DELIRIOUS FACADE

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This paper looks at a recent developments in digital knowledge and design towards what the authors call "raster" based surfaces and away from "vector" lineaments. The authors present this turn in relation to the historical context of facade composition, drawing an analogy between the beaux-arts understanding of facades as a consequence of plan and section and the auditable and verifiable scripts of parametric design. In contrast to the vector, the authors present contemporary developments in machine learning and perception that privilege an interaction with the world based on surfaces and pixels. Lastly they present the potential for the raster digital as a design tool, using artificial intelligence to synthesize hybrid facade designs in a digital dream state.

BACKGROUND

> Forest and city are two things essentially deep, and depth is fatally condemned to become a surface if it wants to be visible… The part of the forest immediately before us is a screen as it were, behind which the rest of it lies hidden and aloof.
>
> –José Ortega y Gasset, Meditations on Quixote

From its formalization at the École Polytechnique and the École des Beaux Arts in the 19th Century, architectural composition was understood as a procedural act which entailed of a series of sequential design decisions.[1] The process of design was taught as moving through three forms of representation, the plan, section and elevation more or less in that order. In his Precis, Jean-Nicolas-Louis Durand describes the order of representation as follows: "the first [plan] represents the horizontal direction of the building, the second [section] its vertical disposition or its construction and finally the third [elevation] - which could not be anything but the result of the two others - represents the exterior."[2] Durand emphasized that the order was an essential logical progression and that to begin with the elevation and proceed to the plan would be tantamount to deducing "the cause from the effect, a notion whose absurdity speaks for itself."[3]

At the same time it was common to relate the three drawings of the orthographic drawing set to the Vitruvian triad of utilitas, firmitas and venustas. In his account of his days as a student of the Beaux Arts, Alexis Lemaistre wrote, "the plan documents the commodity of the edifice; the section documents the solidity and the elevation documents its elegance or nobility - in a word, its beauty."[4] Thus the procedures of design composition in the ecole system ended with the design of the facade, understood as an aesthetically motivated conclusion of programmatic and structural concerns that had developed earlier in the composition of the plan and section. The generative nature of this relationship between interior and exterior, coupled with the relative stability of ornamental and formal languages meant that facade composition was circumscribed.

Yet, with the advent of reinforced concrete and the cantilevered floor slab, the causal connection between the facade and the elevation was largely severed. There are other examples, but Le Corbusier's free facade is the most emblematic.[5] The free facade instigated a crisis in what had otherwise been a logical conclusion to the procedure of architectural composition. Indeed counter to the easy sounding name, the free facade actually requires more compositional work; Le Corbusier's invention of the concept of "regulating lines" and his use of the facade diagram in Towards a New Architecture to backdate them in antiquity is evidence of the difficulty and extra compositional effort that the free facade demands, not to mention its vexing subjectivity. In all this it seems that the composition of facades as well as their decoration has brought with it an uncomfortable and even anxious relationship to legitimation, one which has encouraged designers and architects to find verifiable and non-subjective origins for them in the hidden lines of the building's interior. Le Corbusier's search for "regulating lines" betrays the difficulty of finding lines in the plane of the facade itself without resorting to the mysticism of ratio and proportion.

VECTOR VS RASTER DIGITAL

To date digital practice in architecture has largely perpetuated the line based mode in what we would call the "vector digital". Parametric software articulates part to whole relationships and assemblies of dazzling complexity. Yet the richness of form is attained at the behest of an interior line. It's of no consequence whether this line is a stream of site data, environmental performance or the aleatory gesture of the designer. What is essential is that there is a connection between the outside (the surface) and the inside (the line). The line is the legitimate ground, the auditable origin of surface effects. The vector digital proceeds on the assumption that the built environment is assembled as a material offset from lines that exist inside those assemblies. The vector digital is idealistic, uncompromising and impractical; it lacks the ability to account for existing conditions, its ideal context is a blank slate.

A later development of digital practice in architecture has

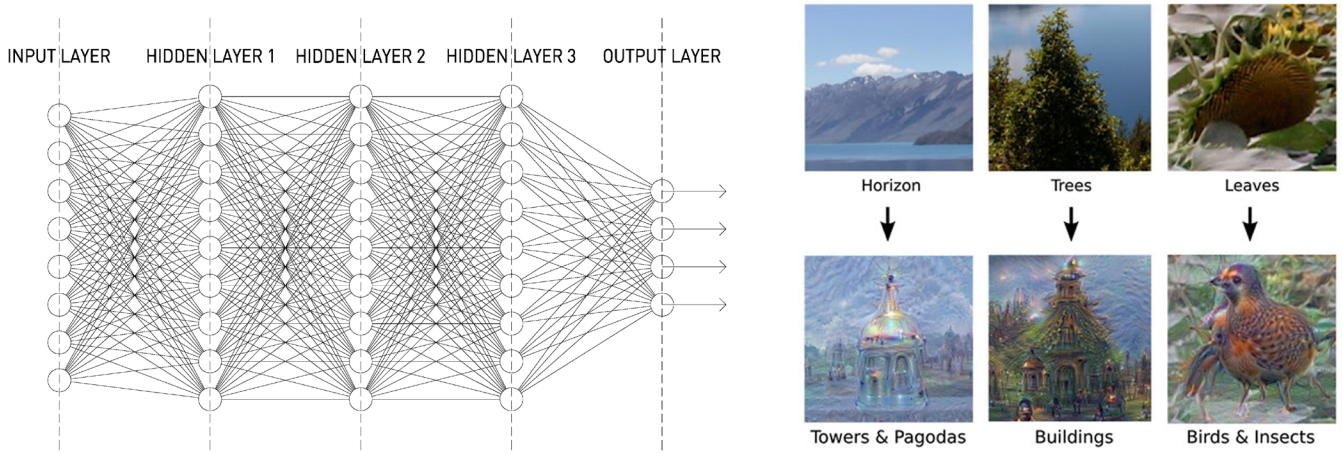

Figure 1: Diagram of the Architecture of Neural Networks (after ***Neural Networks and Deep Learning***, by Michael Nielsen, 2017), and examples of Google DeepDream Images (GoogleNet, Google)

been what we would call the "raster digital". The raster digital gathers information about the world by beginning from the outside, looking at the surfaces of objects and buildings.[6] In order to get started, the raster digital doesn't require that surfaces contain vectors behind them but proceeds empirically with the information that surfaces give up. Photogrammetry is a good example; it uses views taken from multiple points to assemble three dimensional models of objects, buildings, landscapes and people. Not only are three dimensional extents established by the proper registration of images, but also those virtual three dimensional objects are rendered with the visual information of their surface color and texture as captured in the raster image. In architectural restoration work, images are high resolution, resulting in accurate virtual models that can be used to fabricate new replacement parts.

However, the usefulness of photogrammetry does not rest on accuracy alone; low resolution images are equally capable of generating low resolution models in three dimensions with low resolution images plastered on them. The most popular example of this is the three dimensional aerial view on Google Maps, which uses Google Street View and Google Earth imagery to construct three dimensional models of urban centers and landscapes. The models have a painterly quality, due to the distortions of low resolution pixels and the contingencies of surface creation. Trees and buildings smudge into each other, and lower resolution images encourage formal blending of objects. The use value of the models lies in their expediency and relation to reality.

Where the vector digital seeks to create a world of complexity from first principles, building off of a priori lines, the raster digital is a posteriori, it uses empirical data regardless of whether it is poor or rich to create a geometry of surfaces that are de facto empty. Vector digital models become heavy with complexity; at some point they will require more compute. Raster digital springs from the image and so do its specific qualities but it can exist within a spectrum of image resolutions. In that sense the raster is inherently pragmatic and useful.

MACHINE PERCEPTION

The raster makes itself available for further use as a part of data sets in machine learning. For example at the Center for Machine Perception in Prague, Radim Tyleček has tagged sets of images from diverse cities and architectural styles. Initially the arrays of images are given semantic value within the following parameters: facade, molding, cornice, pillar, window, door, sill, blind, balcony, shop, deco and background. This is done by labeling the elements with rectangular overlays where they occur. Once this data set is established, the computer is tasked with learning what the semantic labels are by comparing the salient aspects of things like door, window or wall, across thousands of images. These data sets are the knowledge base that the computer uses when it encounters new images in need of classification. It applies the knowledge within a structure called a convolutional neural network.

Convolutional neural networks analyze images using a layered approach: beginning at the lowest layer, the neural network will determine very basic information about the image such as colour, value, contrast, gradient, etc. Higher layers will begin to add more and more complicated information such as the detection of edges, the detection of shapes and the position of shapes within a part to whole relationship. Each layer outputs statistical probabilities for a number of semantic outputs (for example: window, door, cornice, etc.) At the top layer the convolutional neural net summarizes the knowledge of the highest layer and puts forward one choice above all the others as the most statistically probable.

Given the availability and size of Google Street View's data set there is incredible potential for semantic value in facade images. For example if artificial intelligence can locate structurally active portions of a building such as columns and walls, it would likely be able to analyze large swaths of urban

Figure 2: ***DeepStyle*** hybrid facade of Frank Gehry's Bilbao Museum and H. H. Richardson's Sever Hall

fabric for susceptibility to seismic damage.[7] To us, the most interesting ambition of this work is that it could approach more subjective aspects of building appearance. For example researchers at the Senseable City Lab at MIT are correlating walking data from iPhone geolocators to the visual appearance of streets to find out if there is any relationship between movement and the way the built environment looks.[8] Now that it is possible to train artificial intelligence to recognize and evaluate the visual patterns of architecture it might be possible to return to facade composition through the machine.

CONTEXT: TORONTO FACADISM

> The look of Toronto and how compelling that look is to be in the future, will rest most decisively upon the ways in which Toronto's patterns of diversity are nourished in the years to come. The look of Toronto will be determined by how the European and American influences, the immigrant and native experiences, the old and new styles, the high and low buildings, the brick walls and green spaces are stimulated to interact and in interacting, to provide for the citizenry a vibrant public environment.
>
> -Patricia McHugh, Toronto Architecture[9]

In recent years, the appearance of Toronto's built form has undergone radical changes due to unprecedented growth and development.[10] This largest building boom in Toronto history meant that new buildings—often condominiums and office towers whose materials and appearance espouse a lack of contextual character in the service of easy monetary gain—exerted a disproportionate influence on the look of the city. The prevalence of glass curtain wall and storefront window systems has meant that many of Toronto's most dense neighbourhoods -- arguably representative of most of its built form -- have been constructed to look like nothing at all.[11] In other words, all-glass facades represent very well the market forces which lead to their construction but they don't represent anything else. There is no civic idea or cultural dimension, not even an acknowledgment of best architectural practices for durable and sustainable construction methods.

At the same time, unchecked development is often accompanied by the demolition of existing buildings and the erasure of building context. One response to this has been the practice of "facadism,"[12] whereby the front surface of a historically significant building is retained for a street level facade with a much larger glass building behind and above it. Although it has been talked about for at least 30 years,[13] the past decade in Toronto has shown a sustained interest in print and online news organizations some pejoratively calling it "facadomy".[14]

If we evaluate facadist practices purely from a compositional point of view, they will appear most similar to collage. However where constructivist, surrealist, or cubist collage seeks a relationship or dialogue between the juxtaposed parts even an oblique one, the facadist composition allows the two elements to proceed independent of each other. There is no attempt to balance the scale of one against the other, or even to relate the old facades to the spaces they front. In our approach to facade composition, we were interested in

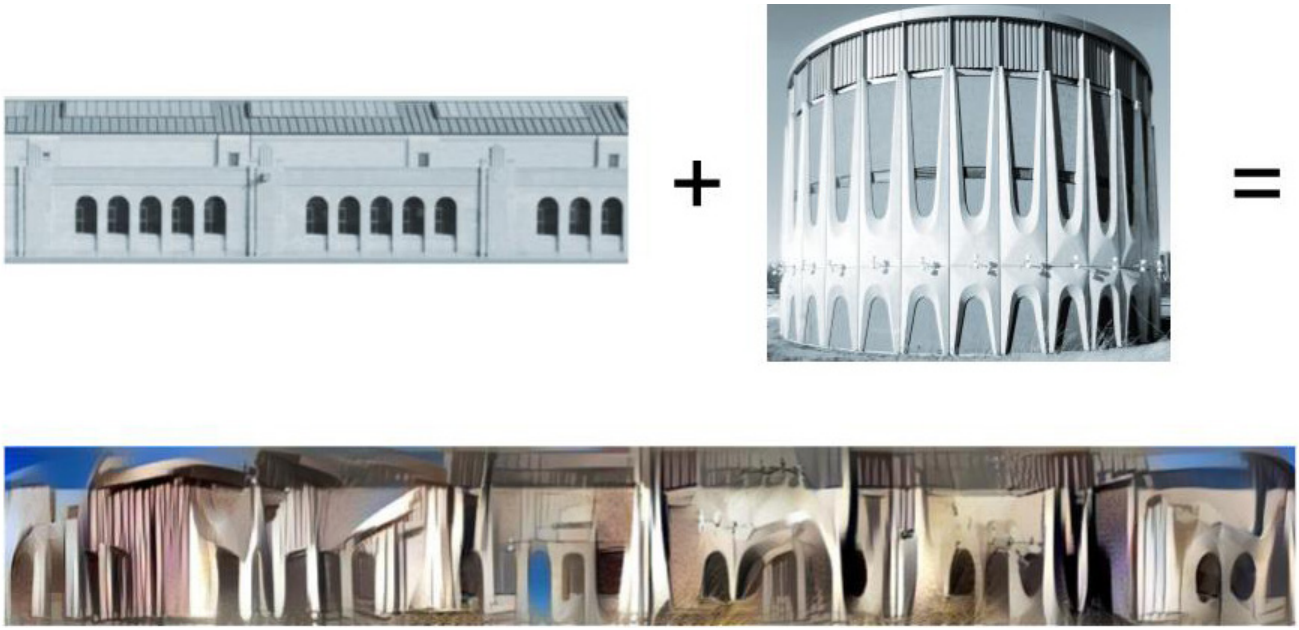

Figure 3: LAMAStyle hybrid of facades.

facadism's combination of different epochs, but sought to go beyond the collage. The facadist composition is contingent upon the existence of heritage building stock which is by definition finite. Our design objective was to create new facades containing heritage elements without resorting to the theme park of postmodernism. Against the background of an incredibly diverse, though otherwise unremarkable city,[15] we were interested in the notion of heterochrony as a result of a city growing haphazardly in the latter part of the 20th Century, a situation in which the artifacts of several different times could exist simultaneously in an undifferentiated field.

DEEPDREAM ALGORITHM

A compositional strategy that could contain the diversity and heterochrony of Toronto's built form is perhaps best exemplified by the popular Face Swap cellphone app which, through the proper registration of eyes nose and mouth, is able to realistically combine the faces of two people on a smartphone camera. Would it be possible to create a facade swap? To accomplish this we made use of another recent development in visual processing: Google's Deep Dream algorithm. Originally designed as a response to the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) to automatically recognize and classify images in given data sets (such as exist in Google's image database), DeepDream can also be repurposed to project bias outward on existing images. Google's DeepDream algorithm repurposes this layered structure, but in reverse. Instead of learning from the image, DeepDream foregrounds a semantic conclusion: "DOG" for example, and then asks the convolutional neural network to skew its data set (the pixels in the image) at every layer until the image looks more like a dog. Thus, the higher layers (part to whole relationships) look like a dog's body and head, and the lower layers (the texture, colours and edges) fill in the picture with believable dog fur, nose colour and eyes. In other words the algorithms of DeepDream heighten the computer's capacity for pareidolia, the human perception of familiar objects or

Figure 4: DeepStyle hybrid of Oyler Wu Collaborative and Venetian Pallazzos, including 3D model of facade. (work by University of Michigan students: Lori Gjoni and Christina Kim)

patterns where none exist, like seeing shapes of rabbits in cloud formations. This allows the computer to automatically seek out images of cats, dogs, buildings, etc. in random or even disordered images.[16] The results look dream like and hallucinatory.

LAMAStyle, the application that we have coded using Google's DeepDream algorithm, does something slightly different. Using the same layered system and with the goal of mixing two images our app takes the upper layers of image 1 and the lower layers of image 2 and imposes them both, together onto a random field. For example if image one is Frank Gehry's Bilbao Guggenheim and image 2 is H. H. RIchardson's Sever Hall, the resulting image will have the massing of Bilbao with the red brick texture, piping and fenestration of Sever Hall. By using another online application called DeepStyle Generator in different contexts with different buildings, we are able to generate new facade forms and reactions to given historical contexts. In other words instead of preserving only a swatch of a heritage building and collaging it with new construction, we have the ability through hybridity to create new fabrics of fenestration, ornament and composition. In the context of Toronto, we have tasked the algorithm to apply the style of arched windows in the smooth reflective curtain wall of an office building, or to see the strong horizontal lines of 60s era housing in the facade of a two story house.

Once the application has created the image of a hybrid facade, we rely on human and automated processes to find the edges of its geometry and project them into bas relief. Bringing the facade image into three dimensions requires the painstaking interpretation of the graphical output into three dimensional texture, windows, doors and massing. Initially, we were satisfied to do this work, alongside a somewhat rudimentary program for the translation of pixel values into Z coordinate values in a 3D mesh. Yet, proceeding from the premise of artificial intelligence, we are still working toward a fully automated system that would correctly interpret DeepDream images into vector based 3D models with accurate locations and geometries for doors and windows.

Working with research assistants from the Computer Science Department at the University of Toronto, we are in the early stages of an app that will convert DeepDream images with some semantic accuracy. The challenges in this endeavour lie in the fact that the very aspects which make the DeepDream facades compelling are what make them inscrutable to visual processing software. The work builds on notable computer science research into machine perception for the purpose of more accurate 3D mapping for urban contexts. One of the precedents that we looked at by Yongjian Lian notes that, "In practice, repetition detection can benefit from the apparent regularities and strong contextual relationships in façades."[17]

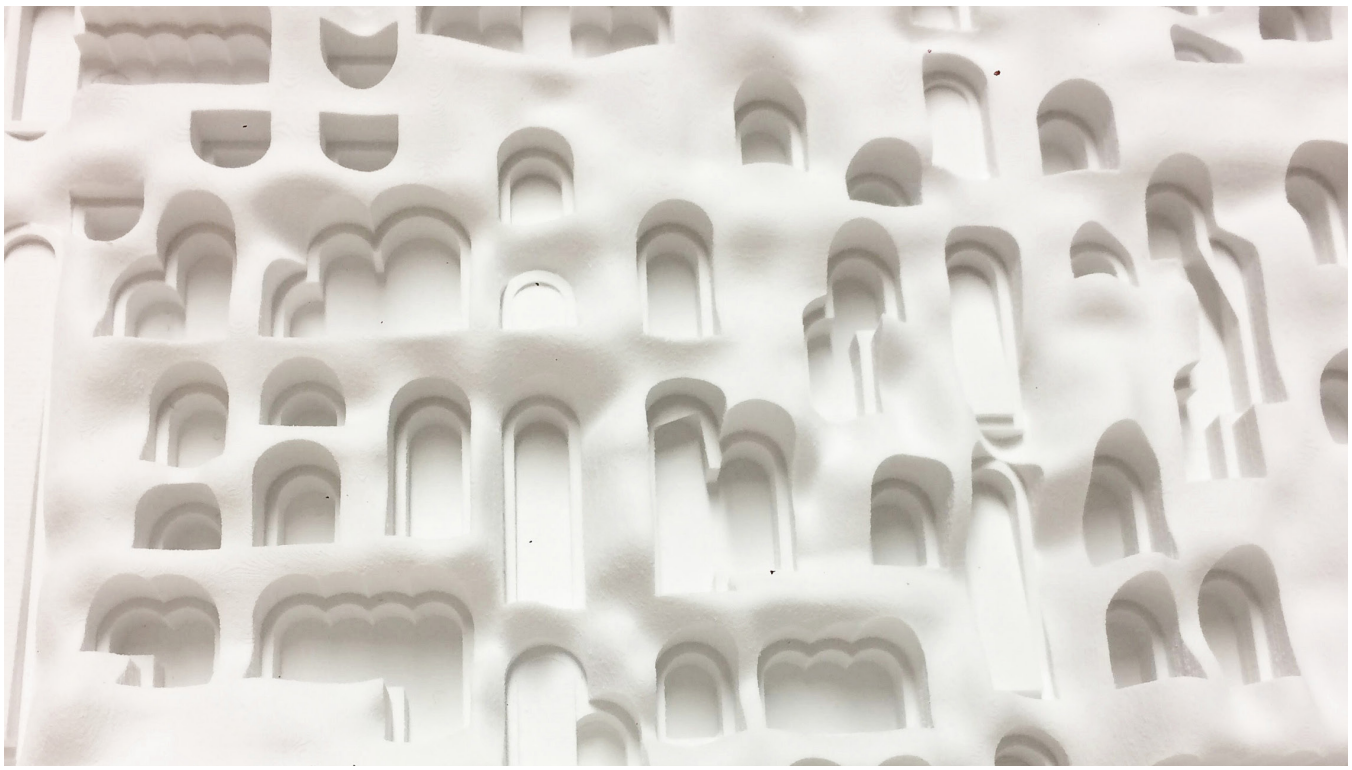

Figure 5: LAMAStyle Project Study #2 Combining the Toronto Royal Bank Plaza (1976) with the Christie Biscuit Factory (1974)

Thus far, the confusion of figure and ground that is essential to the hallucinations of DeepDream have made its images inscrutable to artificial intelligence. Thus far the process is an unruly combination of automated and decision driven design, in which the designer is constantly questioning the appropriate role of the computer and human intelligence.

Delirious Facade erodes the dichotomy of growth and context, allowing for the expedient creation of new facades from existing contexts. The resulting facade proposals are inherently contextual, and relate to historical precedent but do so in ways that are not tied down to dominant formal narratives. The development of the project's methodology has been an ongoing research in our office and recently we used the application to teach design research workshops at the graduate and undergraduate level.

CONCLUSION

Public space in cities is bordered by the vertical surfaces of the facades of buildings. If these surfaces tend towards a lack of differentiation then public space becomes impoverished. In the context of global urbanization there is an adversarial relationship between new development and existing context. The impetus for the work described in this paper is the elusive nature of the composition of façades in this context. When Robert Venturi and Denise Scott Brown credited Walter Gropius with rewriting the Vitruvian triad as a functionalist equation: "firmness + commodity = delight"[18] they were by association also deriding a functionalist endgame for the façade whereby "plan + section = elevation".

This denial of surface, or at least the suturing of its lack, is analogous to a digital practice we have called "vector digital." A recent shift in digital practices which we have gathered under the rubric "raster digital" has the potential to address the lack of facade due to the fact that it is from and for the surface. In this paper we have outlined how the raster digital can create artifacts, external to the designer which can then be interpreted towards viable façade compositions. These are not modernist facades but they are equally at odds with postmodernism. If anything they are altermodern;[19] they are made in the heterochrony of the present, formed "in medias res" (in the middle of things) and aim to embody the contemporary moment in all its delirium.

ENDNOTES

1 For a lengthy consideration of design composition beginning with the Ecole system, refer to Jacques Lucan, *Composition, Non-Composition: Architecture and Theory in the Nineteenth and Twentieth Centuries*, (Oxford, Routledge 2012)

2 Jean-Nicolas-Louis Durand, *Précis des leçons d'architecture données à l'École polytechnique*, Volume I, Paris, 1819 pp 32-33. Later, at the École des Beaux Arts, Julien Guadet espoused a similar opinion of the sequential order of plan, section and elevation as "logical in order." Julien Guadet, *Éléments et théorie de l'architecture; cours professé à l'École nationale et spéciale des beaux-arts*, Volume I, Book I, (Paris 1904): 37

3 Jean-Nicolas-Louis Durand, *Précis of the Lectures on Architecture*, Volume II, Intr. Antoine Picon, trans. David Britt (Los Angeles: The Getty Research Institute, 2000): 139

4 Alexis Lemaistre, *L'Ecole des Beaux-Arts dessinée et racontée par un élève*, Paris, 1889. p 161. Translation from Jacques Lucan, *Composition, Non-Composition*

5 "The columns set back from the facades, inside the house. The floor continues cantilevered. The facades are no longer anything but light skins of insulating walls or windows. The facade is free." in "Five Points Toward a New Architecture" by Le Corbusier, reprinted in *Programs and Manifestos in Twentieth Century Architecture*. (Cambridge, The MIT Press): 100

6 For example, in 2007 Google launched its Street View app which uses stitched images of streets, gathered by car to create immersive and interactive three dimensional panoramas.

7 "Okay, I think I actually have a project idea that uses AI/ML for civic ends concretely (rare):Use existing soft story building inventories + Google Street View to train a model and create a first pass detection for earthquake vulnerable buildings statewide. cc @petewarden" https://twitter.com/allafarce/status/1038920343535022080 September 09, 2018

8 Xiaojiang Li "Investigating the association between streetscapes and human walking activities using Google Street View and human trajectory data" in Shih-Lung Shaw and Daniel Sui, Editorial: GIScience for human dynamics research in a changing world, *Transactions in GIS*, 22, 4, (891-899), (2018)

9 Patricia McHugh, and Alex Bozikovic. *Toronto Architecture: A City Guide*. , 2017. Print.

10 According to the Wall Street Journal, in 2014 Toronto built more high-rises and skyscrapers than any other North American city with 130 projects. Second place was New York City, with 91 construction projects.

11 Glass curtain wall systems were first introduced as part of the so-called International Style of architecture in the 1930s. There are some factors that recommend glass as a facade material: it aspires to disappear with its reflective nature; it is relatively simple to fabricate and install; it is thinner than opaque walls, allowing the developer to maximize rentable space. However the style is often criticized by the public as being sterile, scaleless, and elitist.

12 Cities that have contended with the issues of Facadism include Vancouver, Halifax, Melbourne, Moscow, Paris, Barcelona, Calparaiso, Bucharest, Kuala Lumpur, New York City, Boston, Atlanta, and San Francisco.

13 Two early works on facadism are: Richards, Jonathan. *Facadism*. London: Routledge, 1994. Goldberger, Paul. "'FACADISM' ON THE RISE: PRESERVATION OR ILLUSION?" *The New York Times*, 14 July 1985.

14 Bohnert, Beth. "Façadomy." *Torontoist*. N.p., 30 Aug. 2007. Web

15 Stephen Marche, "Welcome to the new Toronto: the most fascinatingly boring city in the world", *The Guardian* (July 4, 2016)

16 "Inceptionism: Going Deeper into Neural Networks" June 17, 2015 Posted by Alexander Mordvintsev, Software Engineer, Christopher Olah, Software Engineering Intern and Mike Tyka, Software Engineer

17 Lian, Y., Shen, X. & Hu, Y. Vis Comput (2018) 34: 491. https://doi-org.myaccess.library.utoronto.ca/10.1007/s00371-017-1355-z

18 Robert Venturi and Denise Scott Brown, *Learning from Las Vegas: the forgotten symbolism of architectural form*. (Cambridge: MIT Press, 1977) 142

19 Altermodernism as coined by Nicolas Bourriaud, explores "multiple temporalities, disdaining the nostalgia for the avant garde and indeed for any era — [is] a positive vision of chaos and complexity. It is neither a petrified kind of time advancing in loops (postmodernism) nor a linear vision of history (modernism), but a positive experience of disorientation through an art-form exploring all dimensions of the present, tracing lines in all directions of time and space." Nicholas Bourriaud, "Altermodern" in Nicholas Bourriaud (ed) *Altermodern: Tate Triennial* (London: Tate, 2009): 3