel-gazing, elitist exercises masquerading as socially-engaged art, or at worst, parasitic practices that import authenticity by using local communities [2]. Similarly, site-specific artwork which sometimes coincides with relational work, especially when the site is construed as a community, has also been critiqued for exacerbating power inequality, remarginalizing constituents and depoliticizing issues [19].

Perhaps a more useful framework for considering the structure of ITAT is the *boundary object*. A boundary object [32] is an object (e.g. image, document, device) that makes possible the coming together of various stakeholders around a common issue. Where each stakeholder agrees to the more general components of this representation but finds specific components within the representation which suit his/her particular agenda. The strength of this concept comes from the fact that it describes specific instances in socio-technical systems which act as translators between various stakeholder groups without the need to creating consensus. People can share, use, and contribute to some kind of representation of a given issue and agree to its main features but find more precise features that relate to his/her goals. In other words, a visualization can be a common ground without requiring everyone to agree to exactly what it means or represents.

The boundary object, according to Star and Griesemer [32], is a modification of the concept of *interessement* and translation used in actor-network theory (see Latour [20], Law [23], Callon [6]). This is the process by which actants are brought in and bound to a particular assemblage (e.g. people, policy, technology, site) through the translation of the concerns of one group of people into those of another group of people. Star and Griesemer [32] also employ an ecological analysis to how concerns around a given issue are mediated and represented. That is to say, they do not hold any point of view as primary, originary and more valid than any other.

For the purposes of this discussion it is useful to think of the activists, designers, users, passersby, media, viewers, etc. as party to the boundary object. Rather than rely on a polysemous or subjective reading approach to understanding how this visualization project functions, the boundary object can help model the way that a network of actants may participate in the life of a project. It is not necessary for all users, viewers, designers, activists, researchers, etc. to see the exact same thing in the visualization. In fact the power of a visualization may rest in the ability to be vague enough that people may invest in a particular representation of data to the extent that they can agree on the general contours of the issue being represented. In the case of ITAT, we can think of the association of weather and homelessness through the (aesthetic) boundary object.

One of the explicit goals of information visualization is the reduction of complexity in the aims of augmenting human cognition and pattern recognition [5]. The ITAT project may represent a reversal of this putative role of visualization where instead the complexity is posited on the interpretive and participatory side rather than on the representation of data. This project combines and visualizes three streams of data (i.e. wind speed, wind direction and Twitter activity) using a very low resolution matrix (i.e. the building LED façade) and very simple mapping of data to visual elements as discussed above. These are rather simple data sets but whose juxtaposition invites implications and interpretations which are potentially quite complex.

Furthermore, our focus on expressivity over direct and descriptive representation, and the element of mystery that invariably confronts the uninitiated viewer by way of the glowing building, served to help differentiate this data visualization as

artistic or aesthetic. Artistic data visualization, according to Viegas and Wattenberg [33] does not attempt to represent the sublime (i.e. the totality of the complex problem of homelessness), but instead endeavors to point to it without undue reduction. The complexity of a problem such as homeless renders it unrepresentable. What can be represented is complexity itself, as well as a sense of the immensity of the issue, its material reality, and the care and concern associated with it. So, while mapping wind speed and twitter activity onto the building may not be directly apparent to the passerby, nor does it solve the problem of homelessness, it expresses the complexity of the problem poetically and the stakes for the citizen: do we care enough to find out about the marginalized amongst us, those hidden in plain sight, and once privy to this complexity, are we willing to enter into it in some way. The motivation of participants to post tweets with #homelessness will vary. Of course, many experts in the field were already posting information using #homelessness. We also witnessed participants using the mobile interface to promote the project itself, to express an opinion, to show solidarity and of course, to simply see the building turn red.

Here, we would suggest that artistic data visualization can be seen as a medium unto itself, a subset or stream of digital or new media art. While definitions of any form of art are by their very nature debatable, digital culture theorist Sean Cubitt [9] argues that digital art should be "communicative rather than representational" and should not be assessed for legibility but for the breadth, depth, and complexity of the networks and relations engaged and engendered in its expressions. What digital art should do, and what we have tried to do with ITAT, is not to simply seek empathy or a collective understanding of singular facts or messages, but to seek a greater understanding of the networks that create and address matters of concern by amplifying and exposing them and making them amenable to participants.

Our work is heavily influenced by the work of several artists that have used large projections and displays in ways that incorporate elements of data visualization, including Alfredo Jaar [18], Krzysztof Wodiczko [34], Jenny Holzer [17], and Rafael Lozano-Hemmer [24]. In particular Jaar's project for Montreal's Mois De La Photo, Lights in the City (1999) informed our ITAT project. Lights in the City asked clients of downtown homeless shelters in the city to press buttons which, in turn, triggered red lights in the Cupola of the Marché Bonsecours [18]. Jaar's project is laden with an overriding symbolic layer relating to crisis or disaster. The colour red with its near universal (yet not exclusive) association with risk or danger. The cupola with its history of fires that have destroyed the building. Jaar merges participation, symbolism and visualization in order to communicate a strong feeling and message about the everyday crisis of homelessness.

Lights in the City (LITC) may also serve as a useful contrast to In the Air Tonight. LITC can be understood as creating a correspondence between the homeless people using a shelter and public announcement of the issue. On the other hand, ITAT can be understood as creating an event that takes place over a certain duration in which several people/objects are assembled. Here we return to the notion of expression which helps us understand the relationship between what is visualized and how it comes into being.

Brian Massumi [26] states that: "It is important not to think of the creativity of expression as if it brought something into being from nothing. There is no tabula rasa of expression. It always takes place in a cluttered world. Its field of emergence is strewn with the after-effects of events past, already-formed subjects and objects and the two-pronged systems of capture (of content and expression, bodies and words) regulating their interaction: nets aplenty."

Expression is thus as much an entanglement as it is a manifestation. Massumi (with Deleuze and Guattari) demands that we remove the causal and communicative function of expression in order to understand the formation of social arrangements, law, culture, architecture, technology, etc. When applied to an artifact/process such as aesthetic visualization we can consider that where a communicative goal would seek to create a correspondence between a sender and a receiver, an expressive goal would understand the creative movement between one thing and the next thing — never settling too long in one form or another. The expressive is nothing if not emergent — the form of which is most surely to shift over time. Cubitt's use of communication in digital artwork [9], as noted above, emphasizes the relational aspects of a network and not the indexical or claim to a correspondence.

The question of the role of visualization in society is also raised through this public installation project. Visualization is a powerful technique that can be used to empower or disempower the user and therefore as creators of these visualizations we must bear in mind both the data that we acquire and display as well as the multiple ways in which these images can be interpreted. ITAT's focus on the entanglement of multiple actors implicated in homelessness was an attempt to respect this complexity and not be tempted by reductionist techniques. We aimed, in fact, to make things public much in the way advocated by Latour [33]. Things, in this case, represent complex arrangements of actors which when made explicit reveal contentious matters of concern [34]. Matters which are often of deep importance to society and whose visual representation may help us understand complex social, political, economic and technical arrangements alongside environmental phenomena which would, in turn, equip us to make better decisions leading to the creation of a more just society.

As described above, the ITAT project, beyond the representation of environmental variables and social network traffic found expression through a variety of mediums including architecture, mobile phones, desktop computers, homeless shelters, Twitter, social justice walks, local news media (including the weather report) and Art & Design online journalist media. This diffusion and creation of a discursive field regarding our public visualization project was our originally stated goal and therefore warrants an expanded notion of visualization to fully account for the conception, execution and circulation involved in this project. When one includes these various aspects in the understanding of visualization one may be forced to consider visualization as a process but also as an event. Massumi [26] reminds us that "expression is an event" in order to emphasize the process, the movement and above all the constant change and mutation that is involved.

4 CONCLUSION

The ITAT project was a public aesthetic visualization installation that knew itself to be also an event and a work of digital art. The various aspects of the projects were designed in order to foster activities and interactions that could take place. A public visualization is a specific kind of installation using a specific understanding of what is meant by visualization. Nevertheless, there appears to be elements in this installation that hold true for most if not all instances of visualization — namely: assembly, representation and interpretation. As designers and artists working with visualization we would like to emphasize the relationship between its construction, its circulation and its interpretation often left out of consideration of visualization projects.

Future directions for this project are currently being planned. A top priority in designing the next iteration is to investigate various forms of participation and event in order to further flesh out the expressive form of this visualization project. The inclusion of

other data sets is also of great interest to us since we find that the surprising juxtaposition of variables invites discussion that goes beyond simply considering correlation.

REFERENCES

[1]   T. Binder, G. De Michelis, P. Ehn, G. Jacucci, P. Linde, and I. Wagner, *Design Things*. Cambridge, Mass.; London: MIT Press, 2011.

[2]   C. Bishop, "Antagonism and Relational Aesthetics," *October*, vol. 110, pp. 51–79, Oct. 2004.

[3]   D. Bouchard, "Ryerson Image Centre LED Facade," *dead pixel*, 2012. [Online]. Available: http://www.deadpixel.ca/led/. [Accessed: 20-Nov-2013].

[4]   N. Bourriaud, *Relational aesthetics*. Dijon: Les Presses du réel, 2002.

[5]   S. K. Card, J. D. Mackinlay, and B. Shneiderman, *Readings in information visualization : using vision to think*, vol. The Morgan Kaufmann series in interactive technologies. San Francisco, Calif.: Morgan Kaufmann Publishers, 1999.

[6]   M. Callon, "Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay," in *Power, Action and Belief: A New Sociology of Knowledge?*, J. Law, Ed. Routledge, 1986, pp. 196–223.

[7]   City of Toronto, "Statistics on Extreme Cold Weather Alerts in Toronto - Homelessness Services - Housing & Homelessness Services | City of Toronto." [Online]. Available: http://tinyurl.com/mpmqf8k. [Accessed: 31-May-2014].

[8]   D. Cox, "Metaphoric Mappings: The Art of Visualization," in *Aesthetic Computing*, P. A. Fishwick, Ed. Cambridge, Mass.: MIT Press, 2006, pp. 89–114.

[9]   S. Cubitt, "Precepts for Digital Artwork," in *Fluid Screens, Expanded Cinema*, J. Marchessault and S. Lord, Eds. University of Toronto Press, 2007.

[10]   Diamond Schmitt Architects, "Ryerson Image Centre / School of Image Arts | Diamond Schmitt Architects." [Online]. Available: http://www.dsai.ca/projects/ric-ryerson-image-centre-school-of-image-arts-ryerson-university. [Accessed: 31-May-2014].

[11]   G. Deleuze and F. Guattari, *A thousand plateaus : capitalism and schizophrenia*. London; New York: Continuum, 2004.

[12]   C. DiSalvo, *Adversarial Design*. Cambridge, Mass.: MIT Press, 2012.

[13]   C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. K. Allen, M. Tignor, and P. M. Midgley, Eds., *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Cambridge University Press, 2012.

[14]   P. A. Fishwick, *Aesthetic computing*. Cambridge, Mass.: MIT Press, 2006.

[15]   J. A. Francis and S. J. Vavrus, "Evidence linking Arctic amplification to extreme weather in mid-latitudes," *Geophysical Research Letters*, vol. 39, no. 6, pp. 1–6, 2012.

[16]   A. R. Gaviria, "When is information visualization art? Determining the Critical Criteria," *Leonardo*, vol. 41, no. 5, pp. 479–482, 2008.

[17]   J. Holzer, "Projections," *Jenny Holzer: Projections*. [Online]. Available: http://projects.jennyholzer.com/projections. [Accessed: 15-Jun-2014].

[18]   A. Jaar, "Notes on Lights in the City," 2000. [Online]. Available: http://www.alfredojaar.net/index1.html.

[19]   M. Kwon, One place after another: site-specific art and locational identity. Cambridge, Mass: MIT Press, 2002.

[20]   B. Latour, Reassembling the social : an introduction to actor-network-theory. Oxford; New York: Oxford University Press, 2005.

[21]   B. Latour, "From Realpolitik to Dingpolitik – An Introduction to Making Things Public," in *Making Things Public - Atmosperes of Democracy*, L. Bruno and P. Weibel, Eds. MIT Press, 2005, pp. 4–31.

[22]   B. Latour, "A Cautious Prometheus? A Few Steps Toward a Philosophy of Design (with Special Attention to Peter Sloterdijk)," presented at the Networks of Design, Design History Society, Falmouth, Cornwall UK, 2008.

[23]   J. Law, "Actor Network Theory and Material Semiotics," in *The New Blackwell Companion to Social Theory*, B. S. Turner, Ed. Oxford, UK: Wiley-Blackwell, 2009, pp. 141–158.

[24]   R. Lozano-Hemmer, "Individual Projects," *Rafael Lozano-Hemmer*. [Online]. Available: http://www.lozano-hemmer.com/. [Accessed: 01-Feb-2012].

[25]   L. Manovich, "Data Visualization as New Abstraction and Anti-Sublime," *manovich*, 2002. [Online]. Available: http://manovich.net/index.php/projects/data-visualisation-as-new-abstraction-and-anti-sublime. [Accessed: 13-Aug-2014].

[26]   B. Massumi, A shock to thought: expressions after Deleuze and Guattari. London; New York: Routledge, 2002.

[27]   C. Mouffe, "Artistic Activism and Agonistic Spaces," *Art & Research: A Journal of Ideas, Contexts and Methods*, vol. 1, no. 2, Summer 2007.

[28]   V. Petoukhov and V. A. Semenov, "A link between reduced Barents-Kara sea ice and cold winter extremes over northern continents," *Journal of Geophysical Research: Atmospheres*, vol. 115, no. D21, p. 1–11, 2010.

[29]   J. Pickles, A history of spaces : cartographic reason, mapping, and the geo-coded world. London; New York: Routledge, 2004.

[30]   W. Sack, "Aesthetics of Information Visualization," in *Context Providers*, C. Paul, V. Vesna, and M. Lovejoy, Eds. University of Minnesota Press, 2007.

[31]   C. E. Shannon and W. Weaver, *The mathematical theory of communication*. Urbana: University of Illinois Press, 1964.

[32]   S. Star and J. Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39," *Social Studies of Science*, vol. 19, no. 3, pp. 387–420, 1989.

[33]   F. B. Viegas and M. Wattenberg, "Artistic data visualization: Beyond visual analytics," in *Proceedings of the 2nd international conference on Online communities and social computing*, Beijing, China Berlin, Heidelberg, 2007.

[34]   K. Wodiczko, "Krzysztof Wodiczko / Public Projections," *October*, vol. 38, pp. 3–22, 1986.