**The Genetics of Design**

*The Biology behind Design that Delights*

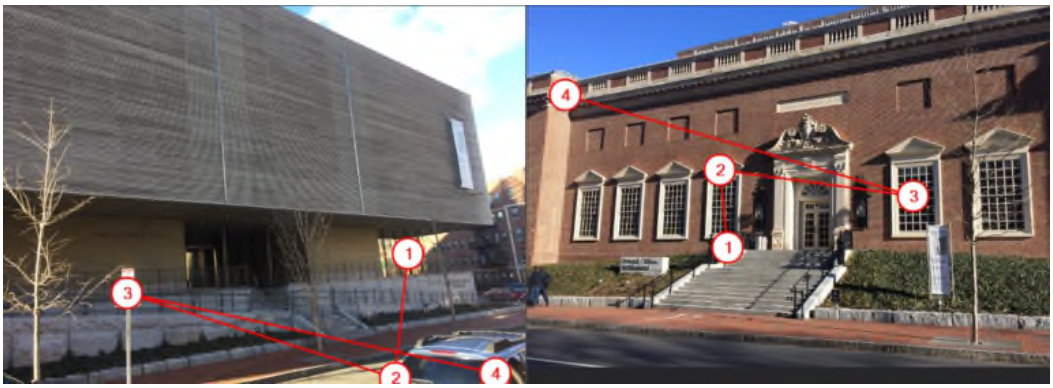
## Why Ornament + Detail Really Matter in Architecture

Posted on June 29, 2021 by Genetics of Design

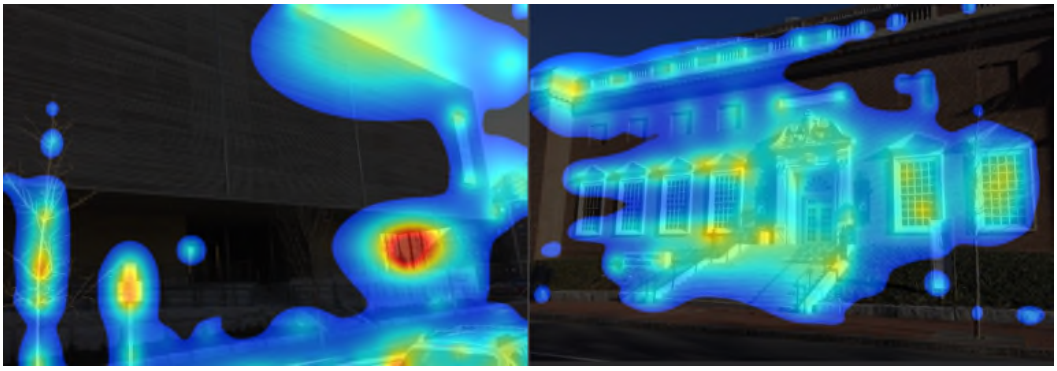
"Details make perfection, and perfection is not a detail." – Leonardo da Vinci

Details really matter in architecture, and today we have the high-tech tools to show why and how to make the case quickly. For instance, below are two views of the Harvard Art Museums in Cambridge, Massachusetts. At right, an original Georgian building, dating from 1927, featuring symmetrical door and window details, and at left, its new addition, a modernist structure by famed Italian architect Renzo Piano, added in 2014.

Running both images through biometric software, in this instance 3M VAS (Visual Attention Software), which tracks how eyes take in a scene at first glance, we see how the older building instantly draws people in, while the newer one can't. The images below forecast the visual sequence the eyes will follow; at right we see the focal points immediately falling around the front door of the old museum, which is where you want them to be at a public facility, while focus goes to the far edge and along the street of the newer one, effectively telling people to ignore both the door and building itself.




Biometric software makes equally revealing *heat maps* which glow brightest, and reddest, where people look most, fading to blue and then completely black in areas ignored. Note how the Georgian building and stair (below right) are bathed in blue and yellowish hue, keeping viewer attention away from street or sky. The opposite happens with the newer one (below left); it directs viewer attention to its edges, a street sign, the sky and away from the stair and entry, making it instantly less welcoming for a viewer or visitor.



Another useful biometric, Regions of Interest diagrams (ROIs), also called Hot Spots, forecast, as a percentage, where the brain makes people look, creating circles around areas that instantly draw the eye. Again note how 59-to-65 percent of views fall directly on the old museum (below right), and its entry, whereas 56-to-85 percent of views fall around the edges, sky and street artifacts, in the newer one (below left). This matters, revealing why it is harder for people to situate themselves in front of the new space.


Remember, even in our high-tech time, people are still animals, hard-wired for attachment, both to each other and the things we make. Successful design acknowledges our origins, and how evolution, and that struggle for survival that made us, preset our subliminal responses to surroundings including where we look first without even realizing it.

Details really matter in architecture because they draw us to a place, reflect how we attach, giving us what we need to see to secure ourselves in a space, and make us feel at home in a place. Details represent external manifestations of hidden internal brain requirements for survival in our dynamic eco-system; in sum: far from arbitrary or extraneous, details are requisite!

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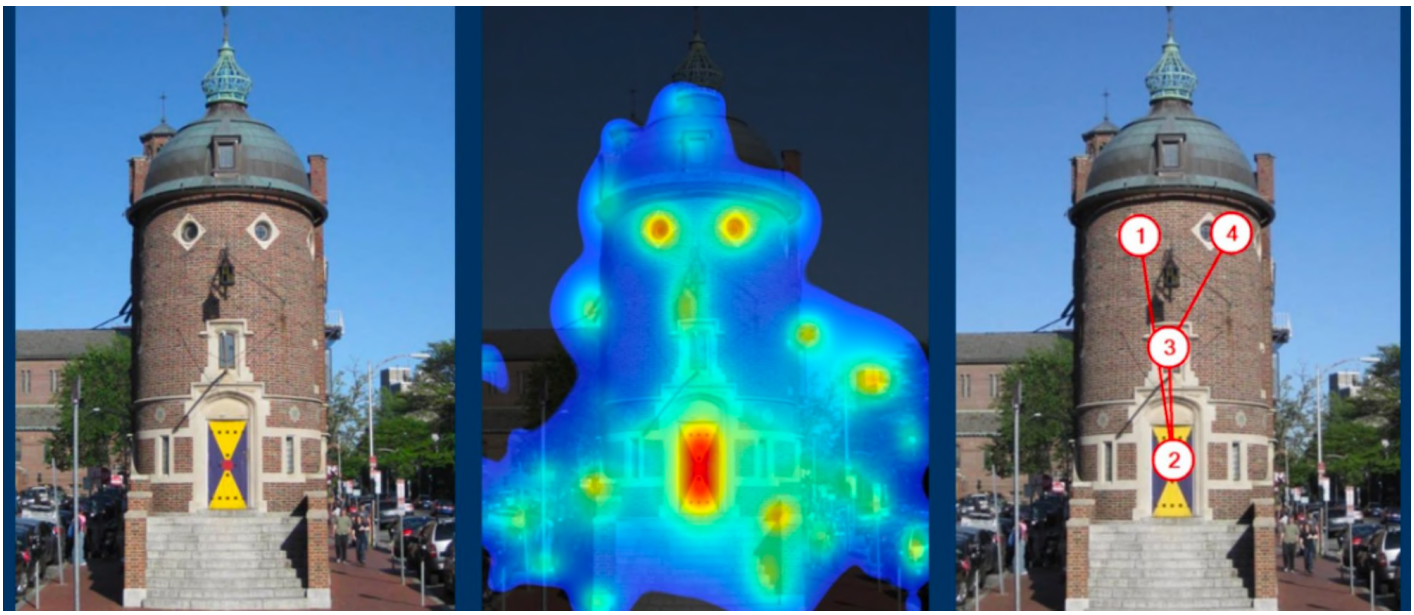


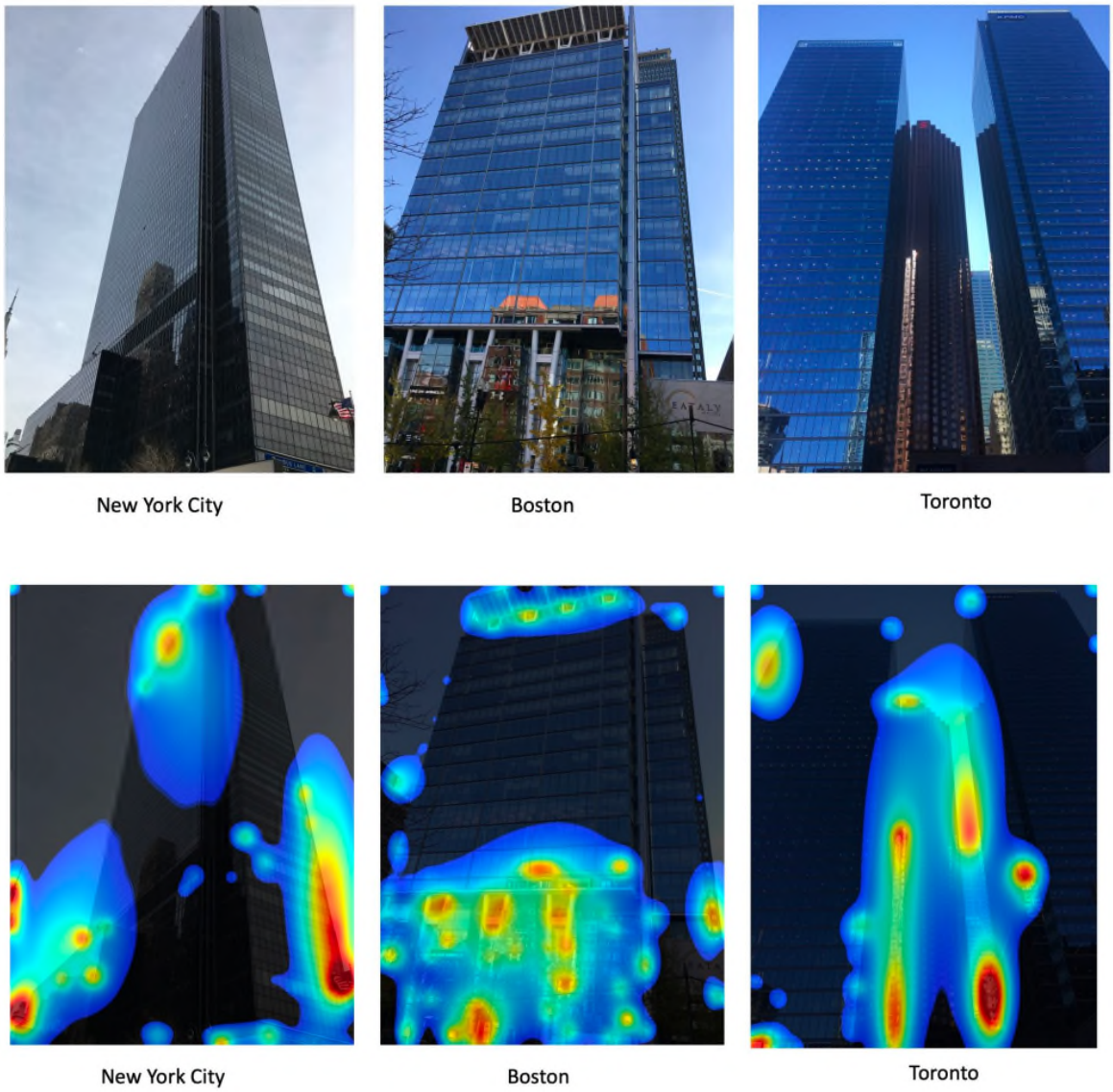

IN DEPTH

# How Biometric Software is Changing How We Understand Architecture—and Ourselves

06.08.2021

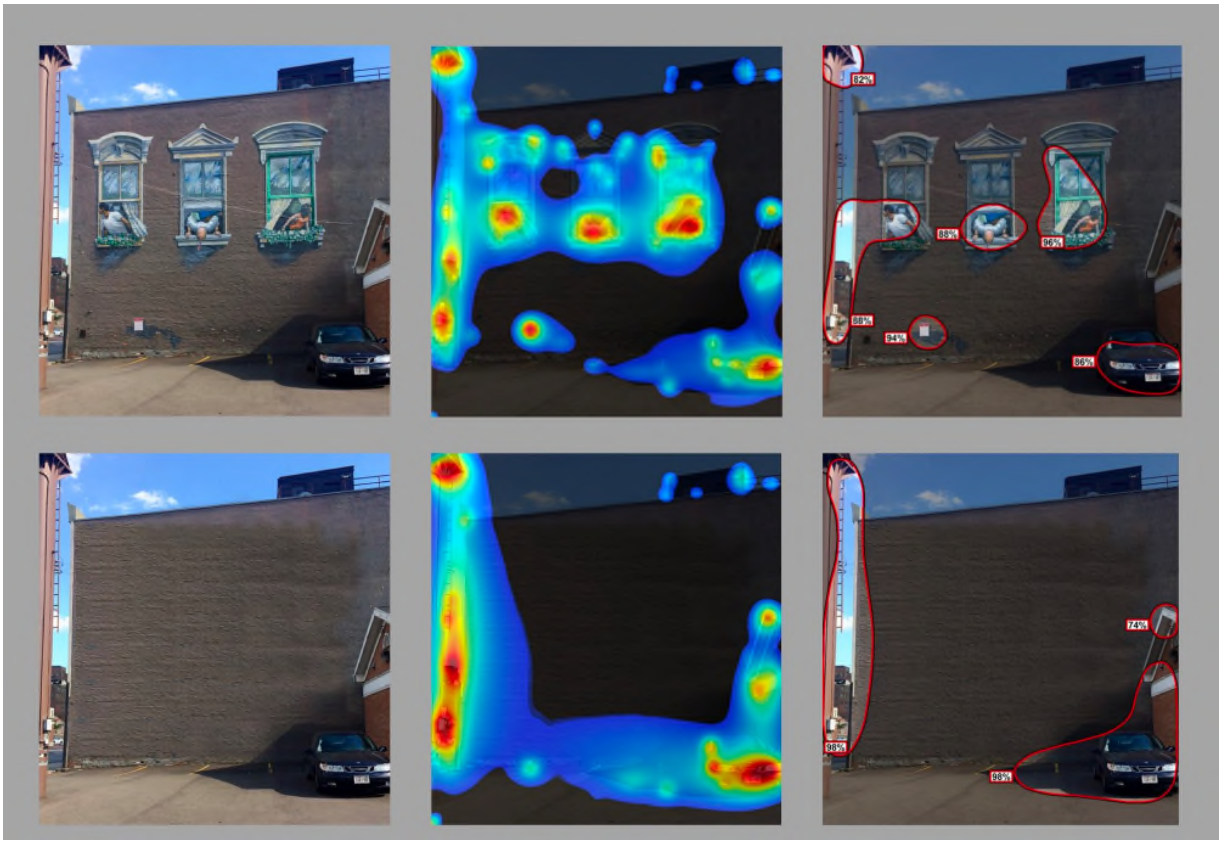
By Ann Sussman, Janice M. Ward

It doesn't matter where they are—city, state, country, continent, it makes no difference. When it comes to big and boxy glass buildings, the human brain is hardwired to take them in the same way: *as not much*. Here are photos of towers in New York City, Boston, and Toronto. Below are the heatmaps, generated by biometric software, predicting where people will look at first glance, or within the first few seconds, before their conscious awareness is activated.




The heatmaps glow red where people might look most, fading to blue and then black in the areas that are ignored. What's stunning about the images is how much of the buildings is initially *not considered*; our brain focuses on the edges, areas of high contrast, and ignores the buildings' core. Wherever we may encounter massive, glassy boxes, we process them in the same way.

The same is true with blank walls; human instinct is not to look at them. These findings can help explain an interesting phenomenon, why wall art helps revitalize blighted urban areas, as seen in these pictures from downtown Cincinnati:



**Blank wall in historic Cincinnati. VAS indicates how human engagement with the building changes once it has art. Images: © theHapi.org.**

Note how attention shifts to engage with the wall once it has colorful art, rather than focusing on its edges and the parked auto when the wall is blank. At the far right, top level, regions of interest (ROI) diagrams indicate with red contours that 88%–96 % of predicted views will fall in the center of the building's new mural, the area that is most ignored when the wall is blank.

Welcome to our New Age of Biology, as the OECD, or Organization for Economic Cooperation and Development, labeled the 21st century in 2012, where new insights in life sciences, paired with new technologies, have transformed not only what we do, but how we see ourselves and reframe understandings of what we need to see and be around to be at our best.

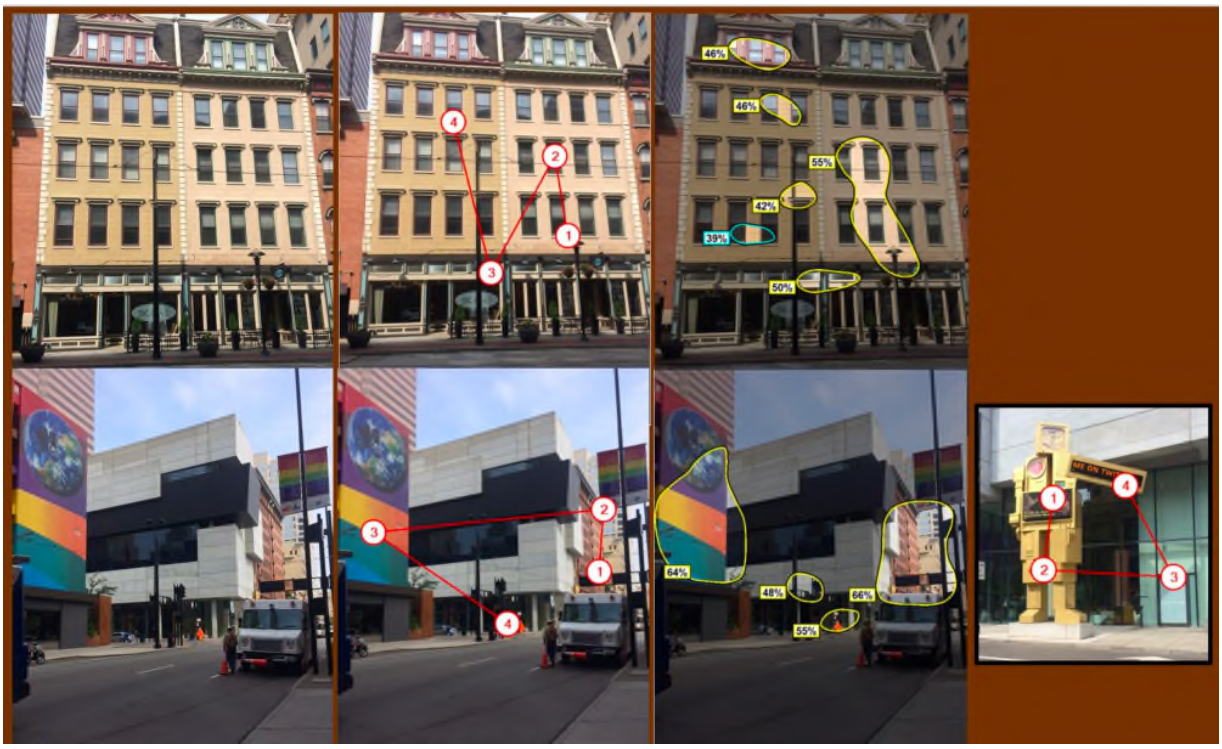
The tech tool here is 3M's Visual Attention Software (VAS), which arrived in 2011 and became a plug-in for Adobe Photoshop and Illustrator in 2020. (There are similar biometric tools on the market now, including attentioninsight.com.) VAS developed from over 30 years research at 3M, studying human responses to visual stimuli. The software simulates the first, subliminal phase of vision, which is before gender, age, or culture affects our attention, and also before conscious awareness sets in. Initially used to inform

the advertising, website, and signage design, VAS is now working its way into urban planning and architectural research and curricula. 3M promotes it as a "spellcheck" for all types of design, since, after all, the human viewer and the biology of our visual perception remain the same.

"The students are very excited by this software," says Catholic University of America architecture professor Robin Puttock, RA. Her students used VAS for the first time to analyze new construction on their Washington, D.C., campus this spring. "I see so many 'a-ha' moments on their faces when they understand what it does and what it can do. They want to run photos of their latest design boards to learn what people will see first, and start brainstorming other ways they can use it."

VAS made her and students see buildings differently, she said. "It has been interesting to note time and time again in our research that simple glass facades are just not seen by us precognitively. Humans seek visual interest, patterns, edges, nature and most of all, *other humans*. This has made me think more critically about what kind of buildings support our well-being."

When it comes to understanding how ornament and detail, as well as organized complexity, matter in building facades, VAS can make the case quickly. For instance, because humans are hardwired to ignore blank spaces, the brain directs a viewer to look around Cincinnati's modern art museum, the Contemporary Arts Center, by Zaha Hadid (completed in 2003), rather than at it. Note how, in the images below, the VAS Visual Sequence diagram goes around the new building, while staying in the center of neighboring 19th-century building facades, shown above it. No surprise: A decade after opening, *Metrobot*, a sculpture in the museum's collection by Nam June Paik, was installed permanently outside the museum's front door in 2014. And VAS's Visual Sequence suggests how the sculpture is, actually, truly magnetic, making the museum door easier to find.



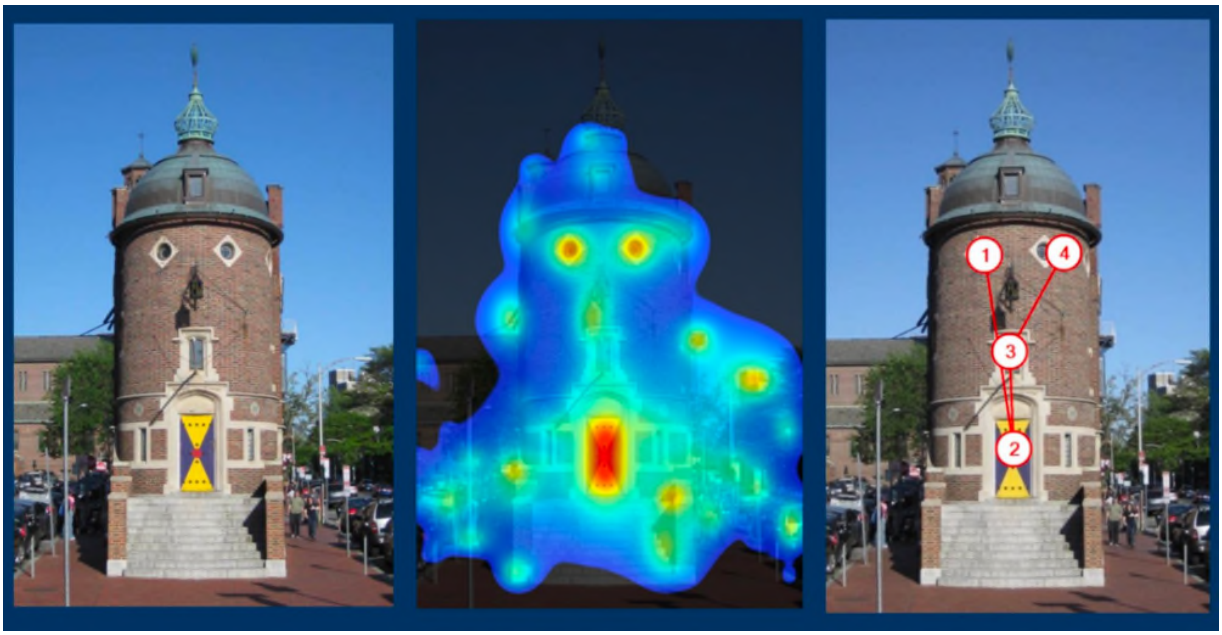

**The 19th-century commercial buildings in downtown Cincinnati draw our attention while the Contemporary Art Museum (c 2003) cannot; VAS indicates how the sculpture, Metrobot, installed permanently by the museum's front door in 2014, does help. Images: © theHapi.org.**

Ironically, high-tech tools like VAS allow us to confront something designers often neglect: consideration of our animal nature and how evolution, and the struggle for survival that made us, preset human visual biases. The fact is, these visual proclivities all remain ancient, making us Stone Age creatures, not modern at all. It's something we may struggle to accept, but something we should understand: how buildings impact our behavior, our stress levels, and, ultimately, our overall health.

"Our visual system very rapidly computes edges, brightness, local intensity contrast and color contrast, as well as the presence of facelike geometries," says Alexandros Lavdas, a neuroscientist using this biometric tool to research the built environment. "This rapid computation has a survival value, as it allows for quick reactions to be initiated, even before the nature of the stimulus has been consciously understood." Evolving in the wild, we essentially still remain wired for that ancestral place.

Why does embracing our animal nature and using biometric tools to track it matter in architecture? "Because it gives objective data on issues that were considered subjective," Lavdas says. Biometrics like VAS "provide an evidence-based tool, and it makes it more difficult to defend forms that do not

visually engage the viewer." And with powerful data points on how engagement actually happens, we can better explain human behavior in all kinds of built environments, such as why a facelike façade in the Harvard Lampoon building in Cambridge, Massachussets, is so often photographed and a frequent stop for tour groups.




**The Harvard Lampoon Building grabs us subliminally. With VAS analysis, we see how.**

Of course the travel buses stop here; they have to. The tower grabs people subliminally, anchoring them in the space and making it memorable. Exactly the opposite experience people have with the glass towers, as seen above. And it doesn't matter that this brick tower is over a century old—it will have the same affect on people a century from now. The fact is, our perceptual system, unchanged for some 40,000 years, will remain essentially the same for a long time.

And that may be the surprising take-away from this biometric tool and architectural research: Helping people understand they are not as different as they think. Asked how VAS changed her perspective, Puttock said: "I find it fascinating that we are all essentially the same. We see the same things precognitively based on our shared evolution."And what could be a more fitting finding for the start of the 21st century than the Age of Biology? Understanding how we look at buildings helps us to see ourselves.

*All images courtesy of Ann Sussman.*

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# EYE-TRACKING BOSTON CITY HALL TO BETTER UNDERSTAND HUMAN PERCEPTION AND THE ARCHITECTURAL EXPERIENCE

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**Abstract**. Learning how architecture impacts human perception can help us understand how civic monuments bring us together or drive us apart, create community cohesion and identity or the reverse: anomie, placelessness and the fragmentation of the public realm. Boston City Hall and Plaza, an urban renewal project from the 1960s, intended to revitalize a historic American city, makes for an excellent case study to see how buildings impact us and in this instance, promote 'avoidant' behavior. This pilot-study shows the power of one biometric tool, an eye tracker, to quickly reveal how the City Hall architecture does not fit human evolutionary predispositions, implicitly turning people away — and always will.

***Keywords:*** *architecture, urbanism, design, eye tracking, fixations, evolution, conscious and pre-attentive processing.*

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## 1. Introduction

Piazza del Campo in Siena, Italy and Boston's City Hall Plaza are often cited as the best and worst of what architecture can be, (see Figure 1). The Italian piazza with its crenelated city hall and tightly-aligned buildings has invited public gathering and acclaim for centuries, frequently making *best in design lists* (D'Alessio, 2016). Boston's 50-year old plaza, on the other hand, an urban renewal project from the 1960s, has never lived up to its promise. Instead, one can find it listed as one of "the most disappointing places in America," (Project for Public Spaces, 2002) and even calls for its demolition (Renzas, 2012).

Why is this? The question has been studied extensively. Researchers have carefully analyzed Boston City Hall Plaza for years, including in graduate school theses (Helfand, 2009) and recent Tufts University planning classes (Wu, 2016). In 2015, Boston's then-new Mayor, Marty Walsh, launched yet another initiative (Quinn, 2015) to find ways to improve the look, feel and function of his workplace.

So, why does Boston's Government Center fail from a public perspective? Frequently mentioned strengths of the Italian versus the American counterpart, which remarkably enough, was inspired by its historic counterpart, (Helfand, 2009) are listed in Table 1.

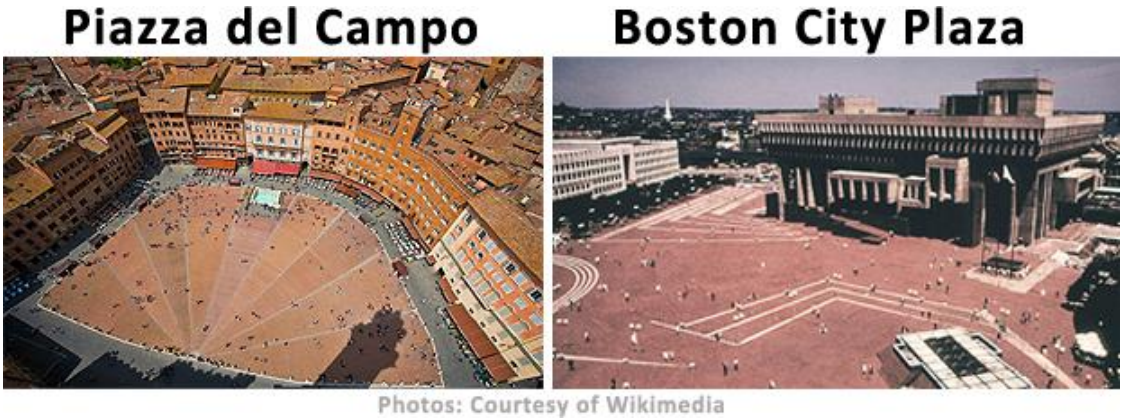


**Figure 1.** Piazza del Campo and Boston City Plaza

**Table 1.** Strengths of Piazza del Campo versus Boston City Plaza

| **Piazza del Campo, Siena, c. 1349** | **Boston City Hall Plaza, MA, c. 1968** |
|---|---|
| • Pedestrian friendly access to and within the plaza;<br>• Buildings and plaza scaled for people with safe, obvious places for gathering;<br>• Destinations for all, such as shops, eateries;<br>• Protected from vehicular traffic; cars banned from central city;<br>• Open, yet has awnings for shelter; distinct edges, clear exits. | • Not-very-pedestrian-friendly access to site and uncertain circulation path within;<br>• Buildings and plaza not human scaled; no place really feels safe; no gathering spots beckon;<br>• Few destinations such as shops, eateries;<br>• Unprotected from vehicles to east, west and south;<br>• Open design offering little shelter or well-defined edge-conditions. |

Our research suggests there is something more. Indeed, to make sense of Boston City Hall Plaza today, we think you first need to ask *really basic questions* — like these:

- How do people actually take in the place?
- Where do they look when they are there?
- What draws their eye initially, then second and third?

Using biometric tools, such as *eye tracking*, which measures our conscious and 'unconscious' eye movements as we take in visual stimuli, and is frequently used in advertising and web design, we can now do so, efficiently and inexpensively (Sussman, Ward & Hollander, 2018). So, what happens when you eye track Boston City Hall?

Much more than we expected. In fact, it took us a while to understand our findings; but after running four pilot-studies, (Sussman & Ward, 2017) eye tracking more than 150 buildings both within and outside Boston over two years, we can now report with some authority:

*Boston City Hall and Plaza fail to attract the public because the building and surrounding spaces don't provide the* ***fixation points****, or places to maintain visual gaze (Krauzlis, 2017) in the first 3-5 seconds the brain needs to see (that's during* ***pre-attentive processing****, before the conscious brain can get into the act), to most easily regulate, feel at its best, and effortlessly move us forward.*

It was astonishing for us to 'see' how difficult it was for people to actually look at, or 'fixate' on *any part of the building*, even with its picture on a monitor placed

directly in front of them. Check out two of the images from our study below. Note where people look: at City Hall's edge conditions, at other people, at vehicles in the vicinity. Only at six (6) seconds in did viewers, not all, but 75% of them, look directly at the building — apparently, the high contrast large black windows with the engraved letters above catching their eye. After that, almost half the participants (15 of 33) quickly looked away to focus on outermost edge conditions again. See Figure 2.

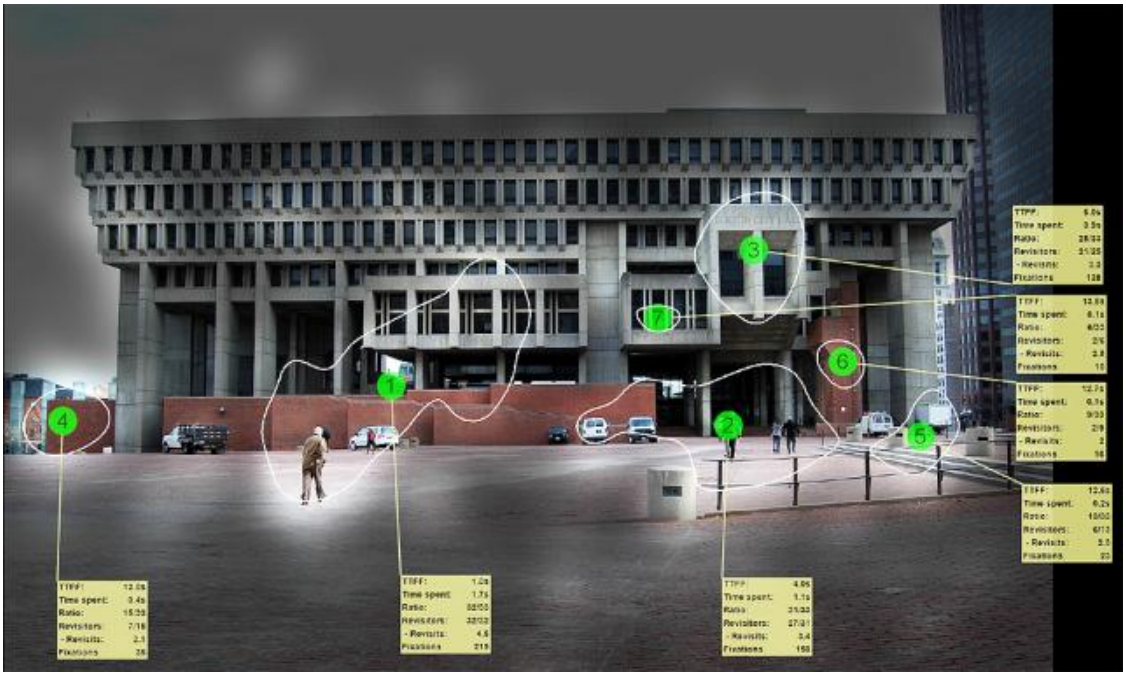

**Figure 2**. Eye Tracking Boston City Hall and its Plaza

The *shadow study* above shows eye-tracking results from our first pilot-study (Sussman & Ward, 2016) of Boston City Hall using *iMotions* biometric software (imotions.com). It aggregates data from 33 viewers and glows brightest where people looked most, fading to dark grey in areas ignored. *Note how much of the building and plaza are in the dark, the unconscious (pre-attentive) brain directing people away from City Hall.* This is hugely significant, revealing right away how difficult it is for people to take in the building. The brain simply does not want them to go there. The green-circled numbers above show seven areas of interest (AOIs) that drew the attention of study participants sequentially. Yellow boxes highlight more eye-tracking metrics.

### *The Metrics*

*Fixations* is where eyes stop to focus. The length of time it takes people to focus is *Time to First Fixation* (TTFF). *Time Spent* is what it sounds like — length of time spent focused. *Ratio* compares the number of people who gazed at an area over total number of participants. *Revisitors* refers to the number of people who looked away and looked back at an area; *Revisits* are the number of times they went back to a same spot.

Figure 3 shows the Fixation Sequence (1 - 7) Boston City Hall (front elevation).

1- By 1.3 seconds, 32 of 33 participants look at the area with a person and through an opening in City Hall to light beyond, (humans are hardwired to look for people and areas of high contrast without conscious effort).
2- Next, 31 of 33, focus on a second group of people and high-contrast area; gaze again appears directed *through* the building rather than *at it*.
3- 25 of 33 then apparently move to study the text and contrast provided by the elevation's tallest punched windows; significantly, this happens at 6 seconds, when more of 'conscious' brain may come online.
4- 15 of 33 then notice a side wall against the skyline; (as mammals, we innately seek out well-defined edges, it's a survival strategy).
5- At 12.6, 13 of 33 shift focus to a person and trucks in the courtyard.
6- 9 of 33 focus on high contrasting section of brick wall, slightly above trucks.
7- At 13.6 seconds, 6 out of 33 finally looked at an almost centrally-placed location on the City Hall building, high-contrast windows above 2nd fixation point; our bifocal vision favors looking at things centered in front of us, so this move seems to take a while.

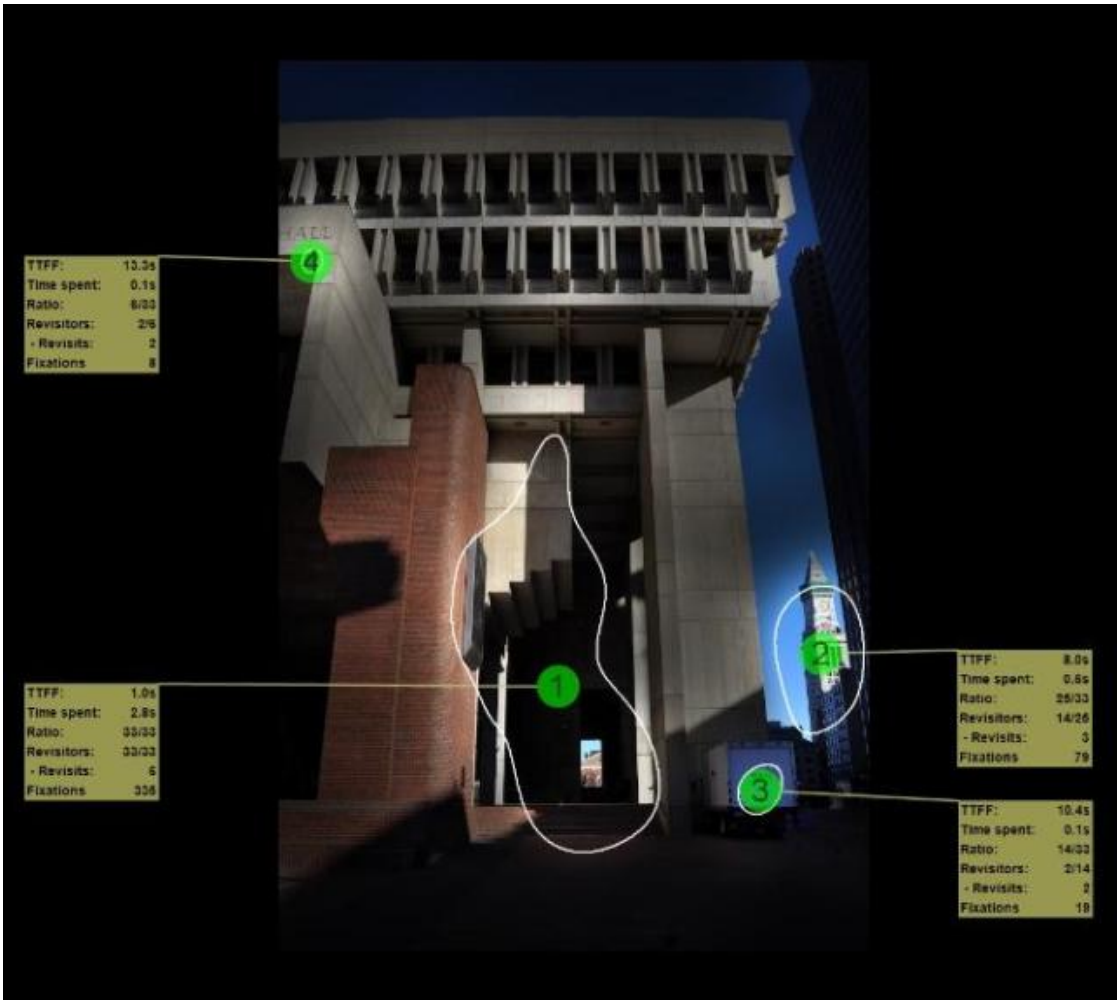


**Figure 3.** Fixation Sequence (1 - 7) Boston City Hall (front elevation)

***Closer Details of the Fixation Sequence (1 - 4) Boston City Hall (front elevation).***

1- By 1 second, 33 participants fixated (335 times) on the high-contrast central area of image; again, gaze appears drawn to the light, blue sky and brick building *beyond* the plaza.
2- By 8 seconds in, 25 of 33 viewers, or 75%, are looking away from City Hall to iconic Custom House Tower.
3- 14 of 33 went for the truck, and its contrasting print letters;
4- At 13.3 seconds, 6 of 33, or 18% of viewers, go back to look at the building, likely drawn to contrasting color, sharp edges and letters above entry, again we see the building promoting 'avoidant' behavior in the critical *pre-attentive* phase.

Of course, a next question would be, what kind of architecture draws the eye in *pre-attentive* processing? That is key to understand if we want to design people-friendly places! And a quick answer would be architecture responding to our *pre-attentive habits* which evolved in nature over millennia; this evolutionary process made human perception relational, pre-set to seek out faces, fractals, and delight in taking in diverse bilateral-symmetrical arrangements. (For more on the forms we innately seek and easily process, see NDI articles by N.A. Salingaros, including *Socio-Cultural Identity in the Age of Globalization* (2018)).

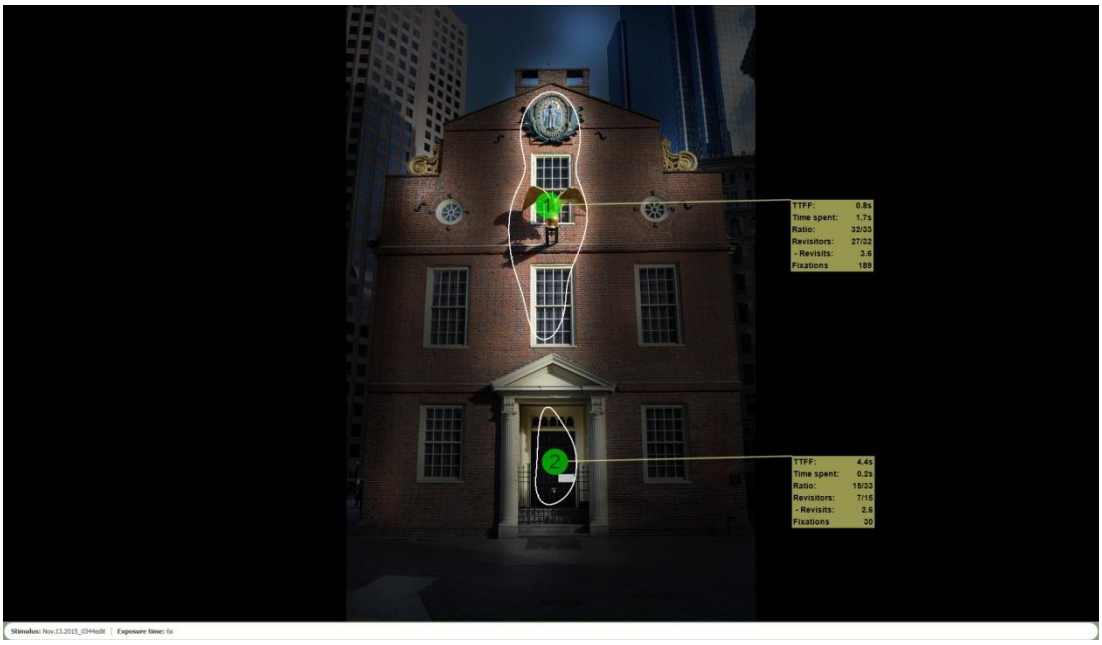


**Figure 4**. Fixation Sequence (1 - 2) Old State House, Boston (rear elevation).
Eye-tracked images©geneticsofdesign.com

No surprise, then, that when you eye track a traditional façade, such as the view of Boston's Old State House, (c. 1713), below, a Georgian creation, listed as one of the oldest public buildings in the U.S. (Wikipedia, 2019), and *less than 1/10 of a mile from Boston City Hall*, you will watch people within 5 seconds — in *pre-attentive processing*

— find the door. The Old State House anticipates *how we see* and *what we need to see* to ground ourselves in space, which significantly is requisite for making us feel like we belong in a place. It is bilaterally symmetrical, with clear hierarchy and a façade suggesting a face. Architecture that fails in *pre-attentive processing*, such as Boston City Hall, fails because it neglects human requirements including *one particularly salient fact*: we see 'reality' through an 'evolutionary scrim' and this ancient brain architecture (Pleistocene) drives our lives, setting the parameter for built environments and city design not only in pre-industrial and Colonial times, but today and into the future. Successful places in our external world must mirror needs of the hidden, internal one. *Natura non facit saltus.* (Nature doesn't make leaps!)

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