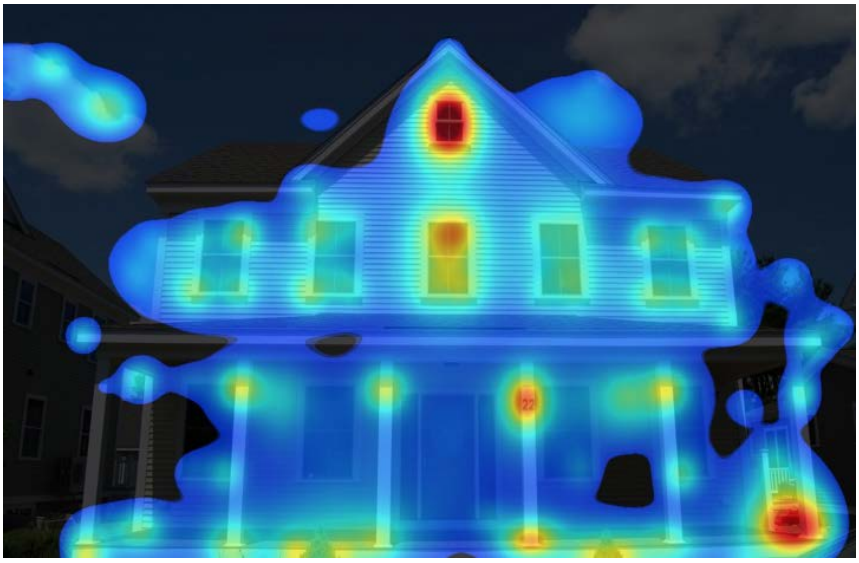
Seeing the 'Unseen' in Devens

A Biometric Pilot-Study to Better Understand the 'Unconscious' Human Experience at Devens, Massachusetts



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INTRODUCTION

Today we live in a new 'Age of Biology' where new findings in cognitive science coupled with new biometric tools can help us better understand human behavior. Technologies such as EEG, which measures brain waves, facial expression analysis software which follows our changing expressions, and eye-tracking software that allows us to record 'unconscious' eye movements, provide game-changing information about how our brain takes in our surroundings and directs our behavior. These technologies are widely used to create advertising, packaging, computers, automobiles, and other products in our world now, but remain relatively unknown and untested in the fields of architecture, planning and real estate development. In this pilot-study, we begin to explore their usefulness in assessing a new residential real estate development which was designed to promote sustainability and healthy living.

While the environmental psychology literature is rich with evidence about ideal street widths, signage, lighting, signaling, and landscaping, this study is one of the first to show how biometric tools can dramatically increase understanding of how people actually respond to the places around them. This study provides new kinds of data on hidden, 'unseen' experience that determine human behavior. This information turns out to be germane in helping us better understand remarkably specific things, such as how difficult it might be to find the front door of a new house, how confusing someone might find signage on an unfamiliar street and how likely it would be for a visitor to walk down a sidewalk in a new neighborhood.

For this study, we used a relatively-new off-the-shelf biometric tool, 3M's Visual Attention Software (VAS), introduced in 2011, to measure the unconscious visual responses people make when presented with the various designs and layouts in Devens' Emerson Green neighborhood. The results suggest new kinds of parameters for quantifying a real estate development's effectiveness and more broadly indicate how biometric tools including eye-tracking emulation software, provide a viable means of both assessing and predicting the human experience of place and can help create new neighborhoods that more successful respond to intrinsic human needs.

LITERATURE REVIEW

Eye-tracking is widely used to measure the effectiveness of visual advertising on consumers, and companies including Microsoft, IBM, and Kraft Foods have used it in product and packaging design (Wedel and Pieters 2008). Research supporting its use as an indicator of spatial attention has led to increased use in marketing and other disciplines (Sheliga et al. 1995; Wedel and Pieters 2008). The technology has also gained ground as a diagnostic tool to assess neurological conditions, including eating, autism-spectrum, and various anxiety disorders including PTSD (Bauer et al. 2017, Guillon et al. 2014, Kimble et al. 2010). Eye-tracking has also lent insight into the way people observe their surroundings; its data has been used to assess participants'

ability to understand ecosystem services (Klein, Drobnik, and Grêt-Regamey 2016), to analyze how people perceive landscapes (Dupont et al. 2013; Lucio et al. 1996; Potocka 2013), and to discern visual preference in relation to various urban elements (Nolan et al. 2016).

3M's Visual Attention Software, or VAS, was developed primarily for use in marketing and signage placement (Moore 2011). Companies such as Clorox, Unilever, and Anheuser-Busch use VAS to aid in designing commercial products ("VAS in your workflow"). Since VAS has been on the market, it has been utilized to measure the attractiveness of various packaging designs (Cottrell 2016), to analyze the effectiveness of roadside signage on motorists (Auffrey and Hildebrandt 2017), and to optimize the placement of advertisements on a busy page (Carr 2011). No published research to date, however, has applied VAS to to better understand the human experience of architecture and urban planning, or place.

STUDY PROTOCOL

- **Photo Inventory**

Our first order of business was to create a photo inventory for Devens. We traveled to the site to take pictures of both the newly constructed houses in Emerson Green on Chance Street and existing conditions of restored and unrestored buildings in the Devens historic district. This visit gave us the opportunity to experience Emerson Green and its surroundings firsthand and make note of places where we felt comfortable and welcome and other areas where we felt less so.

Additional photographs and renderings of the new development were generously provided by the project architect Union Studio Architecture & Community Design of Providence, R.I..

In total, we collected 70 site-specific, color images for the study. (See Appendix A + B).

- **Eye-tracking Emulation Software**

To analyze the images, we used 3M's VAS (Visual Attention Software) which emulates eye tracking, a biometric tool that maps the path the human eye takes looking at something. Eye tracking records fixations, or resting points, and saccades, the rapid movements between them, and can give insight into what features of an image immediately attract attention. Traditional eye-tracking studies use a lab set-up requiring 30 or more test-takers per study and can be costly and time-consuming to complete. So for this Devens study, we selected the web-based 3M product which provides useful (though not as robust) results and is infinitely easier, cheaper, and more efficient to run (Auffrey and Hildebrandt 2017; Cottrell 2016).

VAS's algorithm is based on 30 years of eye-tracking research and predicts human responses to visual stimuli within the first 3 to 5 seconds, or during *preattentive processing* (before our

conscious brain can get into the act). It assesses study images for five “visual elements” known to attract human attention; these are, “edges,” “faces”, color “intensity,” “red/green color contrast” and “blue/yellow color contrast” (3M Corporation 2017).

The data that VAS creates for each image appears as compelling graphic representations, which are typical eye-tracking output. These include *heat maps*, which glow reddest and brightest where people look most, *visual sequence diagrams*, which track the most likely path eyes take looking at a scene and *regions of interest* diagrams, which with simple enclosed lines, delineate areas that draw the most attention in comparison with those that draw less and none at all. The software creates all these quickly, in under a minute, once an image is uploaded to the 3M site.

The 70 original images, their heat maps and visual sequence diagrams generated by the emulation software are in Appendix A.

Appendix B has the regions of interest diagrams generated by VAS, along with the original images and the same heat maps.

Appendix C presents a figure-ground drawing of the Chance St. area of Emerson Green indicating the layout of houses and the locations of photos used.

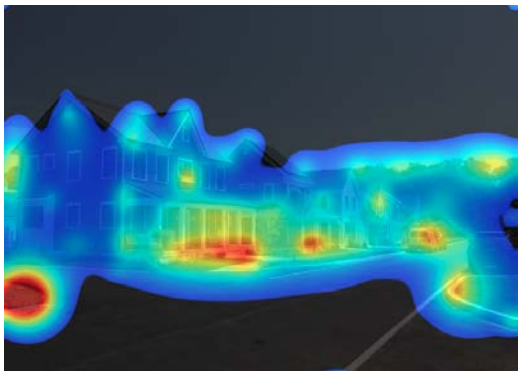
FINDINGS

In the photos below of Chance Street, the *regions of interest* diagrams suggests how effectively specific design elements work in the development, particularly how the front porches of the new homes with their white columns attract attention (Figure 1). We see how lack of detail and simpler design of the garages in the parking alley do not, which may fit the developer’s intent to encourage privacy in this area (Figure 2). Note how the red outlined areas will likely get the most viewing (74% to 98%), with the areas outlined in yellow receiving moderate attention (58% to 63%). Uncalled out regions, such as building roofs and areas of blank roadway will most likely be ignored in the first 3-to-5 seconds.

Figure 1. Regions of Interest diagram of Chance St.

Figure 2. Regions of Interest diagram of Chance St. garages.

The *heat maps*, below, of the same view down Chance Street, present the information in a different form, glowing bright red where people look most, then fading to orange and yellow where they look less and moving to green, light blue, then darker blue where people look least. Areas that will be ignored entirely appear dark grey or black. Both the layout of the buildings on Chance Street and their design encourages viewers to cast their view along and down the street (Figure 3), which does not happen in the parking alley with a design and layout that likely draws attention upwards towards the sky and tree canopy (Figure 4).



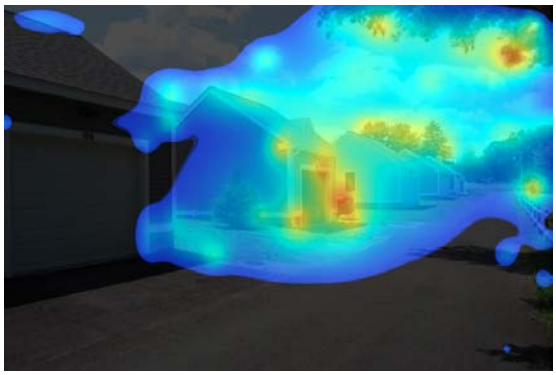


Figure 3. Heat Map of Chance St.
Figure 4. Heat Map diagram of Chance St. garages.

The *visual sequence diagrams* forecast the path the eye will likely follow as it 'fixates' or rests (for several hundred milliseconds (ms) at a time) on different elements in a scene or image (Figures 5 and 6). This turns out to be quite significant. Since our conscious behavior is always rooted in unconscious activity, we see how 'fixations' *we don't know we're making* provide the hidden structure for us to look at something, and then, move our conscious attention or our body forward. Cognitive scientists like to say that 'fixations drive exploration,' a mantra that advertisers know, too. For they understand that if people don't 'fixate' on an ad, it won't direct behavior as intended and fails.

Figure 5. Visual Sequence diagram of Chance St.

Figure 6. Visual Sequence diagram of garages.

When we visited Emerson Green, we noted pretty quickly that it was much easier for us to walk down Chance Street than the parking alley behind the residences; ‘seeing’ the fixation paths above can help us better understand why those feelings occurred; learning about how unconscious behavior directs conscious activity can also clarify why walking around one area seemed effortless and the other, even though a stone’s throw away, much more difficult (Figure 7).

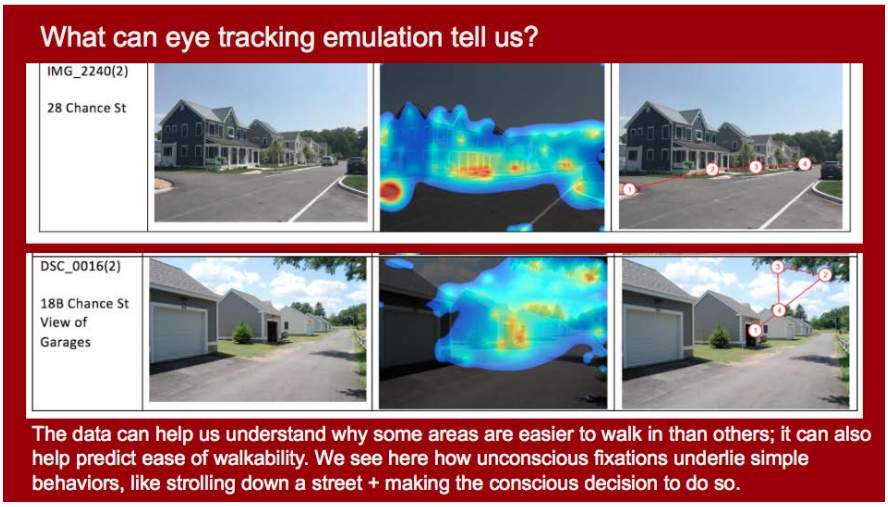


Figure 7. Eye tracking emulation and walkability.

- **Born to Avoid Blankness**

Eye-tracking data also reveals other hidden human habits that are critical for the design of successful habitat; a key one is how much we’re hardwired to avoid looking at blank spaces and places. Our brain is on continuous lookout for areas of high contrast, one more consequence of having a central nervous system that’s an artifact of 3.6 billion years of evolution.

At Emerson Green we saw the impact of this brain design play out in the way the emulation software predicted people would ignore blank facades, such as the development’s garages (Figure 8), particularly their doors, and instead focus on building elevations, both old and new, that offered consistent pairs of punched windows (Figure 9).

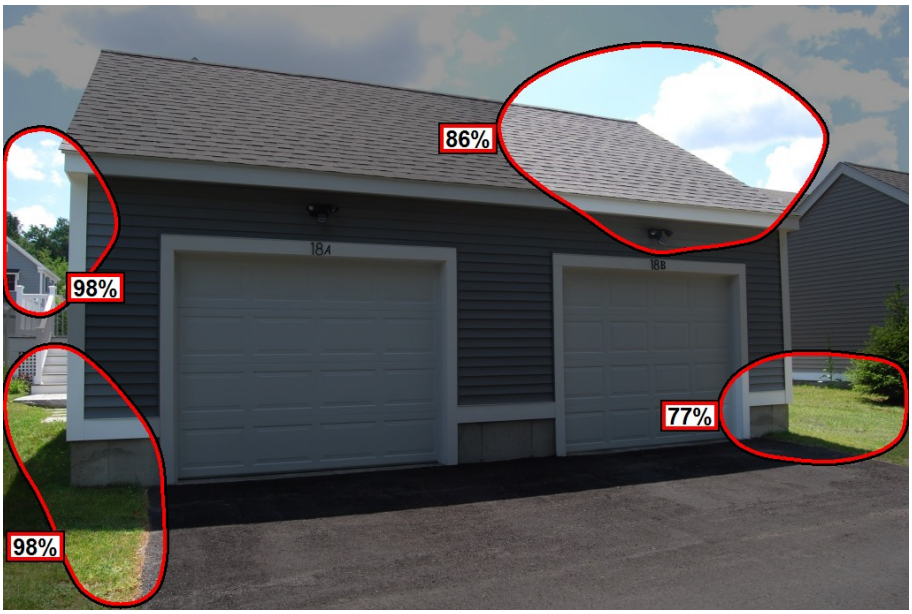


Figure 8. Regions of Interest diagram of 18A and 18B Chance St. garages .

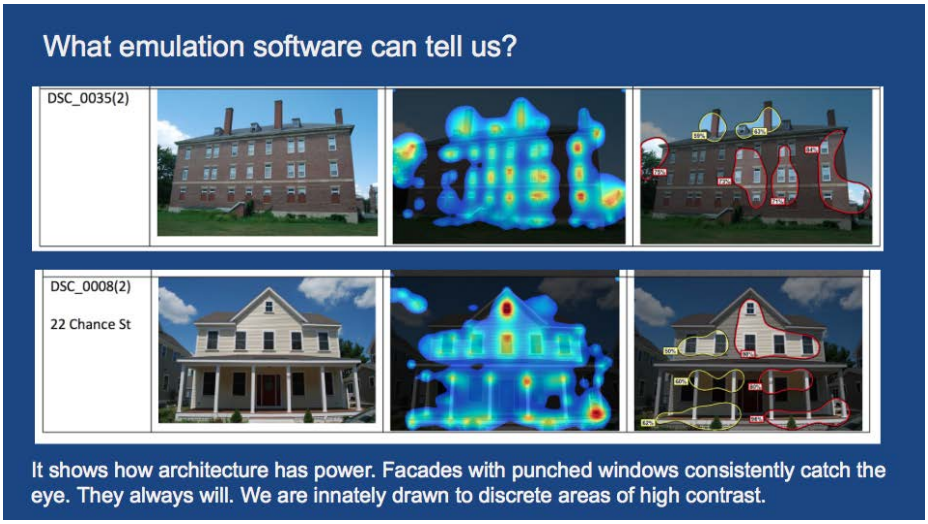


Figure 9. Punched windows and contrast.

- **Red Doors Draw Us In**

Eye tracking emulation is also good at showing how color matters in the built-environment, particularly red. The diagrams below illustrate a red door grabbing viewer attention, showing the same house, 28 Chance St., with and without one. The regions of interest diagrams illustrate the difference particularly well. When the house has a red door, the probability that it will be looked at is within the first 3-5 seconds is 71%, but with a light blue door, that probability drops to less than 60%. The contrast between the red door and the dark background likely causes this measurable change in preattentive focus (Figures 10 and 11). Color can have a measurable effect on our attraction to visual stimuli, and red doors happen to be remarkably, and measurably, effective.

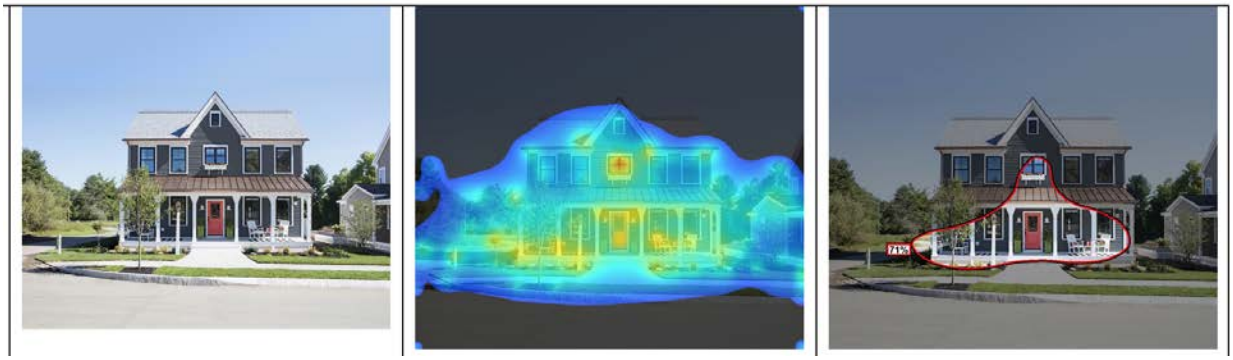


Figure 10. Original, Heat Map and Visual Sequence diagrams of 28 Chance St with a red door.

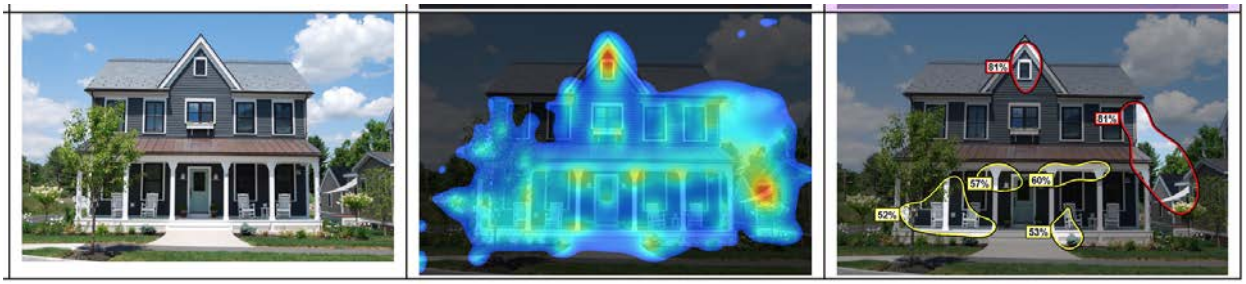
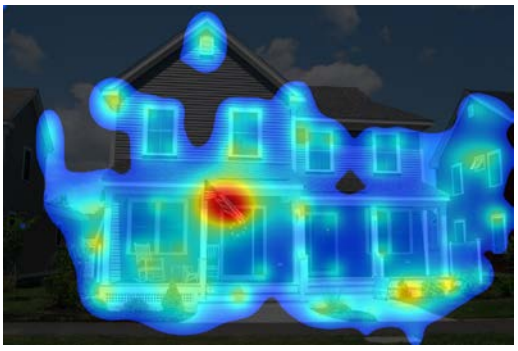


Figure 11. Original, Heat Map and Visual Sequence diagrams of 28 Chance St without a red door.

- **Flags and Banners Captivate, Too**

Below we can see why flags are popular and always will be: they draw us in. The bright red spot on the heat map (Figure 12) and the area of 86% probability of pre-attentive focus on the regions of interest diagram (Figure 13), indicate the intensity of the flags' appeal. These diagrams suggest that of all of the buildings' design elements, the flags are most likely to consistently capture attention first and foremost in the preattentive phase.



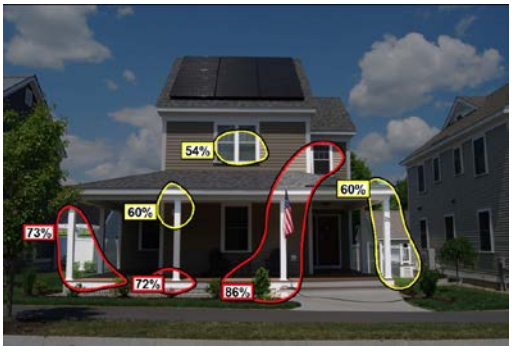


Figure 12. Heat Map of 18A, 18B Chance St.

Figure 13. Regions of Interest diagram of 26 Chance St.

- **What Eye Tracking Emulation Software Can't Tell Us**

While VAS successfully estimates where we'll look in preattentive processing, the software can't tell us about the emotional character of the person's response, or how buildings or streetscape make us feel. Eye tracking tools record how long a person spends looking at an element and their viewing patterns, not their positive or negative emotional responses. For that critical information, researchers combine eye tracking with other biometrics, including EEG, which measures brain waves and approach avoidance tendencies, facial expression analysis, which actively tracks facial muscle movements, and heart rate monitoring, which can indicate levels of arousal and interest, among other metrics. Researchers also rely on 'self-report', or simply asking lab volunteers how they feel taking in a stimulus and systematically recording their responses.

Eye tracking and emulation tools nevertheless remain powerful because they help us instantly see how much of our response to our surroundings is determined unconsciously, they help us literally 'see the unseen'. By doing so these biometric tools change our understanding of how we function and why people respond to buildings and their neighborhoods the way they do, and we hope, can promote building more of what we need to see to make new neighborhoods more successful, happier places for everyone, going forward.

- **Implications for Urban Planning**

There is a lot of potential for the use of eye-tracking emulation software in urban planning. Urban planners can run renderings of their building or street view design through VAS to cheaply and easily learn where the fixation points lie on their designs. It could also help identify which areas are noticed and which are overlooked during pre-attentive processing, which could help a planner to evaluate the effectiveness of their designs. For example, VAS can help a planner to measure whether their streetscape encourages exploration or privacy, depending on the purpose of the development.
Additionally, urban planners seeking to emulate a memorable streetscape (e.g., Venice, Main Street in Disney World, Bourbon Street in New Orleans) can run an image of the streetscape through VAS to learn which elements of the streetscape draw viewers' attention and encourage exploration. Eye-tracking emulation data gained through running existing buildings through VAS can be used to inform the design of new buildings.

CONCLUSION

In this pilot-study using emulation software to understand how people experience the new Emerson Green development, we can draw several conclusions:

- House design and layout matter on the new neighborhood streets. Punched windows and porch columns attract the eye, so it can work well to incorporate these in streetscapes.

- People ignore blank facades; they are less likely to look at buildings with them and thus less likely to enjoy being in areas with them. We aren't wired to focus this way.

- 'Fixations drive exploration,' is key for understanding how our unconscious eye movement direct our conscious behavior. The study suggests that one reason many residential areas aren't walkable is they don't provide requisite fixation points; Chance Street we learned does.

- We summarize that biometrics, such as the emulation product used here, by letting us 'see the unseen,' gives new insight into what makes developments successful and suggests why some neighborhoods fail as well as ways to improve them.

- Finally, Emerson Green, with its emphasis on forward-looking, energy-conserving community design, can establish a prototype for what 21st century development looks like as well as the means for new biometric assessment of its impact on human brain and body.

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Appendix A: Original, Heat Map, and Visual Sequence

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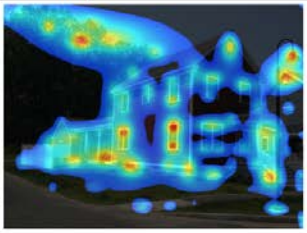
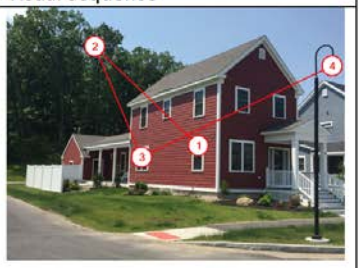
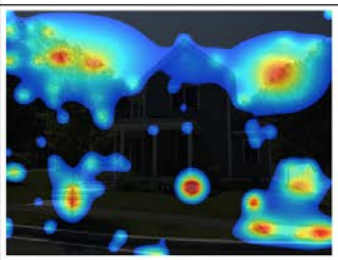
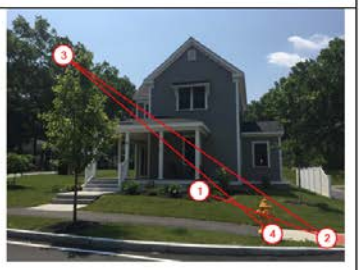
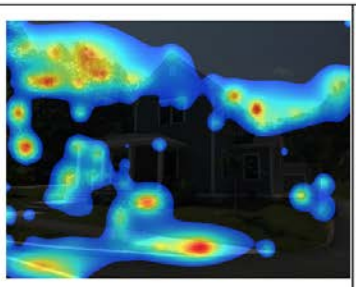
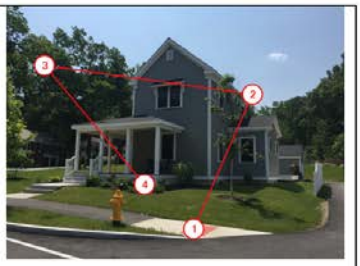
IMG_2267(2) 19 Chance St			
IMG_2261(2) 15 Chance St			
IMG_2260(2) 15 Chance St			
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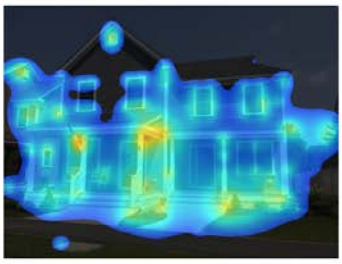
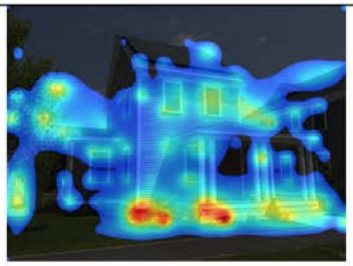
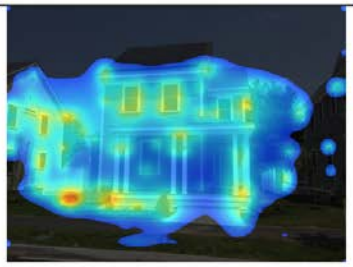
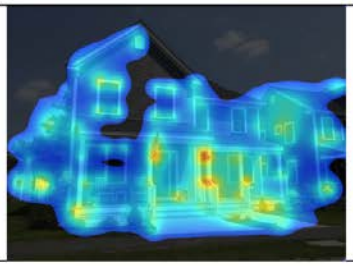
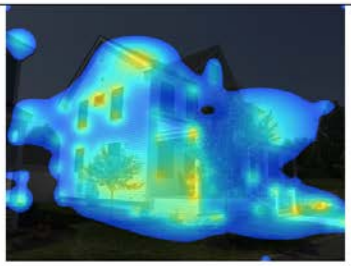
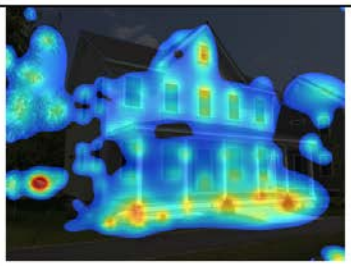
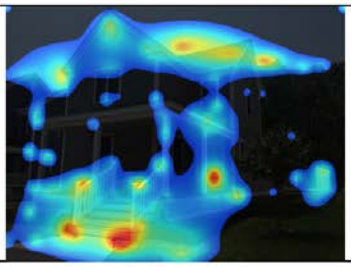
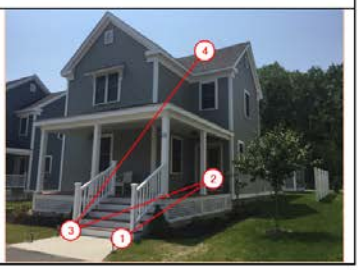
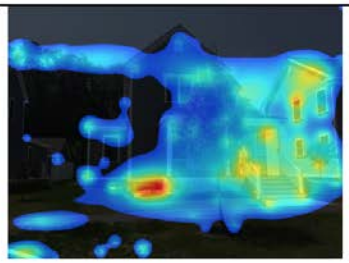
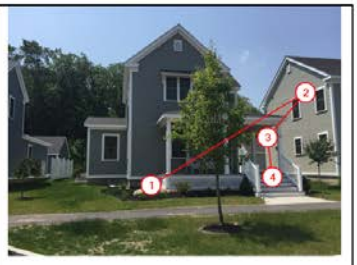
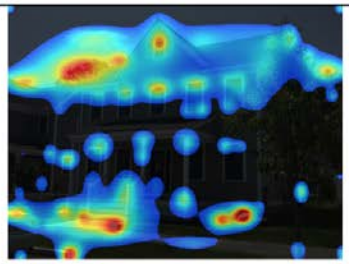
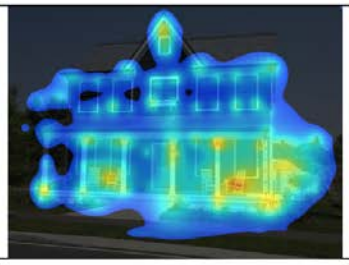
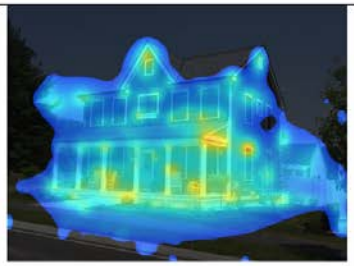
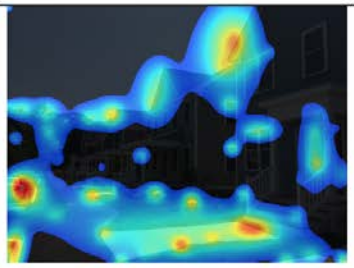
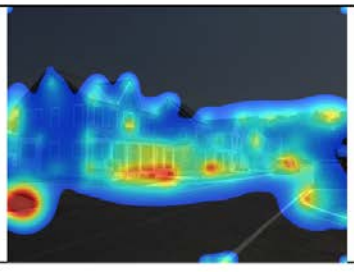
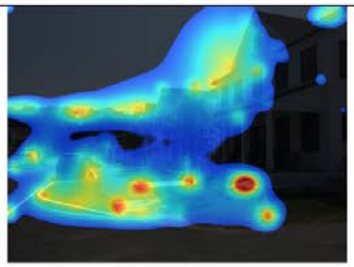
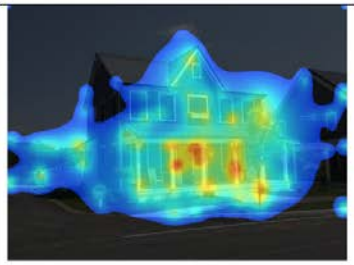
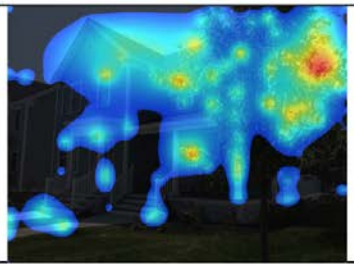
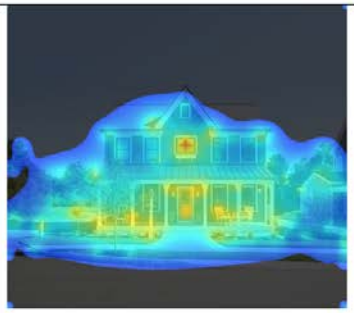
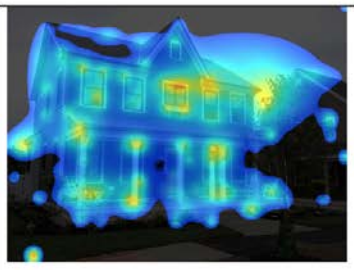
IMG_2256(2) 18 Chance St			

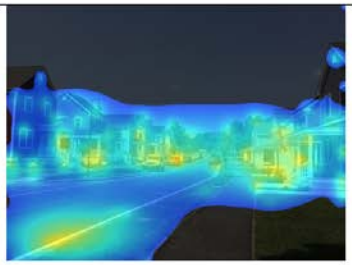
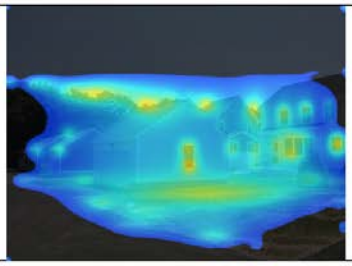
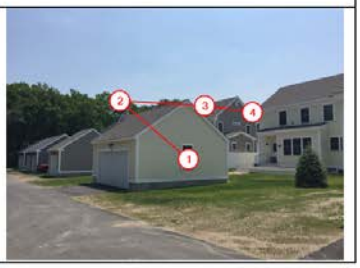
IMG_2253(2) 20 Chance St			
IMG_2254(2) 20 Chance St			
IMG_2255(2) 18 Chance St			
IMG_2248(2) 29 Chance St			
IMG_2251(2) 22 Chance St			
IMG_2250(2) 23 Chance St			

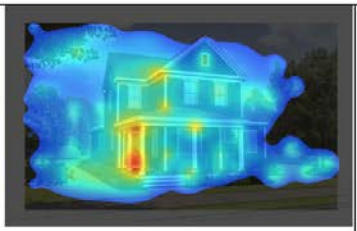
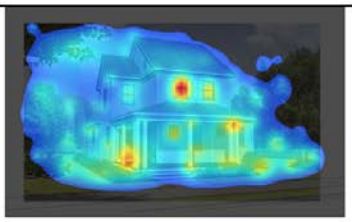
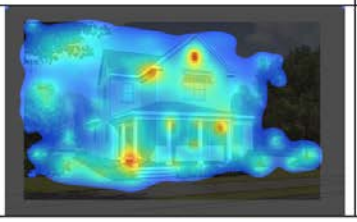
IMG_2249(2) 23 Chance St			
IMG_2247(2) 25 Chance St			
IMG_2244(2) 28 Chance St			

IMG_2245(2) 28 Chance St			
IMG_2243(2) View of Chance St from 27A			
IMG_2240(2) 28 Chance St			

IMG_2239(2) 29 Chance St			
IMG_2241(2) 28 Chance St			
IMG_2242(2) 27 Chance St			

1016Emerson GreenEXTERIORS_V1_FINALS_013-Copy (2) 28 Chance St			
IMG_5815(2) 28 Chance St			

IMG_2252(2) 22 Chance St			
IMG_2262(2) Looking down Chance St			
IMG_2279(2) 22 Chance St			

17_0612-DEV-Persp-Sunday4(2)			
17_0612-DEV-Persp-Sunday3(2)			
17_0509-DEV-Persp-Sunday1(2)			

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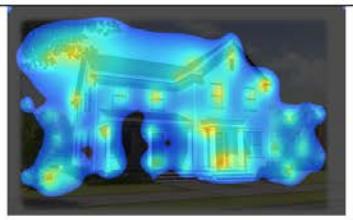
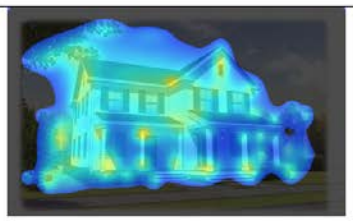
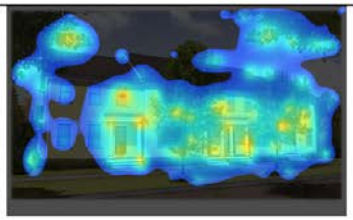
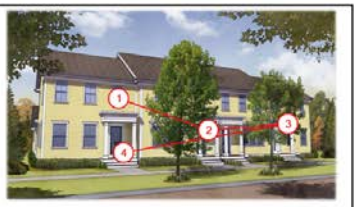
17_0612-DEV-Persp-Hammock1(2)			
17_0612-DEV-Persp-Hammock2(2)			

17_0509-DEV-Persp-Lark(2)			
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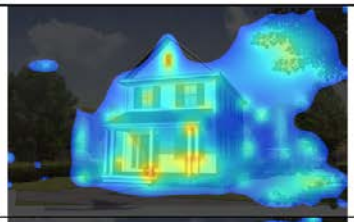
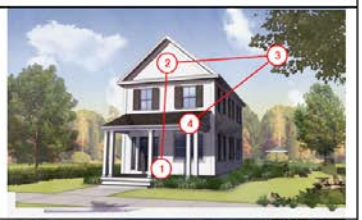
17_0509-DEV-Persp-Song2(2)			
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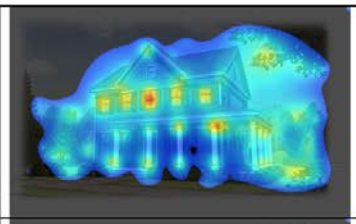
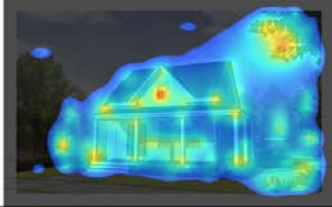
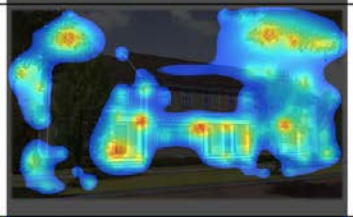
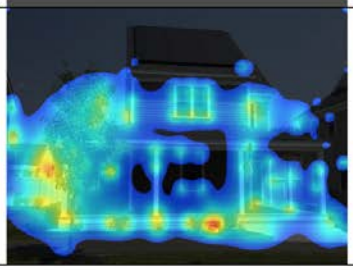
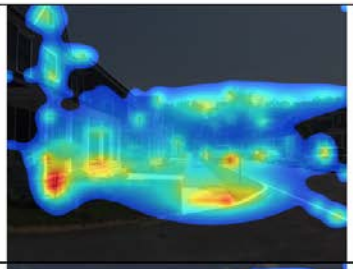
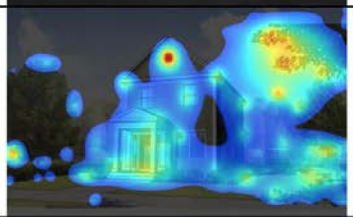
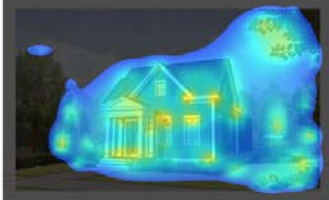
17_0509-DEV-Persp-Garden2(2)			
17_0509-DEV-Persp-Dusk3(2)			
17_0509-DEV-Persp-Field(2)			
IMG_2246(2) 26 Chance St			

IMG_2238(2) View from 28 Chance St			
17_0509-DEV-Persp-Firefly1(2)			
17_0509-DEV-Persp-Dusk1(2)			
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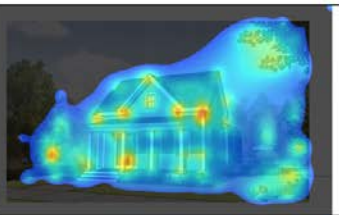
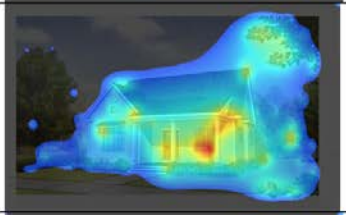
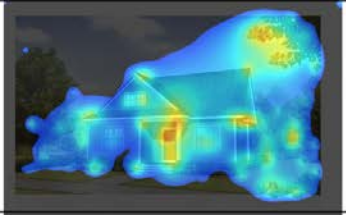
17_0509-DEV-Persp-Dusk2(2)			
17_0509-DEV-Persp-Dawn1(2)			
17_0509-DEV-Persp-Dawn2(2)			
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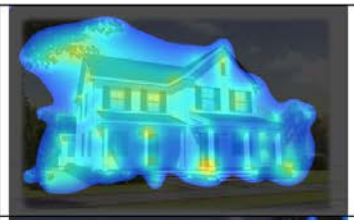
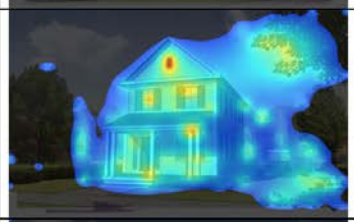
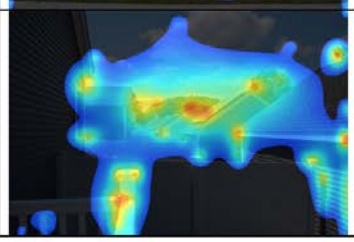
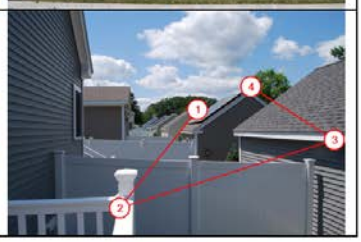
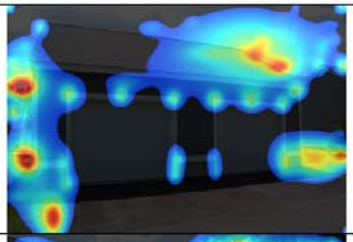
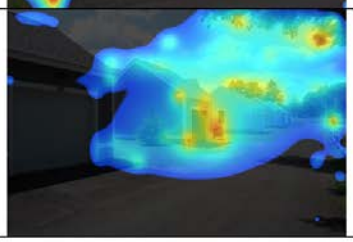
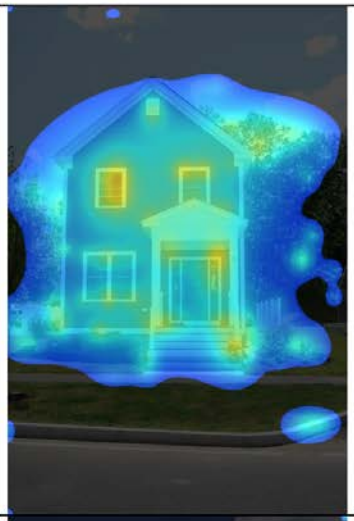
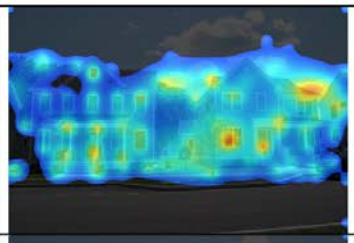
17_0509-DEV-Persp-Breeze2(2)			
17_0509-DEV-Persp-Firefly2(2)			
DSC_0013(2) 26 Chance St			
DSC_0014(1)(2) From 18A Chance St			

DSC_0015(2) 18 A, 18B Chance St			
DSC_0016(2) 18B Chance St View of Garages			

DSC_0007(2) 19 Chance St			
DSC_0008(2) 22 Chance St			

DSC_0010(2) 25 and 27 Chance St			
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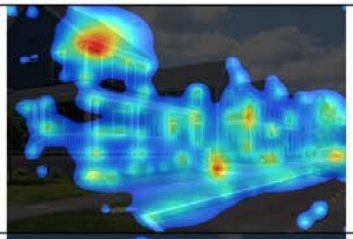
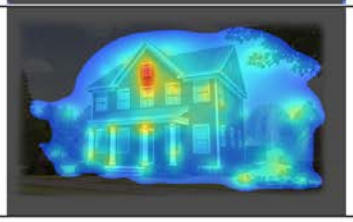
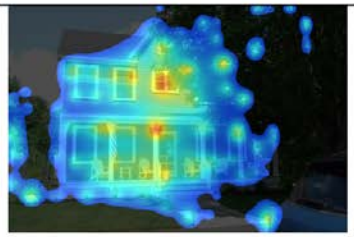
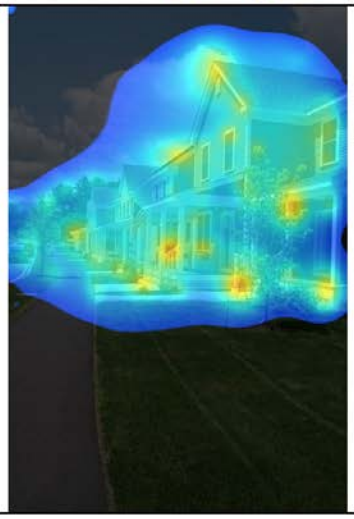
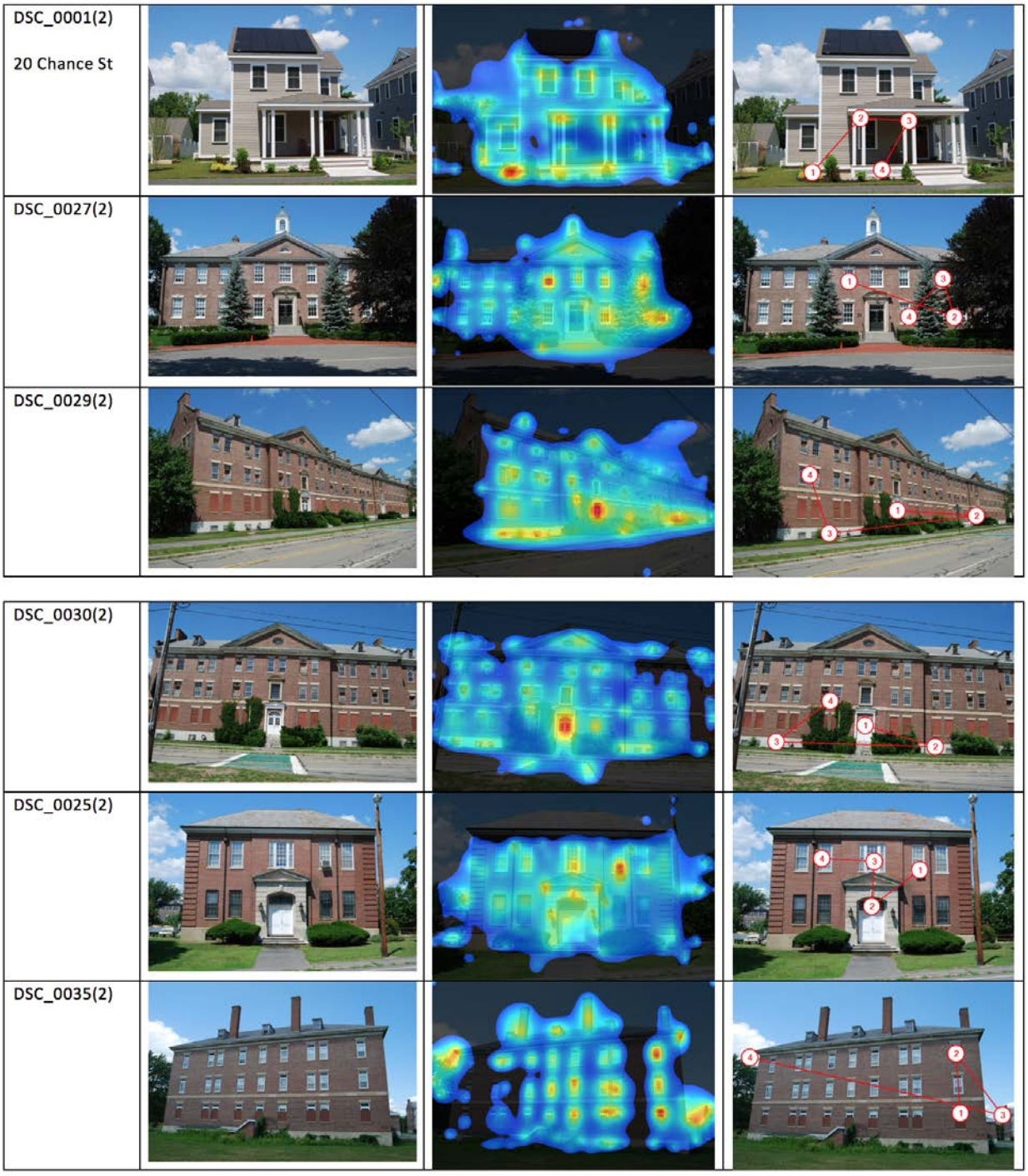
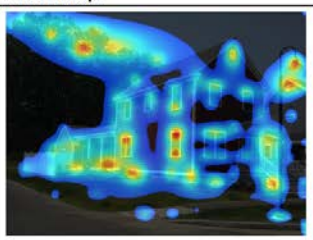
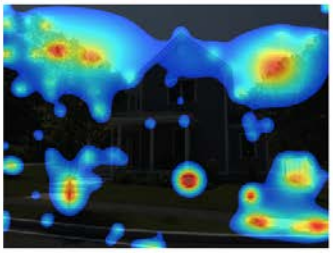
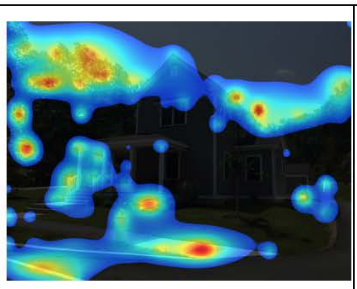
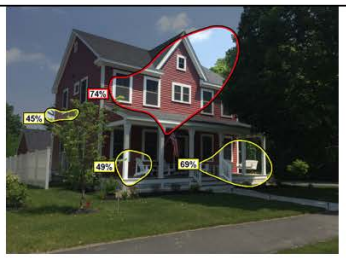
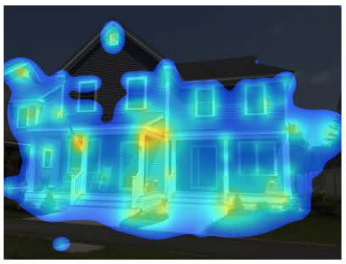
DSC_0012(2) 28 Chance St			

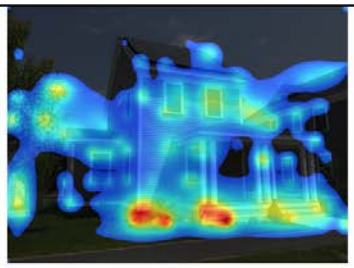
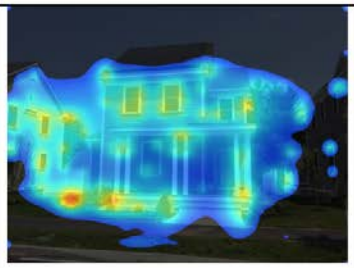
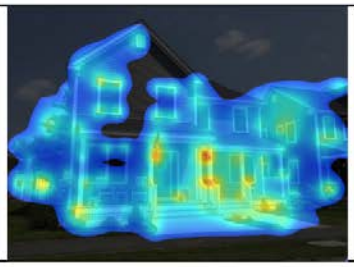
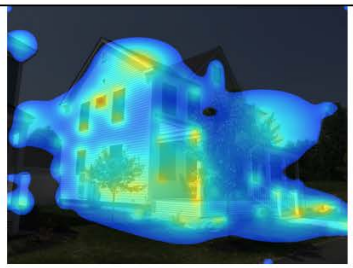
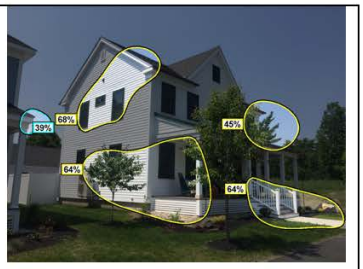
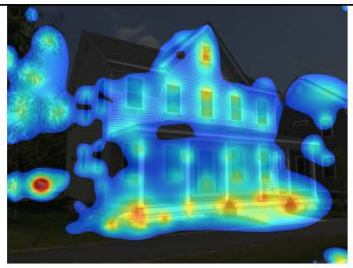
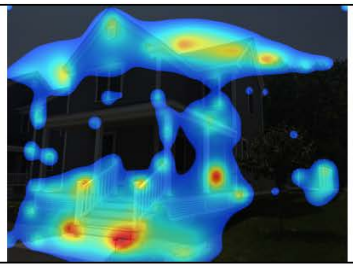
DSC_0006(2) View from 21 Chance St			
DSC_0002(2) 18A, 18B Chance St			
16_0714DEVUnitTOH-Perspective(2)			
17_0509-DEV-Persp-Garden (2)			

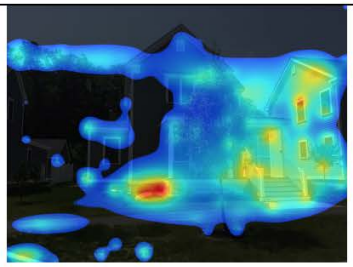
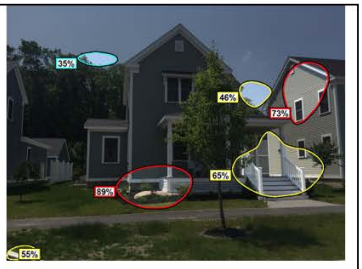
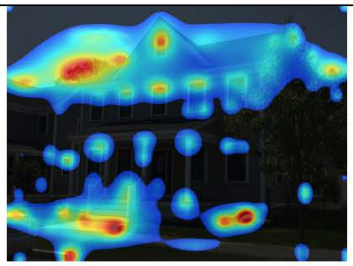
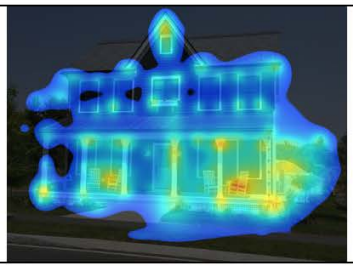
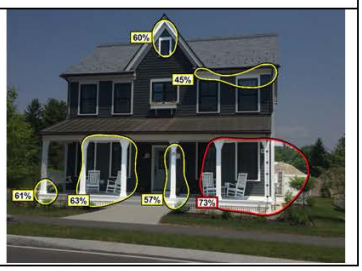
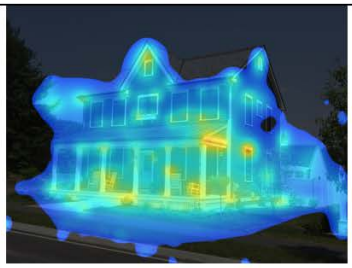
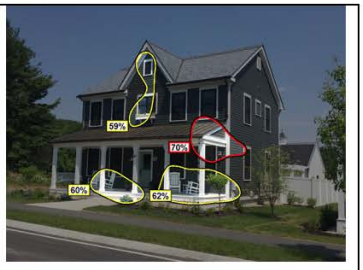
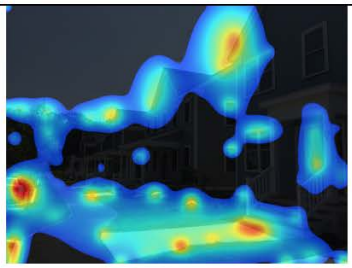
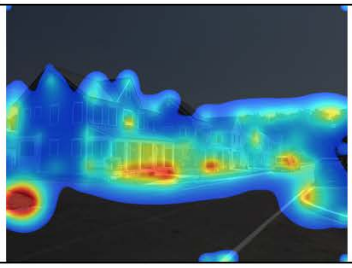
DSC_0004(2) 16 Chance St			
DSC_0005(2) View from 18 Chance St Change language			

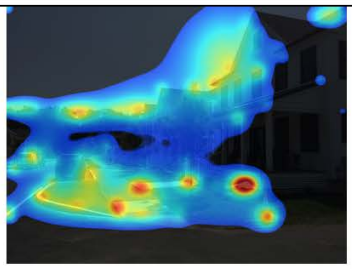
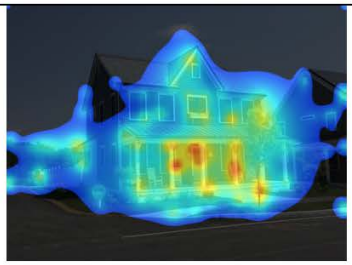
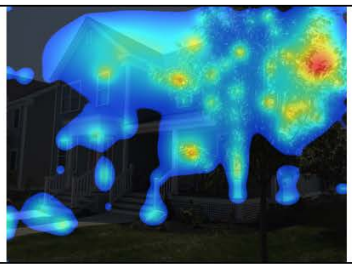
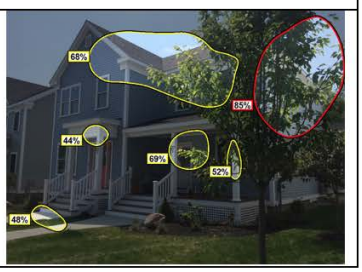
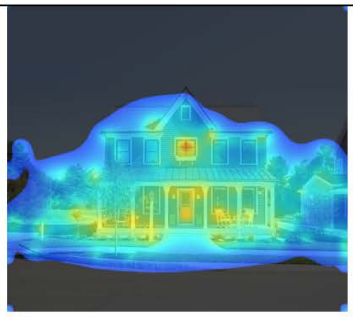
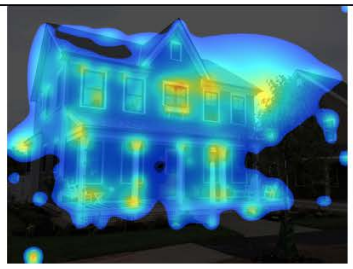


Appendix B: Original, Heat Map, and Regions of Interest

Image Name	Original	Heat Map	Regions of Interest
IMG_2267(2) 19 Chance St			
IMG_2261(2) 15 Chance St			
IMG_2260(2) 15 Chance St			
IMG_2259(2) 16 Chance St			
IMG_2256(2) 18 Chance St			

IMG_2253(2) 20 Chance St			
IMG_2254(2) 20 Chance St			
IMG_2255(2) 18 Chance St			
IMG_2248(2) 29 Chance St			
IMG_2251(2) 22 Chance St			
IMG_2250(2) 23 Chance St			

IMG_2249(2) 23 Chance St			
IMG_2247(2) 25 Chance St			
IMG_2244(2) 28 Chance St			
IMG_2245(2) 28 Chance St			
IMG_2243(2) View of Chance St from 27A			
IMG_2240(2) 28 Chance St			

IMG_2239(2) 29 Chance St			
IMG_2241(2) 28 Chance St			
IMG_2242(2) 27 Chance St			
1016Emerson GreenEXTERIORS_V1_FINALS_013-Copy(2) 28 Chance St			
IMG_5815(2) 28 Chance St			

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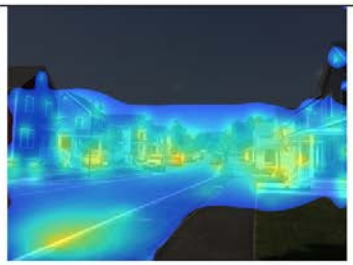
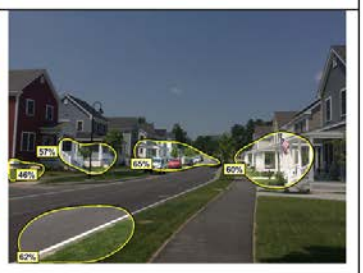
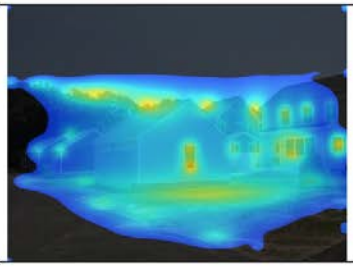
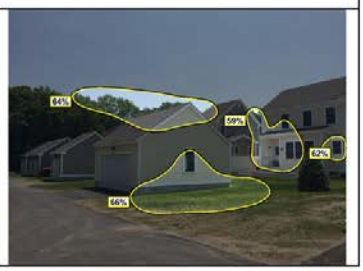
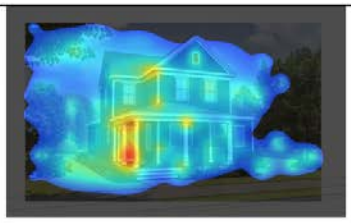
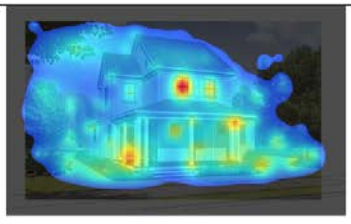
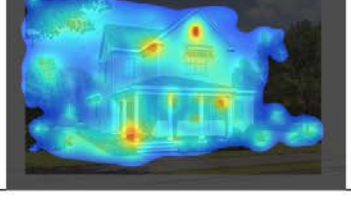
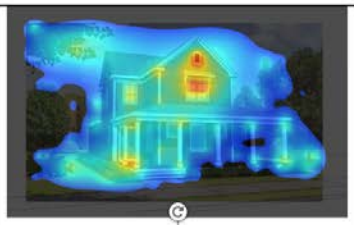
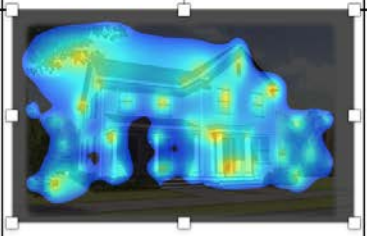
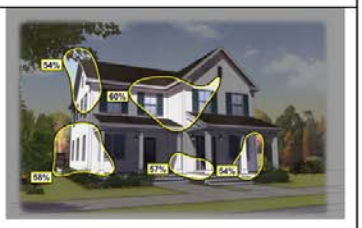
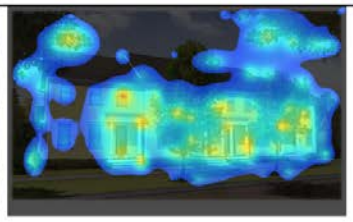
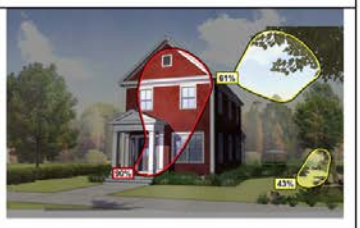
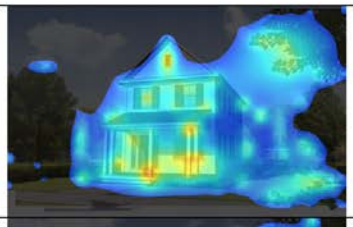
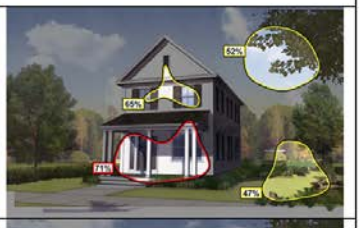
IMG_2262(2) Looking down Chance St			
IMG_2279(2) 22 Chance St			

17_0612-DEV-Persp-Sunday4(2)			
17_0612-DEV-Persp-Sunday3(2)			
17_0509-DEV-Persp-Sunday1(2)			

17_0509-DEV-Persp-Sunday2(2)			
17_0612-DEV-Persp-Hammock1(2)			
17_0612-DEV-Persp-Hammock2(2)			

17_0509-DEV-Persp-Lark(2)			
17_0509-DEV-Persp-Song1(2)			
17_0509-DEV-Persp-Song2(2)			
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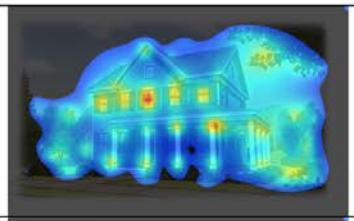
17_0509-DEV-Persp-Garden2(2)			
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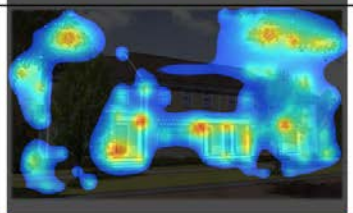
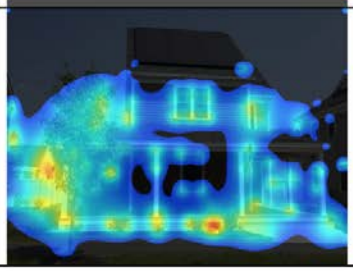
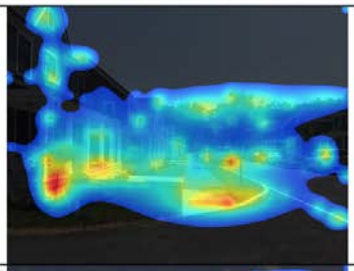
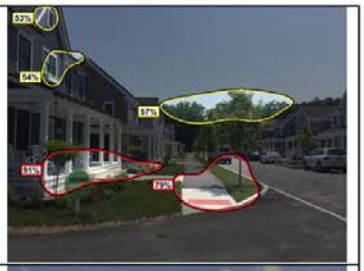
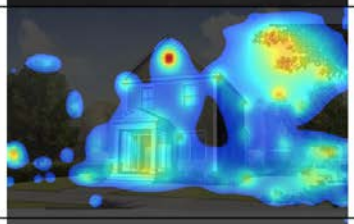
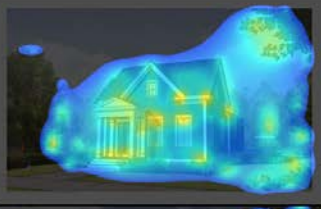
17_0509-DEV-Persp-Field(2)			
IMG_2246(2) 26 Chance St			

IMG_2238(2) View from 28 Chance St			
17_0509-DEV-Persp-Firefly1(2)			
17_0509-DEV-Persp-Dusk1(2)			
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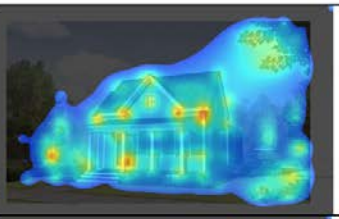
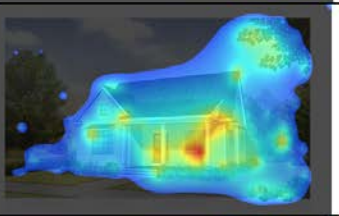
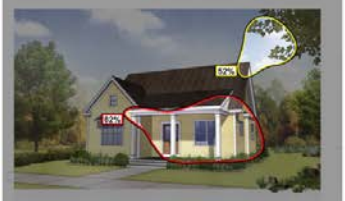
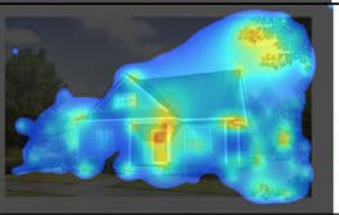
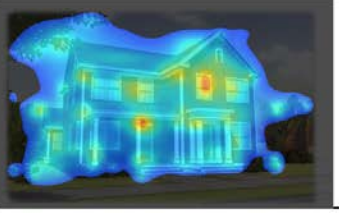
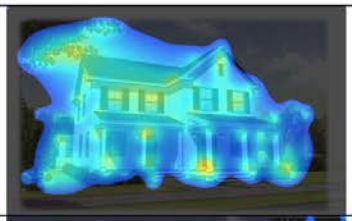
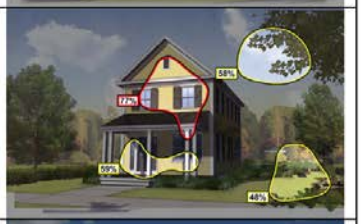
17_0509-DEV-Persp-Dusk2(2)			
17_0509-DEV-Persp-Dawn1(2)			
17_0509-DEV-Persp-Dawn2(2)			
17_0509-DEV-Persp-Breeze1(2)			

17_0509-DEV-Persp-Breeze2(2) 2			
17_0509-DEV-Persp-Firefly2(2)			
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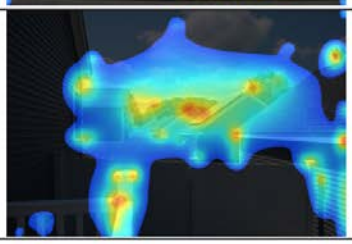
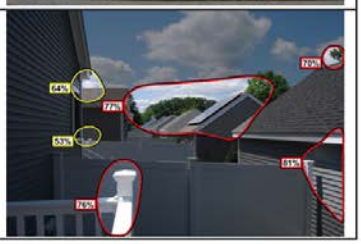
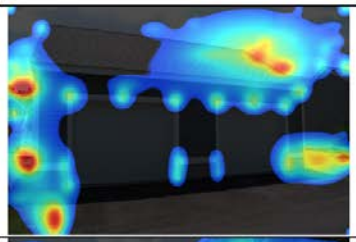
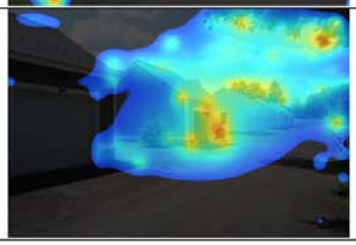
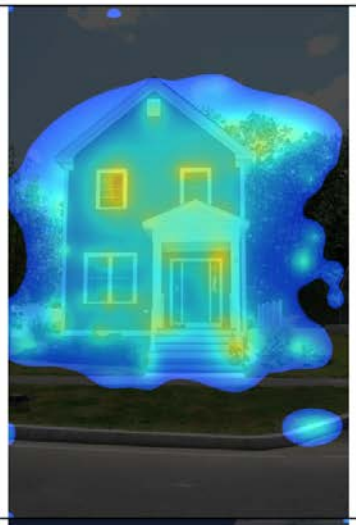
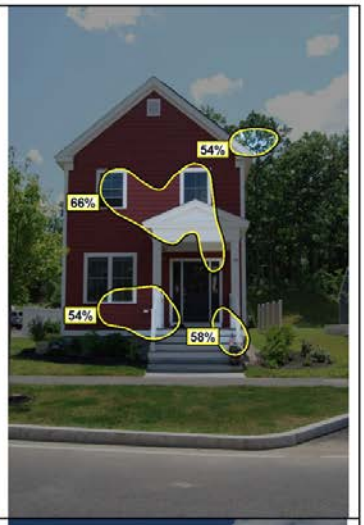
DSC_0014(1)(2) From 18A Chance St			

DSC_0015(2) 18 A, 18B Chance St			
DSC_0016(2) 18B Chance St View of Garages			

DSC_0007(2) 19 Chance St			
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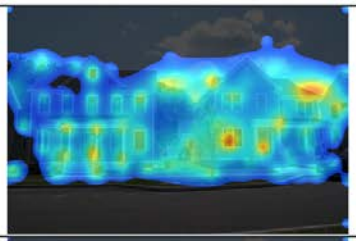
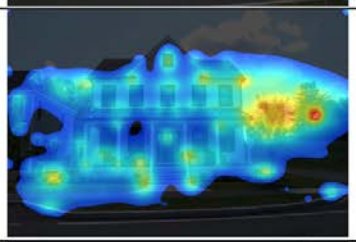
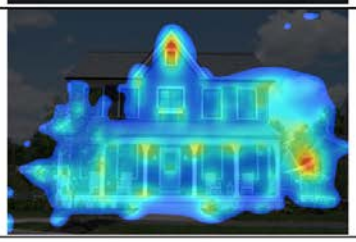
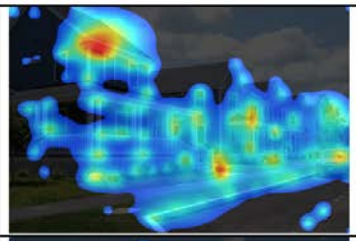
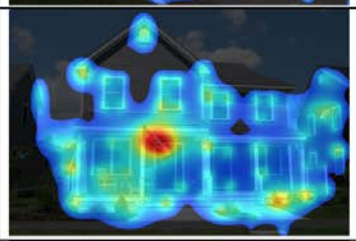
DSC_0010(2) 25 and 27 Chance St			
DSC_0011(2) 29 Chance St			
DSC_0012(2) 28 Chance St			

DSC_0006(2)			
DSC_0002(2)			
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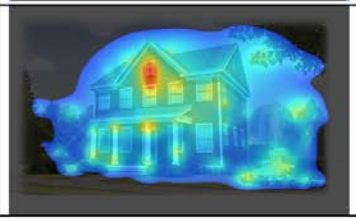
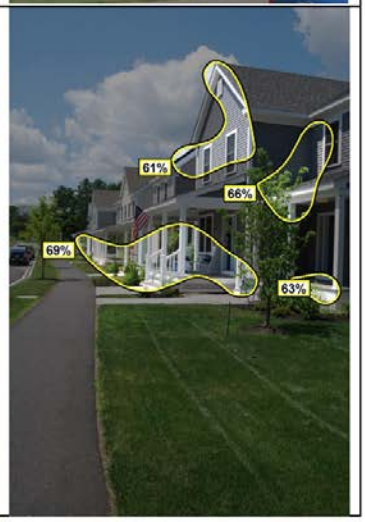
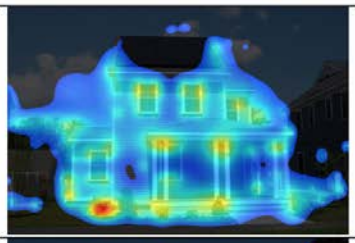
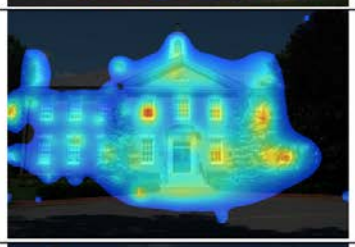
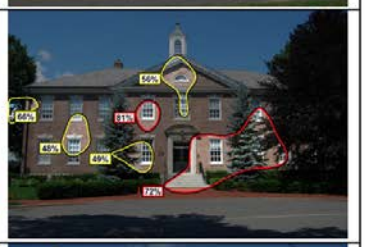
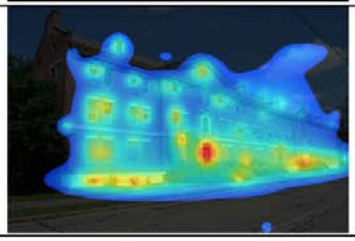
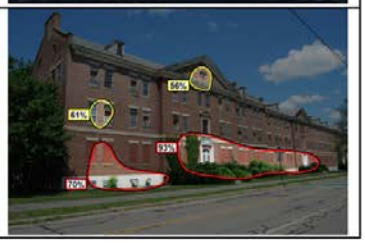
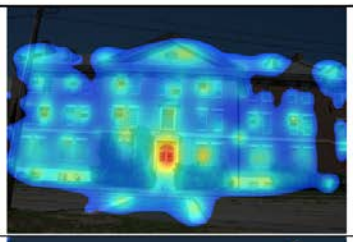
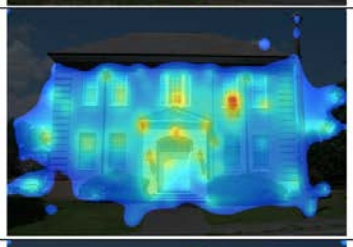
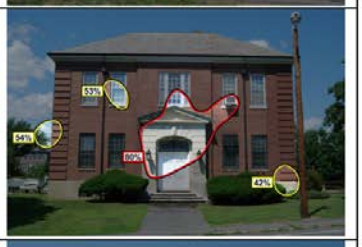
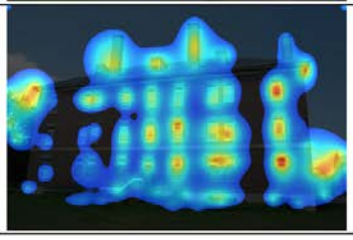
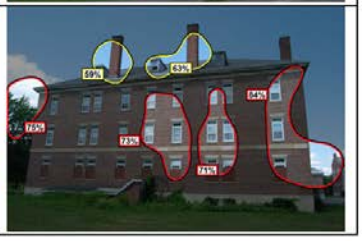
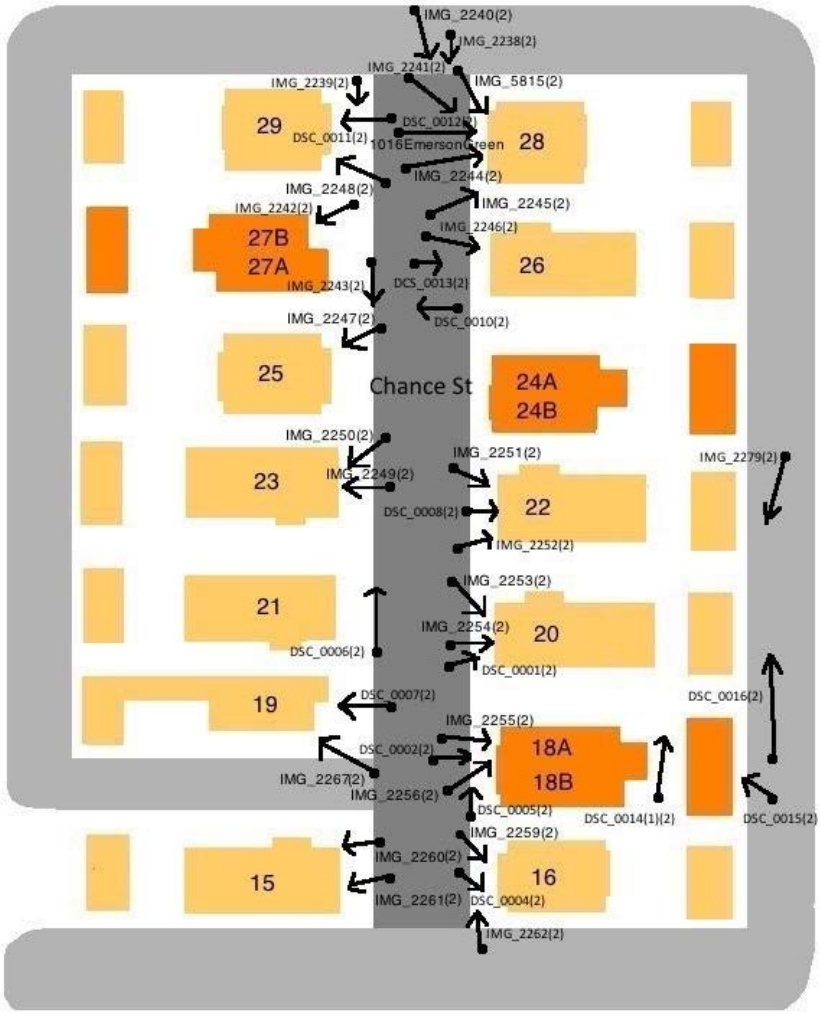
17_0509-DEV-Persp-Garden(2)			

DSC_0004(2) 16 Chance St			
DSC_0005(2) View from 18 Chance St			

DSC_0001(2) 20 Chance St			
DSC_0027(2)			
DSC_0029(2)			

DSC_0030(2)			
DSC_0025(2)			
DSC_0035(2)			

Appendix C: Map of Chance St. and Photo Locations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29
DSC_0012(2)
DSC_0011(2)
1016EmersonGreen
28
IMG_2244(2)
IMG_2248(2)
IMG_2242(2)
IMG_2245(2)
27B
27A
IMG_2246(2)
26
IMG_2243(2)
DCS_0013(2)
IMG_2247(2)
DSC_0010(2)
25
Chance St
24A
24B
IMG_2250(2)
IMG_2251(2)
IMG_2279(2)
23
IMG_2249(2)
DSC_0008(2)
22
IMG_2252(2)
IMG_2253(2)
21
IMG_2254(2)
20
DSC_0006(2)
DSC_0001(2)
DSC_0016(2)
19
DSC_0007(2)
IMG_2255(2)
DSC_0002(2)
18A
18B
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DSC_0015(2)
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IMG_2260(2)
15
16
IMG_2261(2)
DSC_0004(2)
IMG_2262(2)