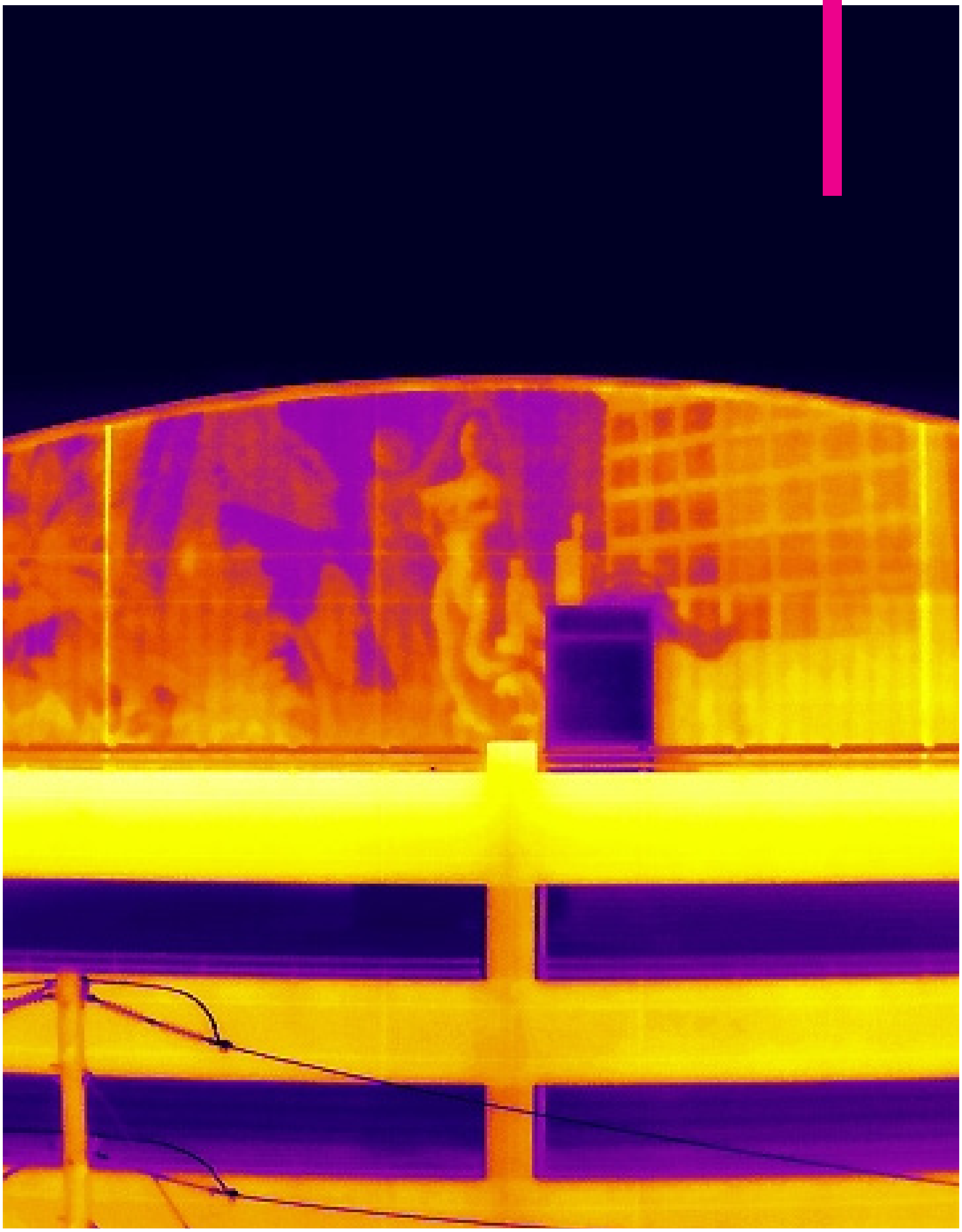
SIRENA PEARL

BLENDING ART AND SCIENCE TO VISUALIZE DATA



HEAT ISLAND

Sirena Pearl Portrait (Source: Baran Sevim)

ABOUT ME

My name is Sirena Pearl, and I am an undergraduate student at Virginia Commonwealth University (VCU) pursuing a degree in Painting and Printmaking. As both an artist and researcher, I am driven by a desire to bridge the gap between science, data, and advocacy. This project focused on making complex environmental and social issues more approachable through visual storytelling. Growing up in urban environments, I became curious with the ways our cities are shaped by forces like climate change and historical inequities. This led me to explore the urban heat island effect in my environmental classes—how materials, design, and policies create stark temperature differences that disproportionately impact vulnerable communities.

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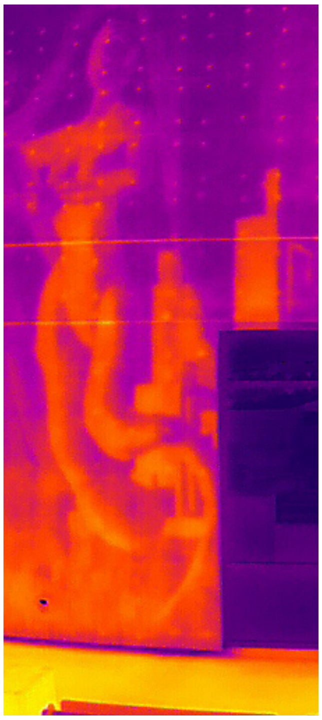

Figure 02 and 04 (Source: Baran Sevim)

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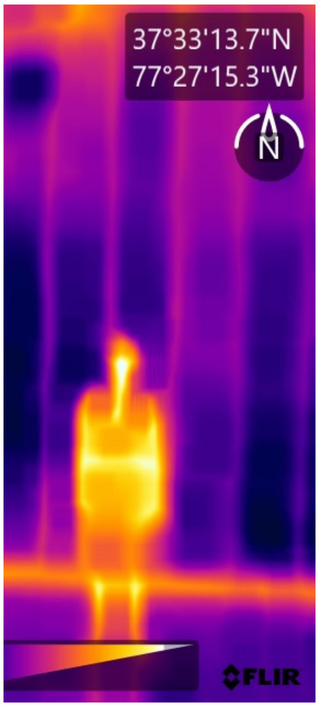
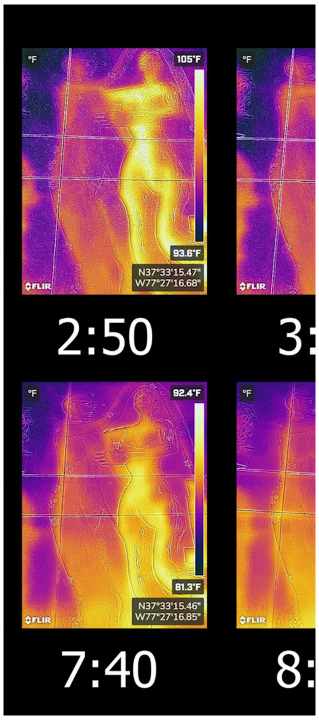
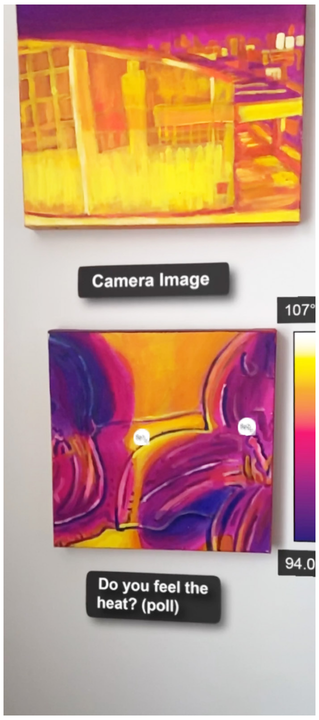






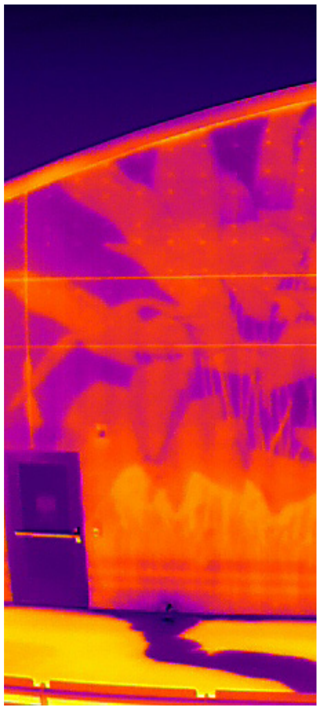
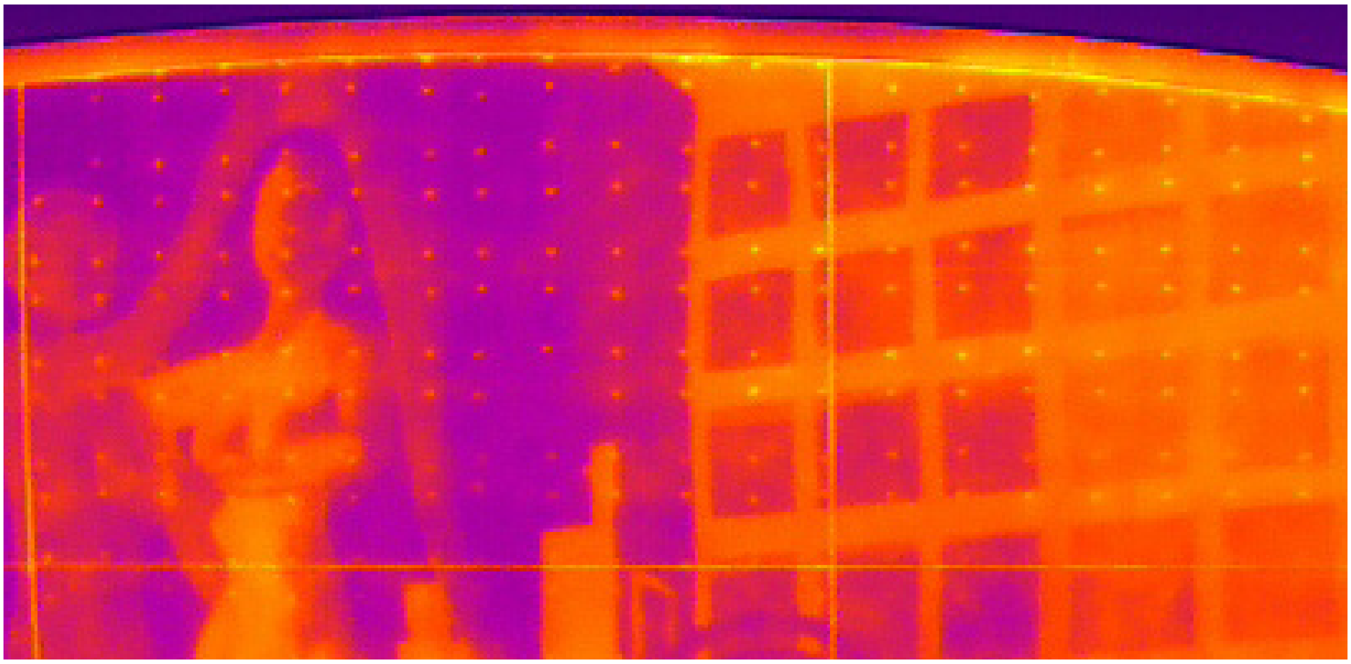


Figure 05 (Source: McNair Evans / VCUarts)

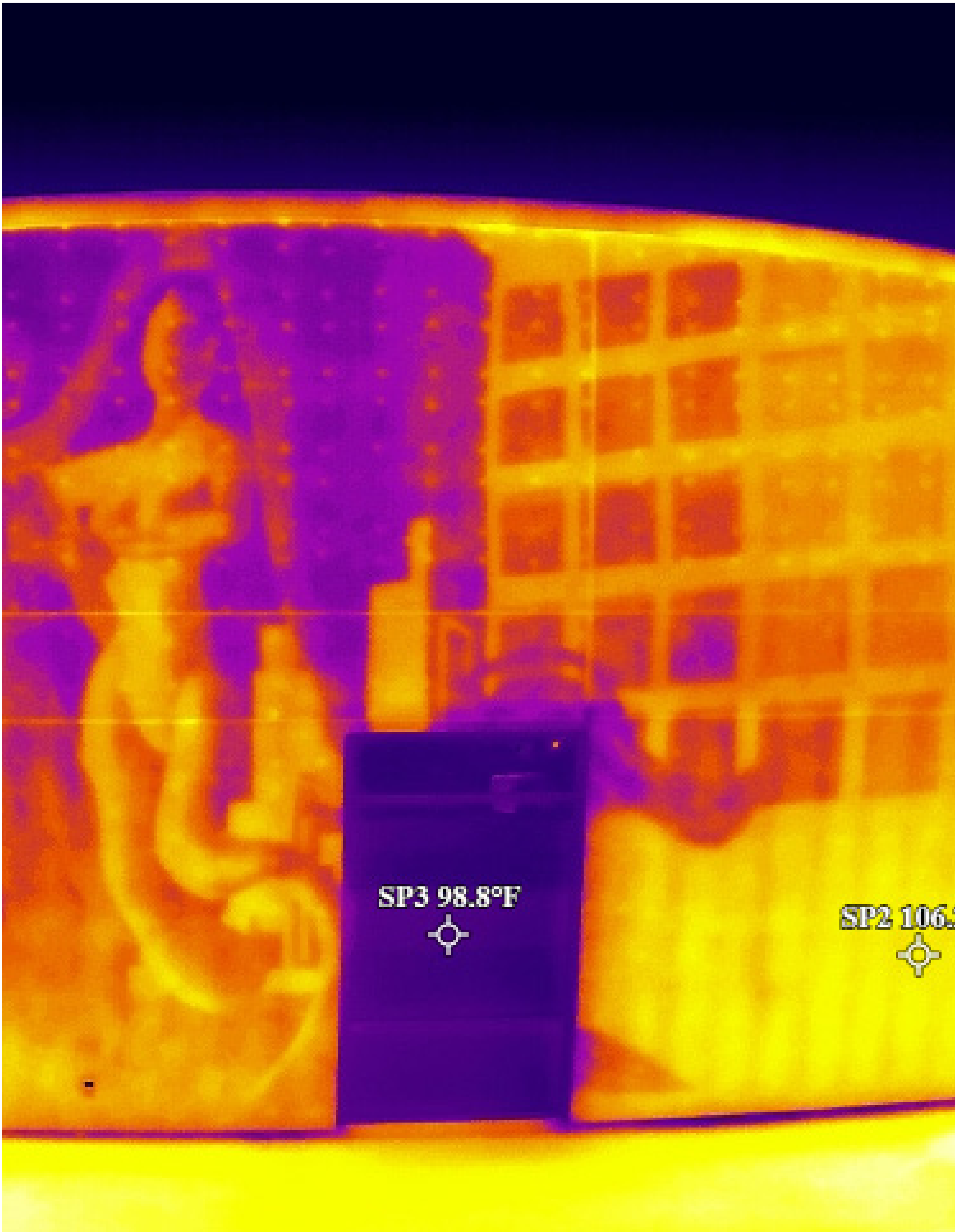
Figure 10 (Source: Melisa Tien)



WHAT IS THE URBAN HEAT ISLAND EFFECT?

The urban heat island effect occurs when cities become significantly warmer than their surrounding rural areas. The temperature difference arises primarily from the materials that make up the urban landscape—concrete, asphalt, and other heat-absorbent surfaces—that replace cooling vegetation and soil. With fewer trees and green spaces, cities trap and retain more heat, particularly during the hottest parts of the day. This leads to increased energy consumption for air conditioning, poorer air quality, and a heightened risk of heat-related illnesses during extreme heat waves. As anthropogenic climate change accelerates, this risk grows more urgent. In early July 2023, the Earth experienced some of the hottest days in modern history, underscoring the severity and immediacy of rising global temperatures. Urban heat islands worsen these conditions, placing enormous strain on city residents. Communities that were historically redlined—denied equitable access to investment and infrastructure—are often the most vulnerable. These neighborhoods typically have less vegetation, fewer parks, and more paved surfaces, resulting in intense heat buildup that puts residents at greater risk of heat-related health issues and economic burdens, such as higher energy bills and medical costs.

However, cities have mitigation options. Incorporating more trees, green roofs, reflective pavements, and energy-efficient materials can help mitigate the urban heat island effect. Understanding these strategies is critical to protecting public health and ensuring environmental justice.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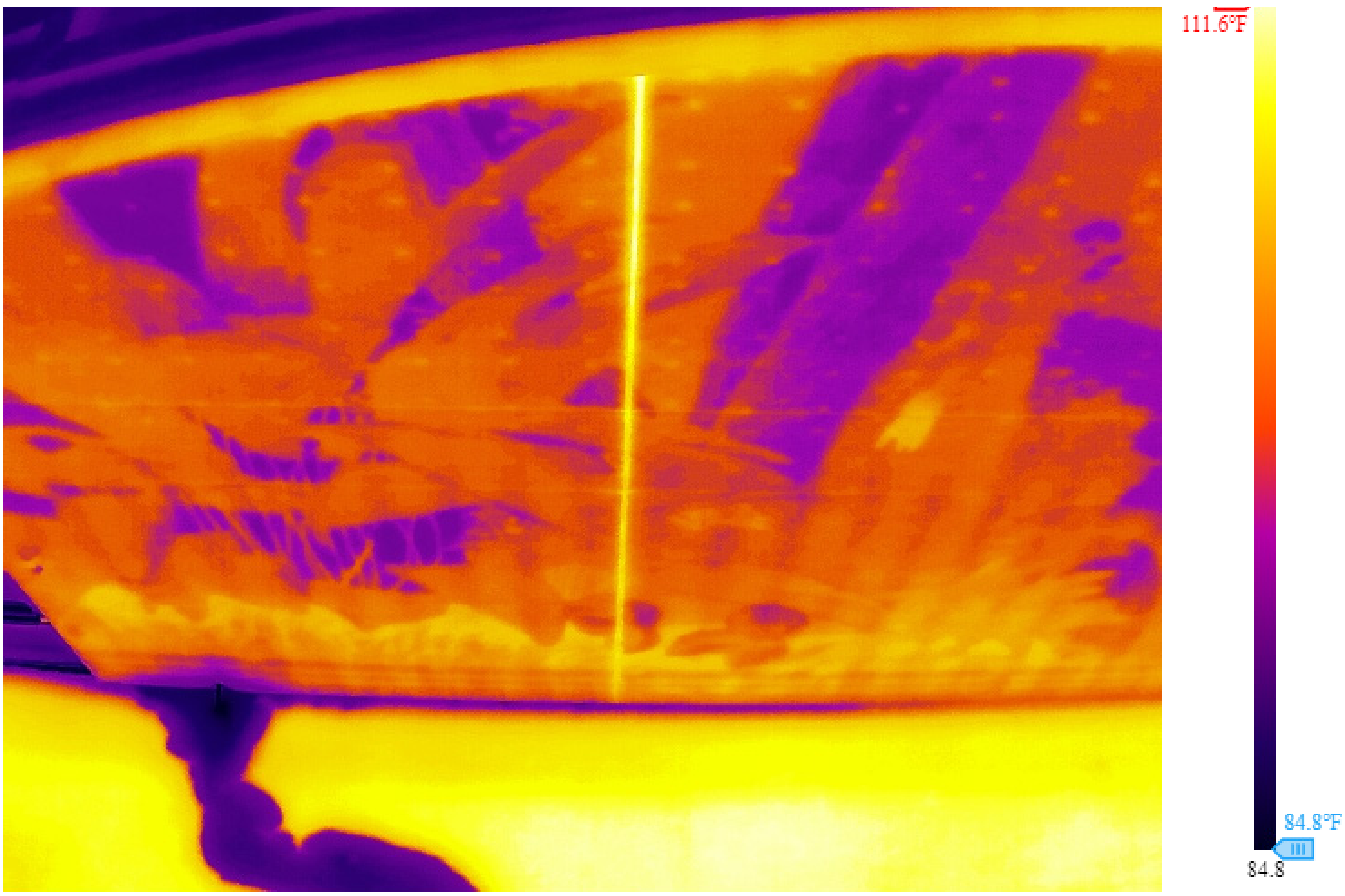
Scaffolding (Source: Baran Sevim)

RESEARCH INSPIRATION AND RICHMOND CONTEXT

Before undertaking this project, I was inspired by previous research that explored the intersection of public art, climate science, and urban heat retention. These studies demonstrated how murals, often created for cultural or aesthetic purposes, could also engage the public in conversations about environmental challenges like the urban heat island effect.

One such project, “Street Art Meets Climate Science in the Big, Blue Face of Zeus” (Braswell), led by UCLA researcher V. Kelly Turner, featured a mural created by the Artist Eric Skotnes in South Los Angeles painted with solar reflective coatings to actively reduce surface temperatures. Turner and her team used thermal infrared cameras to document the mural’s heat signature, revealing the cooling effects of reflective paints. This collaboration between artists, scientists, and urban planners underscored the power of art as both a visual platform and a functional intervention—an idea that deeply influenced my approach. I was inspired to explore how I could combine thermal imaging with artistic design and innovative materials to communicate climate risks.

In Richmond, “See the Heat” (Kwon and Maurakis), a study by University of Richmond researcher Sarah Kwon and Professor Eugene Maurakis, further examined how mural colors affect heat absorption. Using infrared cameras, they analyzed 64 murals, identifying how factors like color palette, sunlight exposure, and wall orientation influenced surface temperatures. Their findings revealed that darker colors absorbed



significantly more heat than lighter tones, especially on walls facing South, Southeast, or Southwest. Their recommendation to use high-reflectivity, lighter color palettes for sunlit areas directly informed my approach to tonal gradations and mark-making techniques in this project.

Both studies revealed a critical insight: even when muralists did not intentionally consider thermal properties, clear temperature contrasts emerged based on color and placement. This observation sparked the central question for my work: What would thermal infrared images look like if an artist purposefully designed a mural with heat retention and cooling strategies in mind?

Richmond provided the ideal context for this exploration. The city is no stranger to the urban heat island effect, where historically redlined neighborhoods, such as Gilpin Court, face disproportionately higher temperatures due to limited green spaces and extensive paved surfaces. These areas become heat traps, intensifying public health risks and economic burdens, particularly during extreme heat events. As climate change accelerates, these challenges grow more severe.

Recognizing Richmond's vibrant mural culture, I saw an opportunity to bridge art and science in a meaningful way. Could a public mural not only highlight this environmental risk but also demonstrate solutions for mitigating heat retention?

The "Urban Heat Island Effect Mural" is my response to this challenge. Located on the Virginia Commonwealth University (VCU) Art Foundation Program Building, the mural uses thermal infrared photography to measure and visualize the impact of different materials, paint colors, and techniques on heat absorption. By intentionally incorporating solar reflective coatings, tonal variations, and mark-making strategies, I created a data-driven mural that transforms complex climate science into an accessible, visual format.

Through this project, I aimed to communicate how urban infrastructure, building materials, and vegetation—or lack thereof—shape the urban heat island effect, disproportionately impacting marginalized communities. By engaging the public with vibrant imagery and tangible temperature contrasts, the mural encourages viewers to reflect on the role of sustainable urban design in creating cooler, healthier cities.

In sum, this project builds on the foundation laid by earlier research while expanding its scope to merge art, science, and environmental justice. It positions public art as a powerful tool for education, community engagement, and climate resilience.

Mural and Richmond (Source: Baran Sevim)

THE DESIGN

The "Urban Heat Island Effect Mural" merges art and environmental risk communication into a single, visual narrative. At its core, the mural presents two contrasting urban environments: one shaped by heat-retaining infrastructure, the other embracing sustainable planning that mitigates excessive warming during the summer. By personifying these concepts, I aimed to foster empathy and accessibility—viewers can imagine cities "sweating" under oppressive heat or "breathing" easily with more vegetation, rather than just pondering abstract data.

The red figure, symbolizing an urban heat island, appears tense and overwhelmed in a setting dominated by concrete, asphalt, and a lack of vegetation. Its red hue references historically redlined neighborhoods.

Opposite to this figure, the blue figure embodies a sustainable city, surrounded by greenery, garden roofs, and reflective materials. This figure's calm demeanor and cooler palette suggest that sustainable urban design can alleviate heat retention. Their interlocking limbs form a pulsing connection, symbolizing how humans, infrastructure, and nature continuously shape each other's fate. Urban environments and their climatic impacts are not static; they evolve with time, growth, and change.

To capture the viewer's attention, I employed bold colors, fluid forms, and dramatic contrasts. Located in Richmond—a city renowned for its mural culture—the artwork can be glimpsed from various vantage points: commuters riding the bus along Broad Street or shoppers at the Lombardy Street Kroger or Lowe's parking lot. By reaching people in everyday settings, the mural acts as an environmental risk communication platform, prompting communities to consider how they might adapt and thrive despite rising temperatures.

Beyond concept, the mural's spatial design and painting process were key. Positioned on the Bowe Street Parking Deck at the VCUarts Art Foundation Building, the artwork measures approximately 25 by 91 feet, covering around 2,279 square feet. Its horizontal format suits the architecture, ensuring both figures remain clear and distinguishable even from a distance. To plan the composition, I used 3D modeling software (Blender) to simulate different viewpoints, lighting conditions, and color gradients. This virtual pre-planning helped me determine the ideal arrangement, ensuring the "cool" sustainable city figure and the "hot" urban heat island figure would stand out in the thermal imagery. On-site, I painted a white base coat, then used a laser level before sunrise to grid the surface accurately. This allowed me to transfer the digital mockup onto the wall with precision.

Once the grid was established, I began color blocking with exterior mural paints. On the sustainable city side, I started with lighter tones to reinforce the idea of cooler, more reflective design. On the heat island side, I used darker paints to create a tonal gradient reflecting the thermal contrasts at play. I blended from a light pink near the sustainable city into a dark fuchsia toward the heat island figure, visually representing how lighter values can reflect heat while darker hues absorb it.

After establishing the basic color fields, I added details using spray paints: the figures, foliage, reflections in windows, and native Virginia flora and fauna. When the imagery was complete, I applied two layers of a clear, solar reflective cool coat over the sustainable city figure and its surroundings, documenting the before-and-after temperatures to quantify the paint's cooling effect. I intentionally left the urban heat island figure uncoated to highlight the measurable temperature difference between the solar reflective paint and standard exterior mural paint.

In conclusion, every aesthetic and technical decision—color choice, composition, painting techniques—aligns with the thermal concept.

Scaffolding Top Left (Source: Baran Sevim)
Scaffolding Top Right (Source: Melisa Tien)

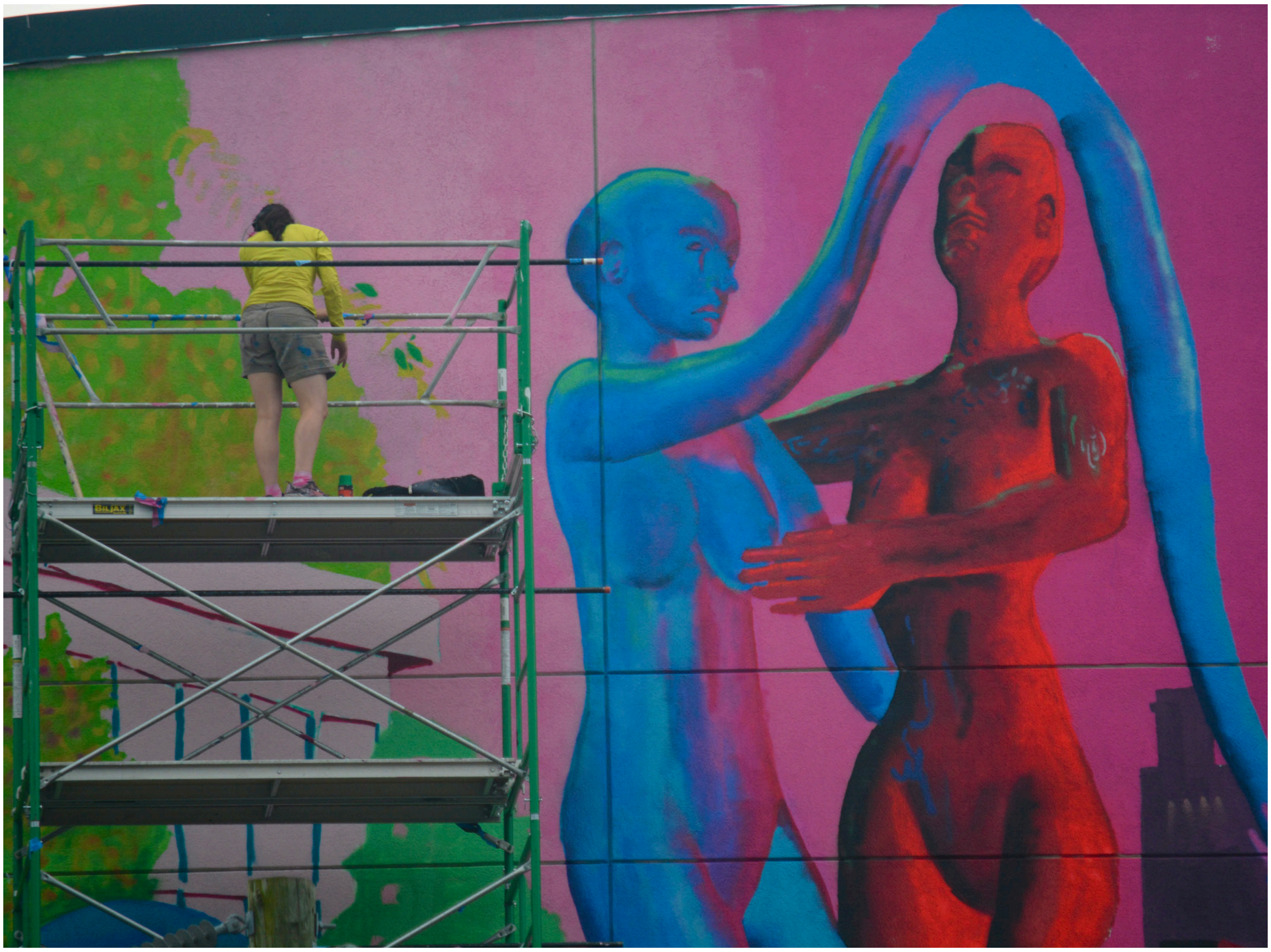
PROCESS

FROM JUNE 9th to AUGUST 8th 2023

Embarking on my first large-scale exterior wall mural required extensive research and preparation. I was fortunate to receive invaluable guidance from Ian Hess, a seasoned muralist and the owner of the art supply store "Supply", who shared essential tips and techniques for tackling such a massive project. His advice covered everything from necessary supplies to spray painting methods, which proved fundamental to my approach.

Gathering materials was an adventure in itself; visits to "Supply" allowed me to connect with other street artists and muralists, who generously offered their insights and advice on public art projects. This community support was vital in shaping my execution strategy.

Funding for this mural came partially from the Creative Undergraduate Research Fellowship at VCU, but due to the high costs associated with large murals—especially those requiring scaffolding and extensive materials—I also relied on contributions



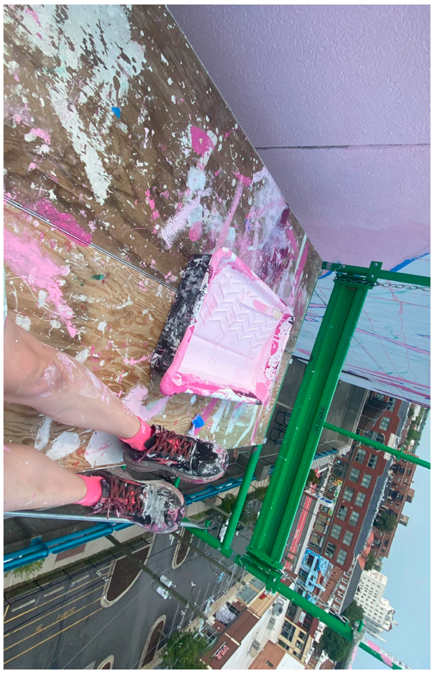
In Progress Painting (Source: John Birch)

from generous donors through GoFundMe. A complete list of these supporters can be found on my acknowledgments page.

The physical setup of the mural was a collaborative effort. My stepdad, Erik, and my faculty mentor, Roberto Jamora, played crucial roles in assembling and dismantling the scaffolding—a task that required multiple hands and considerable effort. The wall's priming, another labor-intensive part of the process, luckily I had help with my mother, stepdad, and partner Baran Sevim all pitching in.

The technical aspect of transferring the design onto the wall involved gridding the surface with a laser level and using a printout of my mural design alongside my phone to sketch the outlines. I applied a washy coat of acrylic paint for the outlines and the grid. Interestingly, some thermal infrared images captured during the project revealed the underpainting and grid lines, invisible to the naked eye but detectable by the camera due to their tonal properties.

One challenge I had to adapt to was the vertical nature of the wall. Typically, I paint at a slight angle, so adjusting to a perfectly upright surface required a shift in posture and technique, adding another layer of complexity to this large scale project.

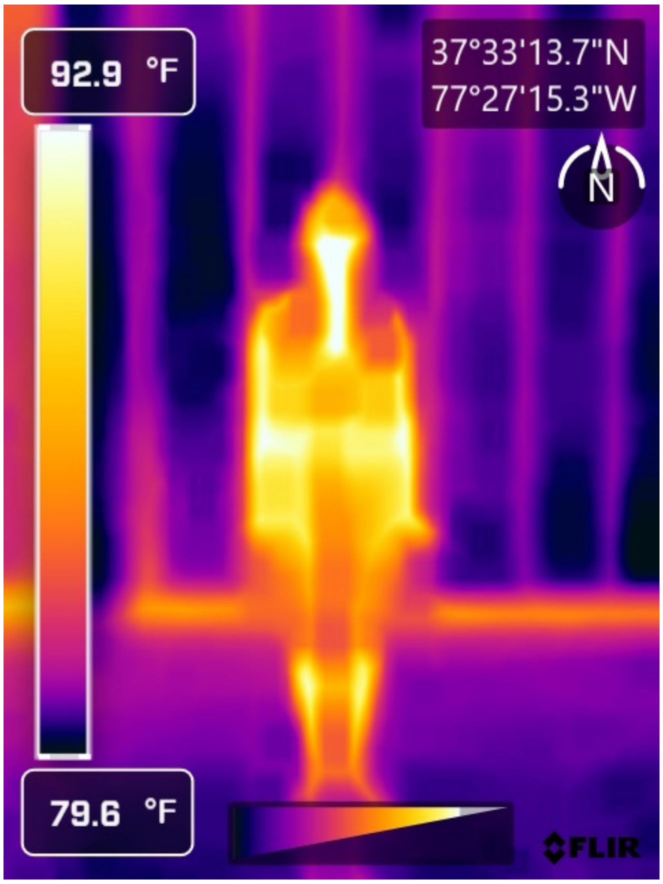


Upper Middle Image (Source: John Birch)
Bottom Image (Source: Baran Sevim)

RESEARCH METHODOLOGY

The "Urban Heat Island Effect Mural" served as both a creative project and a scientific study, aimed at understanding how painting materials and techniques influence heat absorption and retention in urban settings. My approach involved combining thermal imaging with artistic experimentation, allowing the mural to function as a data-driven artwork. By capturing and analyzing temperature variations across the painted surface, I transformed the wall into a living laboratory for environmental research.

Central to this investigation was the use of thermal infrared photography. In 2023, I began my studies with a FLIR thermal infrared camera—generously lent by Dr. Stephen S. Fong from the Department of Chemical and Life Science Engineering at VCU—that could be attached to a mobile phone. Initially, I captured images from the rooftop deck, focusing on small sections of the mural due to space constraints. Although I could not see the entire mural at once, these early observations offered valuable insights into how different paint choices and techniques affect surface temperature.



Thermal Image Portait (Source: McNair Evans / VCUarts)

Recognizing the need for a more holistic view, I pursued an additional undergraduate research grant in 2024. With these funds, I hired a thermal infrared drone pilot to capture overhead images of the entire mural. This aerial perspective allowed me to examine the mural's full 2,279 square feet, providing a comprehensive dataset for understanding temperature distribution.

My research focused on three key areas, each chosen to reflect a different aspect of how art and design influence thermal behavior:

Tonal Gradations:
Color plays a crucial role in heat absorption. Darker shades retain more heat retention, while lighter tones reflect a greater portion of incoming sunlight. To test this, I painted sections of the mural in varying shades—from pastel hues to deep, saturated colors—ensuring that I could compare their thermal properties under similar conditions.

Solar Reflective vs. Regular Paints:
Paint reflectivity can also alter surface temperatures. Solar reflective paints, containing microscopic reflective particles, bounce some solar energy away from the surface, potentially lowering overall heat retention. To assess their effectiveness, I applied a clear, solar reflective "cool coat" to portions of the mural representing the sustainable city. Other areas were left with

regular exterior mural paint for comparison.

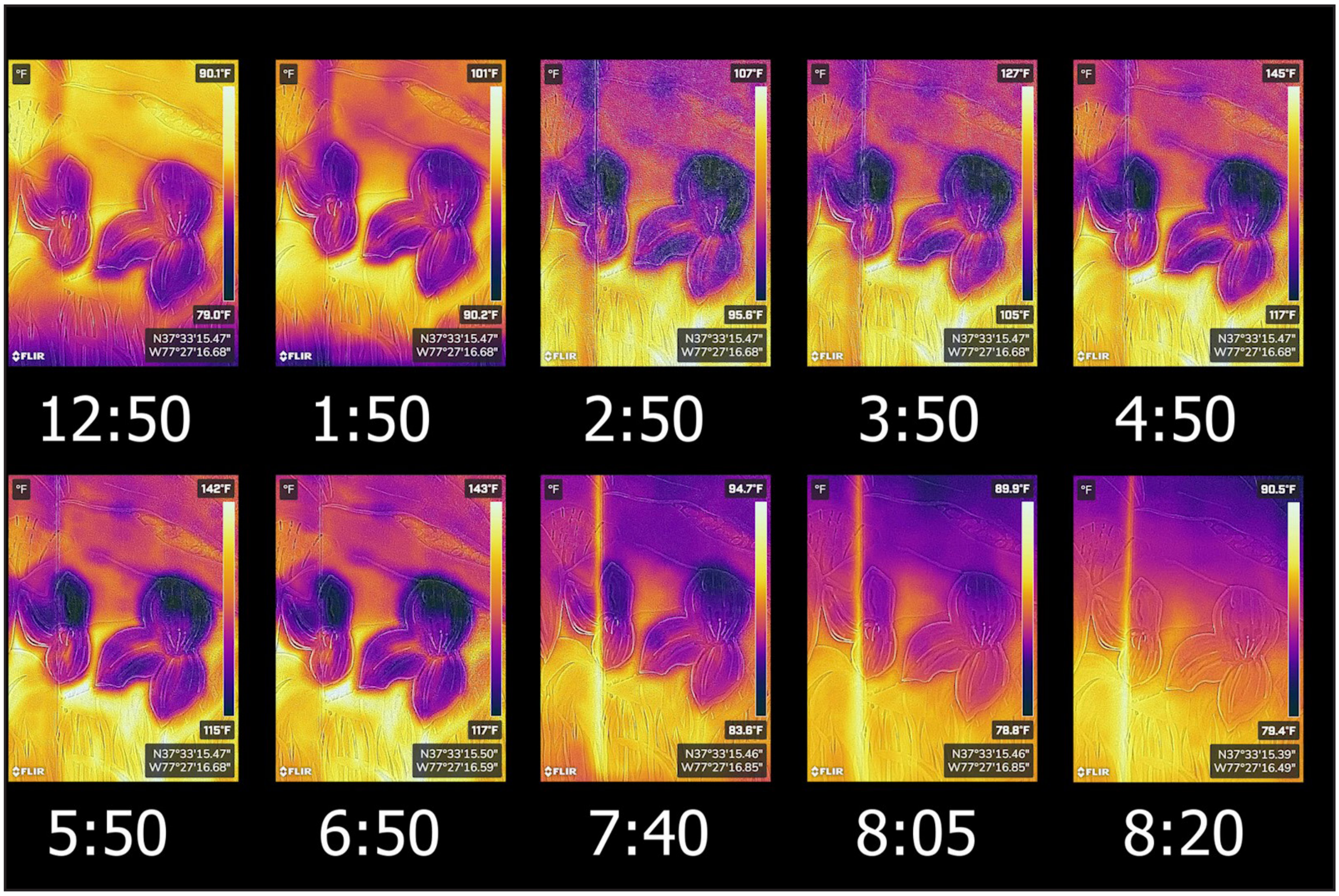
Mark-Making Techniques:
Beyond color and paint type, the way paint is applied may influence heat retention. I experimented with gradients, stippling, clean-cut color blocking, and layered techniques to see if certain patterns dispersed or absorbed heat differently. By varying brush strokes and spray patterns, I aimed to understand whether artistic style could impact measurable thermal differences.

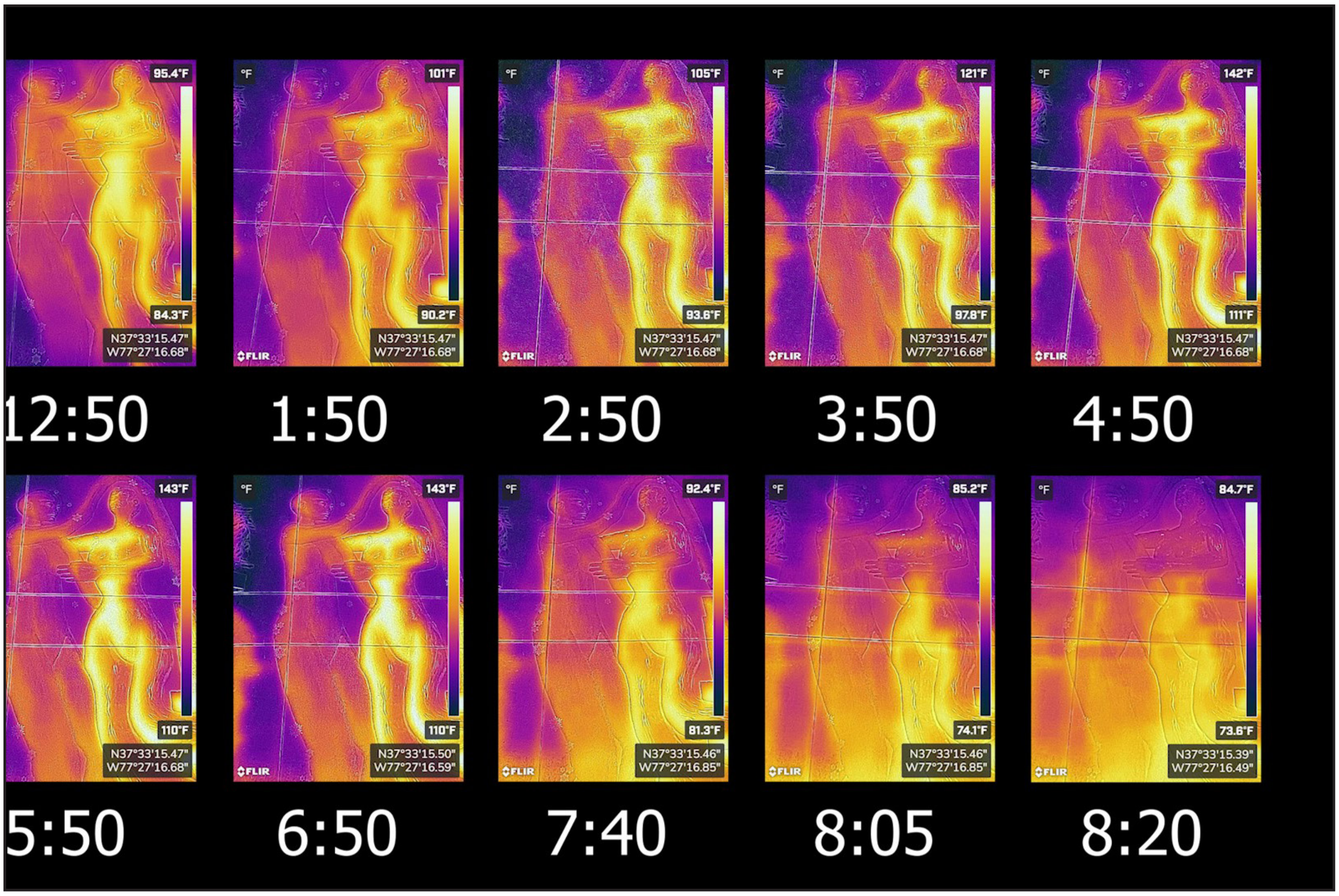
To capture how the mural's surface temperature changed throughout the day, I recorded thermal images at hourly intervals from 12:50 PM until sunset (around 8:20 PM) during the summer of 2024. This allowed me to observe how heat built up under direct sunlight and how it dissipated in the evening. To gain a longer-term perspective, I also photographed the same spots at approximately 5:00 PM each day from July 12th to August 12th, tracking daily variations in response to ambient temperature, humidity, precipitation, and sky conditions.

The addition of the thermal infrared drone images provided a more uniform dataset. With a bird's-eye view, I could analyze the entire mural surface simultaneously, rather than piecing together information from smaller sections. This comprehensive data was crucial for understanding how different areas interacted and how the entire painting responded to sunlight over time.

Once I gathered sufficient data, I compared thermal images from different sections of

ALL TIMES TAKEN DURING PM





RESULTS AND FINDINGS

the mural and different times of day. The results confirmed the hypothesized relationships between color, paint reflectivity, and application techniques:

Tonal Value: Darker shades absorbed significantly more heat than lighter ones, illustrating the importance of color in managing surface temperatures.

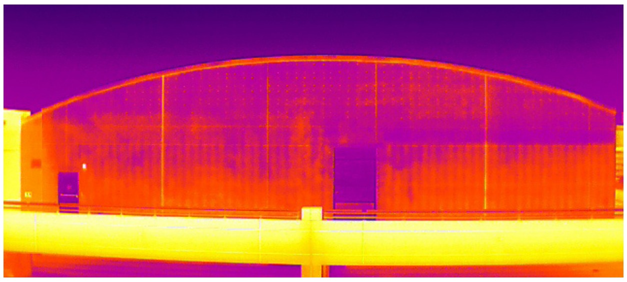
Solar Reflective vs. Regular Paints: The solar reflective coating reduced surface temperatures but was less visually apparent compared to the tonal variations in the paint. This finding highlights the potential of reflective materials to mitigate urban heat, particularly on rooftops, walls, and pavements.

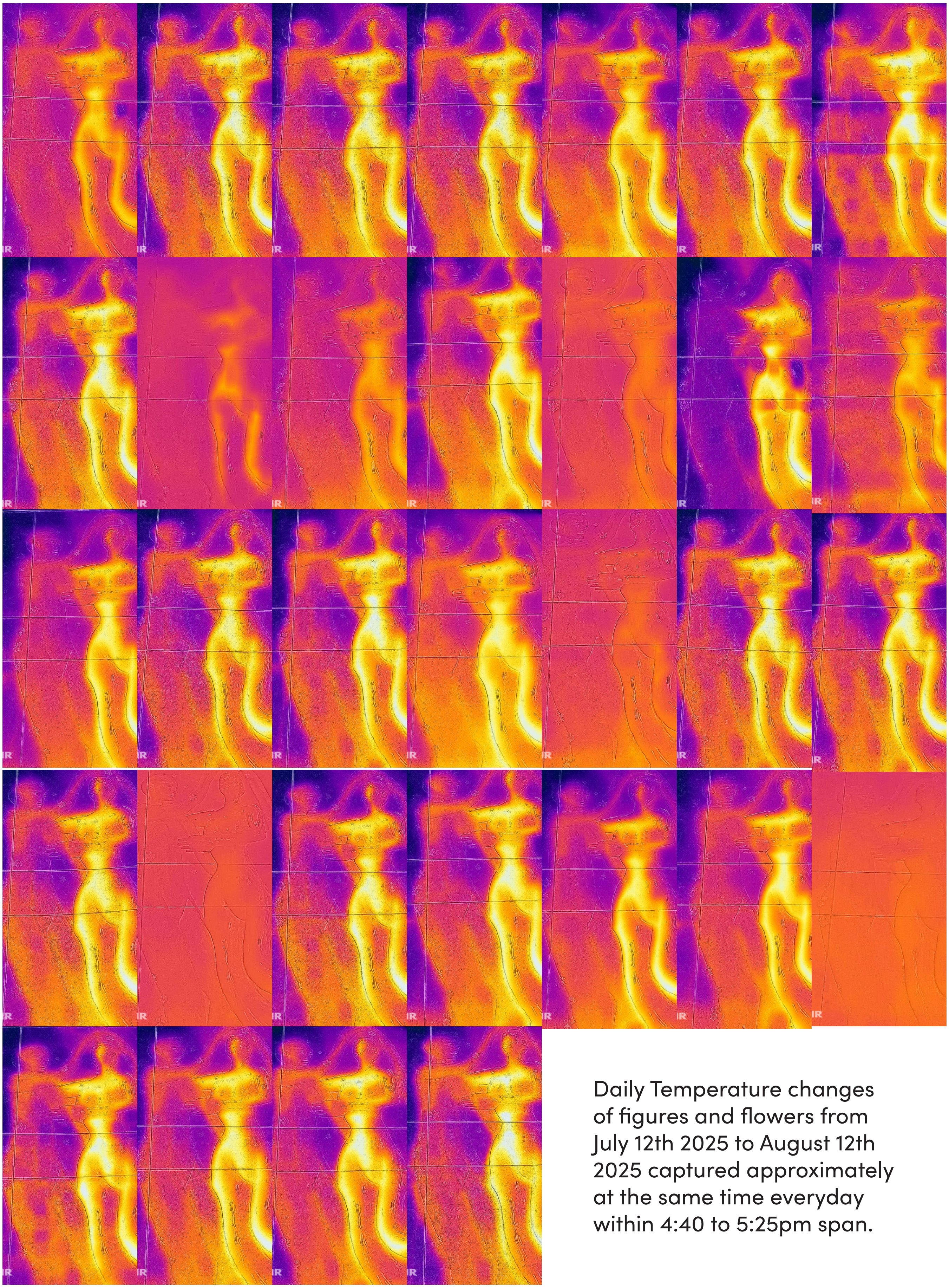
Mark-Making Techniques: Varying painting methods produced distinct thermal signatures. Techniques like layering and blending influenced how evenly the surface absorbed and released heat, demonstrating that even artistic decisions can shape thermal outcomes.

Additionally, the data revealed that the mural's heat retention and clarity peaked between approximately 2:50 PM and 6:50 PM, when sunlight exposure was strongest and most direct. Observing hourly and daily temperature changes highlighted the dynamic nature of heat absorption.

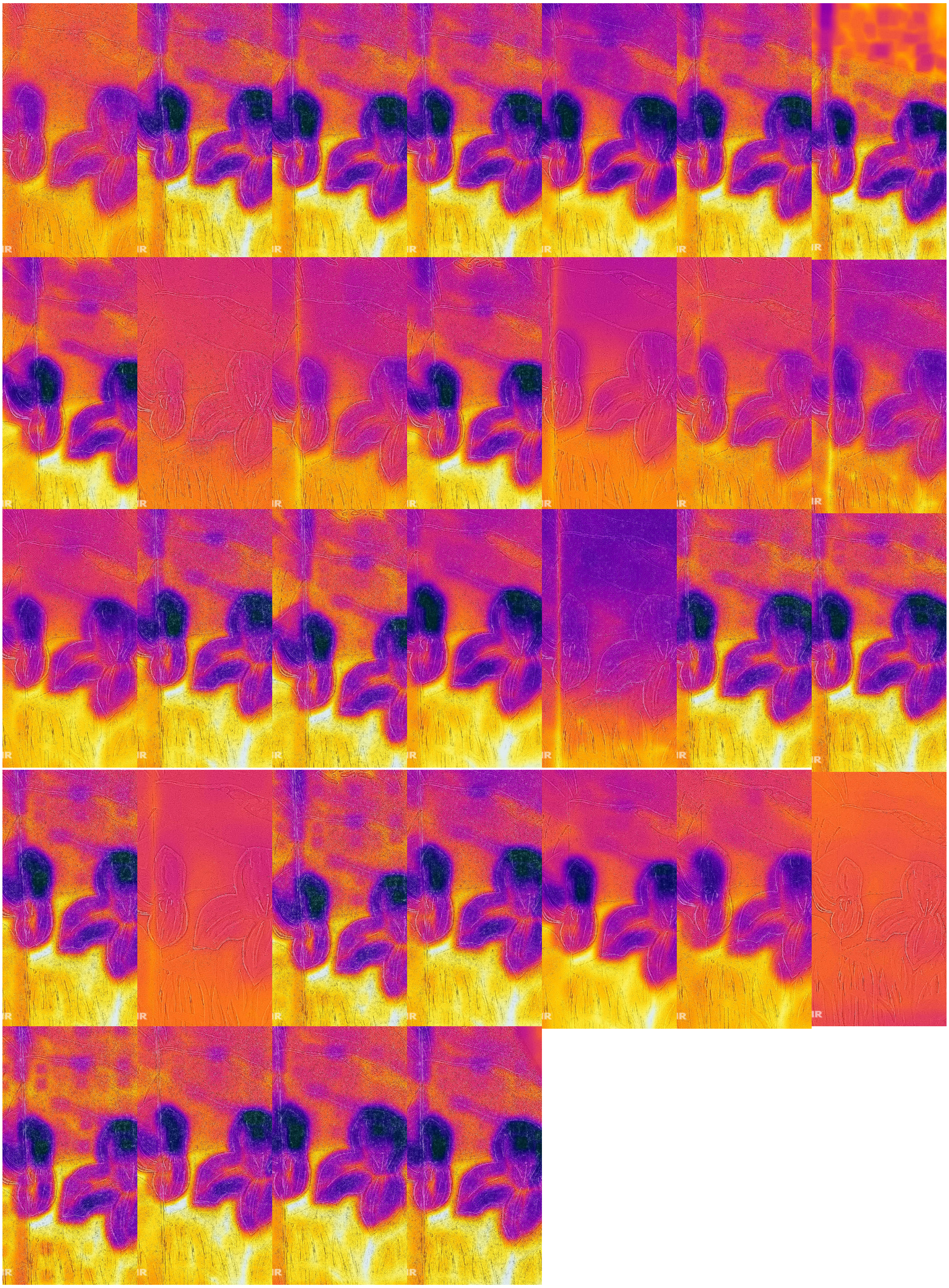
However, it is important to consider the impact of the mural's surface material. The wall, made of porous fake stucco, exhibited different thermal retention characteristics compared to denser materials like asphalt or concrete. These more heat-absorbent surfaces retain warmth significantly longer into the night, contributing more intensely to the urban heat island effect. This distinction underscores the variability of heat retention across materials and the importance of surface composition in understanding and mitigating urban heat dynamics.

By applying scientific methods to a public artwork, we can bridge the gap between art, environmental science, and urban planning. This research demonstrates that subtle choices—color selection, paint albedo, and even painting techniques—can influence how surfaces interact with sunlight and, by extension, how cities manage rising temperatures. Future collaborations and studies could build on these findings, testing innovative materials, incorporating vegetation, or exploring other interventions designed to reduce urban heat.





Daily Temperature changes of figures and flowers from July 12th 2025 to August 12th 2025 captured approximately at the same time everyday within 4:40 to 5:25pm span.



Technology Integration

To enhance the educational impact of the mural, I incorporated augmented reality (AR) using Adobe AERO. Viewers can scan QR codes, next to thermal infrared painting, to access a digital overlay that provides real-time temperature data, thermal imagery, and explanatory text. This interactive element transforms the mural from a static artwork into a dynamic learning experience, allowing the public to see how small changes in paint materials or tonal values influence surface heat in real time.

To amplify the educational potential of the "Urban Heat Island Effect Mural," I integrated augmented reality (AR) technology using Adobe AERO. In my exhbition "Heat Island" at the Anderson, Positioned alongside the large scale print out of the mural, strategically placed QR codes next to physical paintings of the murals thermal imagery allow viewers to unlock a digital layer overlying the physical artwork. This AR overlay provides real-time temperature data and shows the thermal imagery captured from the mural, effectively peeling back the layers to reveal the underlying thermal dynamics. Viewers can also interact with the data through additional digital elements like an interactive poll. This interactive element transforms the mural from a static piece of art into a dynamic educational tool. It allows the public to see firsthand how variations in paint materials or tonal values can significantly affect surface temperatures. These AR-powered visualizations translate complex climatic data into a format that is accessible and easily understandable, breaking down scientific research into compelling visual narratives that engage users directly on their smartphones.

Adjacent to the mural on the Bowe Street Parking Deck, another QR code guides visitors to a digital companion piece. This online resource includes time-lapse animations, comparative

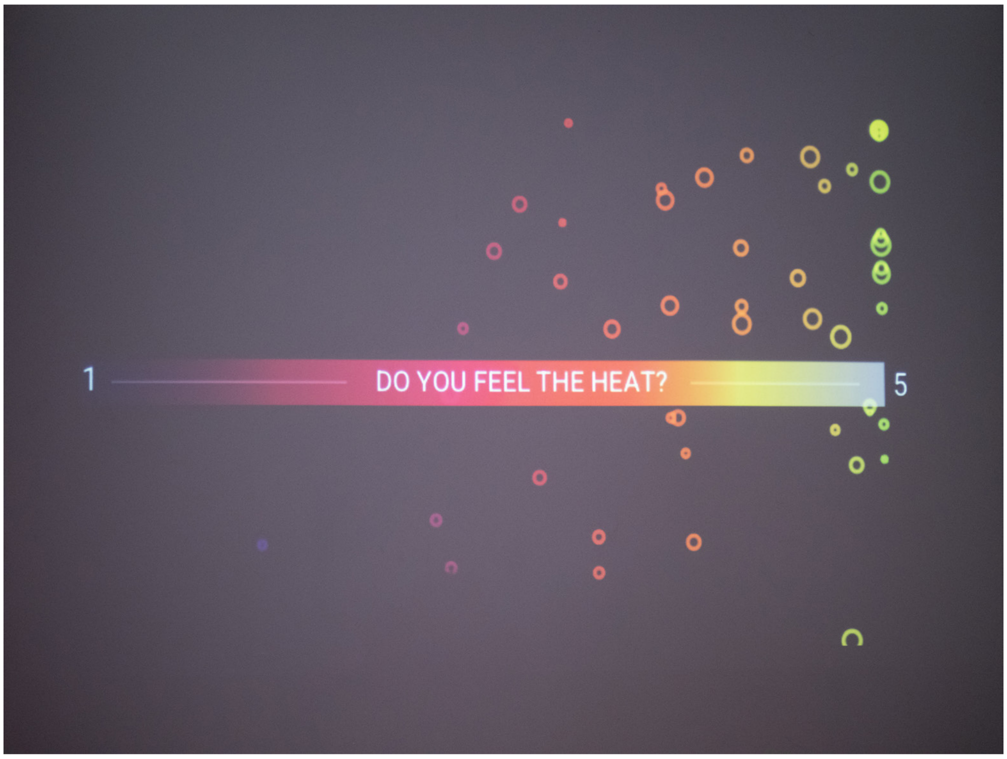
Paintings of thermal infared images of the murals imagery that are scannable with Adobe Aero software to show temperature data from the mural

Heat Island Exhibition (Source: Baran Sevim) temperature charts, and a discussion about the urban heat island effect in Richmond.

By incorporating AR and other digital tools, the mural extends its impact beyond the physical boundaries of its location. It invites people from Richmond to engage with this crucial environmental risk directly through their mobile devices. This approach not only fosters curiosity and dialogue but also inspires action, encouraging a broad audience to consider sustainable urban strategies and community-driven solutions for reducing urban heat.

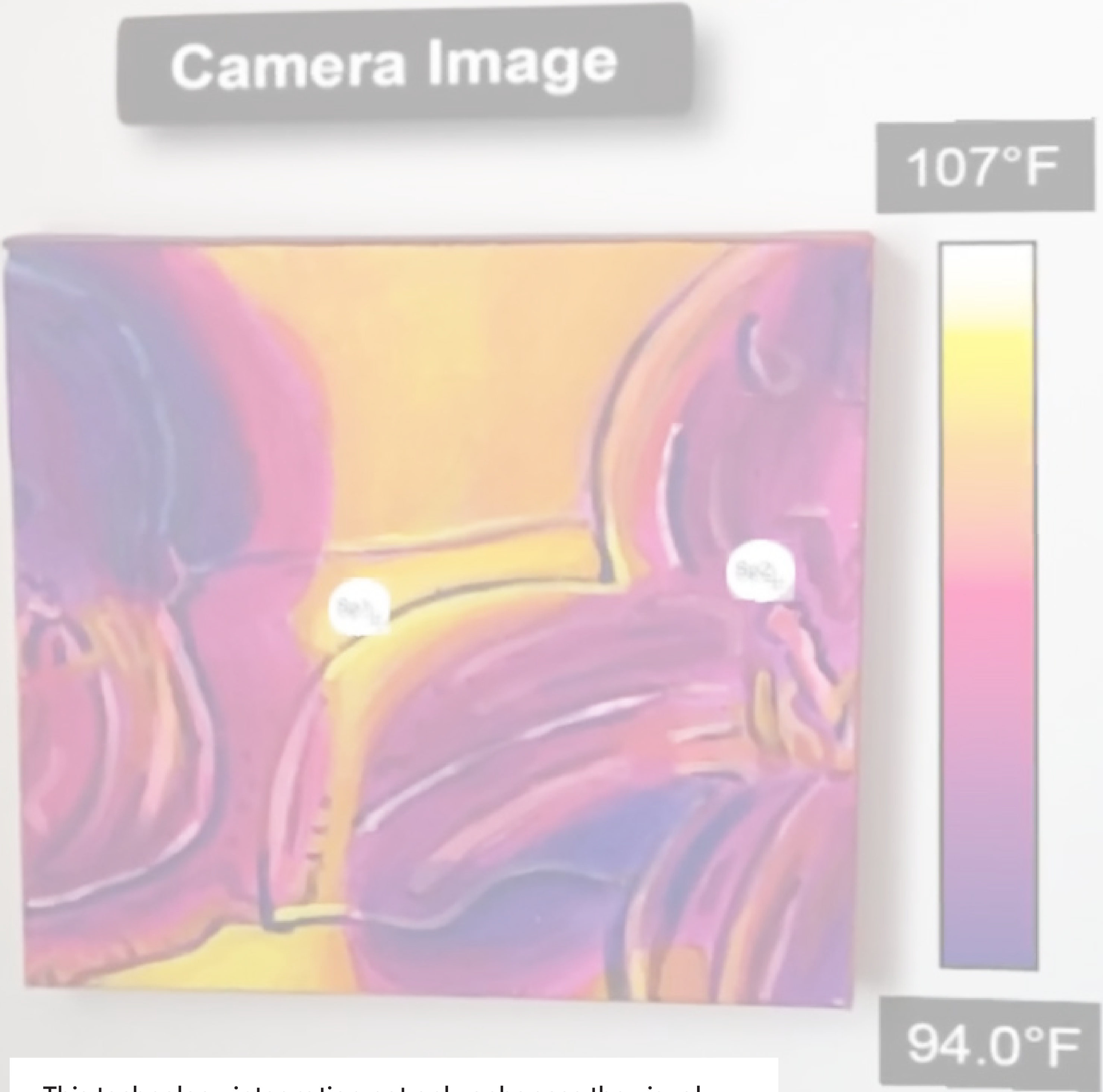
The integration of technology culminates at the Anderson exhibit "Heat Island," where I have set up a live data visualization linked to a real-time interactive poll. Exhibition attendees can input their experiences with urban heat in Richmond through this poll, and their responses are immediately plotted on a scatterplot displayed on a gallery wall. This live data visualization ranks their experiences on a scale from 1 to 5, aggregating community feedback to illustrate collective perceptions of heat intensity.

Adjacent to this interactive display, a looped projection plays continuously on the opposite wall, featuring drone footage of the mural captured in thermal infrared, daily temperature collection time-lapses from the peak summer heat, and a full timelapse of the mural's creation. These videos provide a comprehensive look at the mural's impact on surface temperatures throughout different times of the day and across the hottest months of the year.

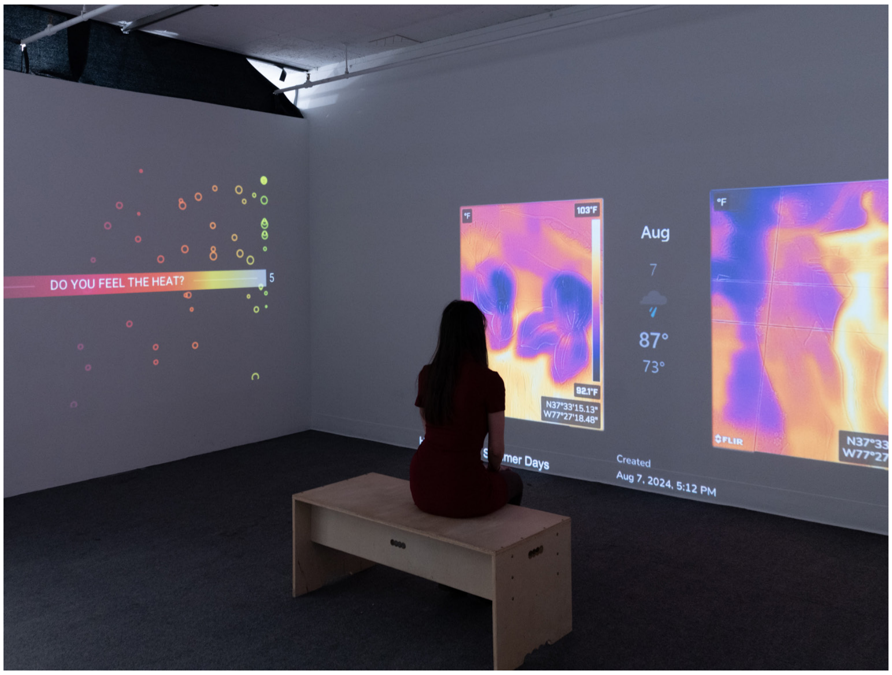


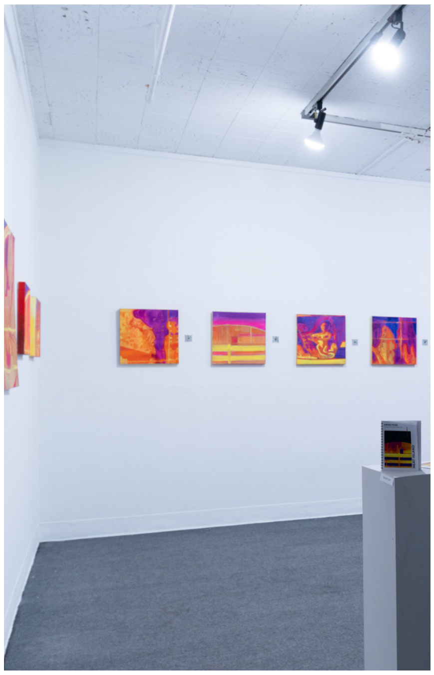
This is an image capture of the realtime data visualization. A new user submits a response to the scatter plot to show how much heat they feel.

Data visualization (Source: Baran Sevim)



This technology integration not only enhances the visual and educational impact of the mural but also exemplifies how art can serve as a powerful medium for scientific communication and community engagement. By blending creative expression with cutting-edge technology, the project invites the community to visualize and understand complex environmental issues in new and impactful ways, fostering a dialogue that can lead to real-world changes and a deeper commitment to environmental sustainability.





All Images (Source: Baran Sevim)


DO YOU FEEL THE HEAT?

All Images (Source: Baran Sevim)


Heat Island
Sirena Pearl

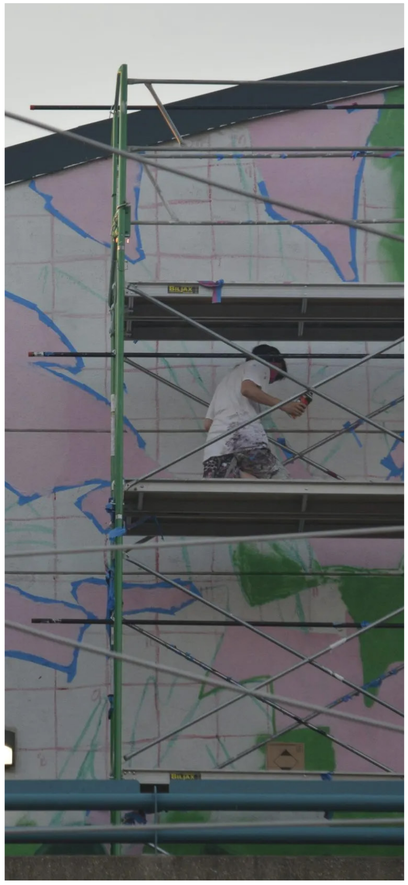
HEAT ISLAND

BROADER IMPACT

By translating dense climate science into a visual and interactive format, the mural and its AR components engage community members, policymakers, and students who may not have expertise in quantitative analysis or environmental studies. This inclusive approach fosters greater participation in conversations about urban heat and sustainability, encouraging a diverse range of stakeholders to understand and address this critical issue. Public murals offer a unique medium for environmental risk communication, capable of reaching audiences who might otherwise feel excluded from these discussions. This project exemplifies how art can bridge the gap between scientific data and public understanding.

The urban heat island effect is not just an environmental challenge; it is also a profound social justice issue. Historically redlined neighborhoods, which often lack cooling infrastructure like green spaces and trees, bear the brunt of extreme heat. The mural brings these disparities into focus, highlighting the disproportionate health risks faced by marginalized communities. By calling attention to these inequities, the project advocates for equitable urban planning and investment in underprivileged areas. Initiatives like urban gardens and partnerships with environmental justice organizations such as Groundwork RVA can play a transformative role in fostering healthier, more equitable living environments. This mural underscores the

Mural and City (Source: Baran Sevim)
Spray painting Scaffolding (Source: John Birch)



urgency of addressing these disparities while showcasing the steps that can be taken toward more equitable urban development.

The mural provides tangible examples of solutions, such as the use of solar reflective paints, strategic color choices, and eco-conscious urban design. By showcasing these approaches, the project encourages civic leaders, developers, and residents to consider practical ways to cool urban spaces. Whether through planting more trees, selecting reflective materials, or implementing policy changes, viewers are inspired to envision and adopt sustainable strategies for their own communities. These actions not only address the urban heat island effect but also contribute to broader goals of climate resilience and improving public health.

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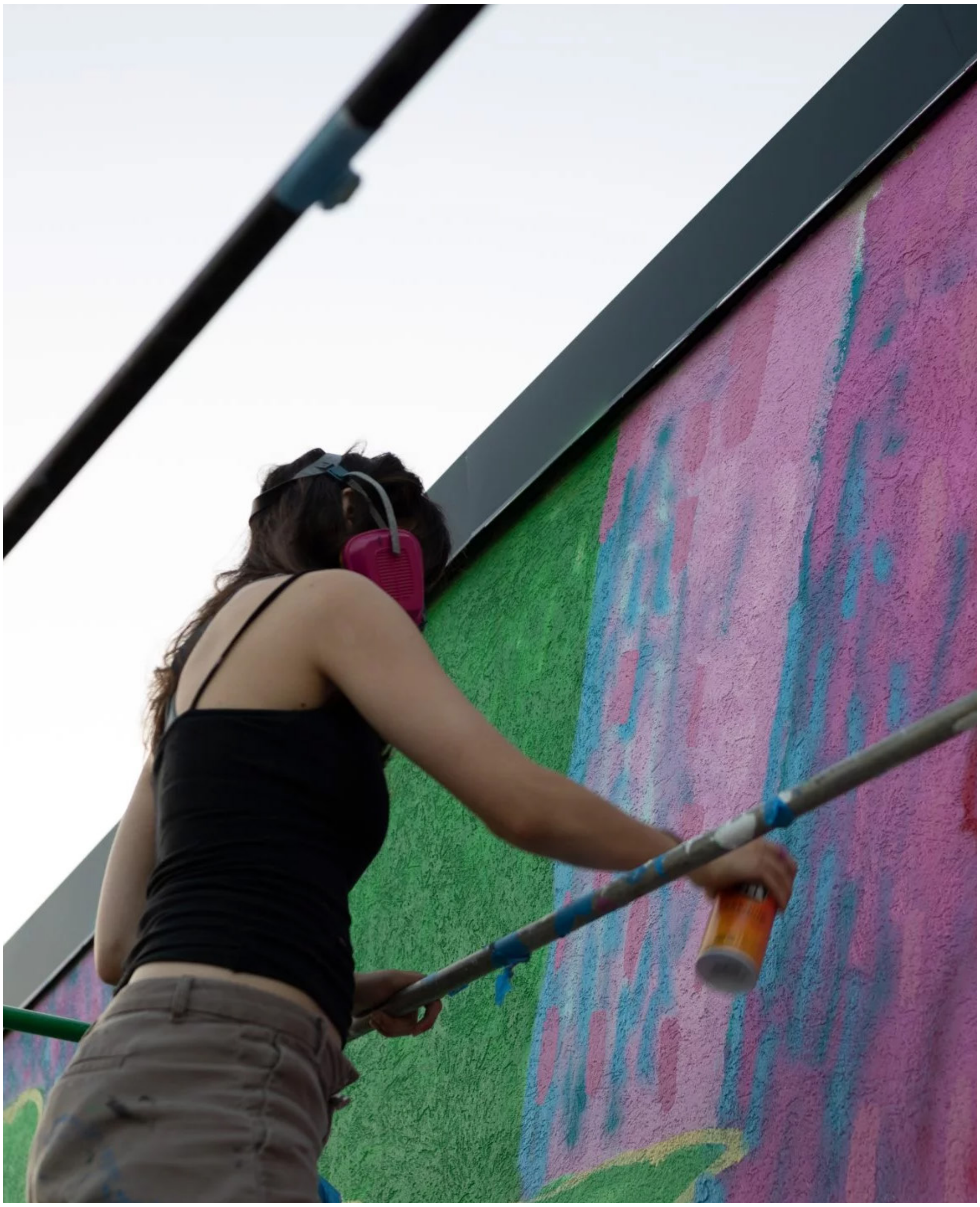


ADDING DETAILS TO TREES (Source: Baran Sevim)

The "Urban Heat Island Effect Mural" demonstrates the potential of interdisciplinary collaboration, integrating art, science, technology, and community engagement to address a pressing environmental challenge. This project serves as a blueprint for communities seeking innovative ways to communicate climate data and drive impactful action.

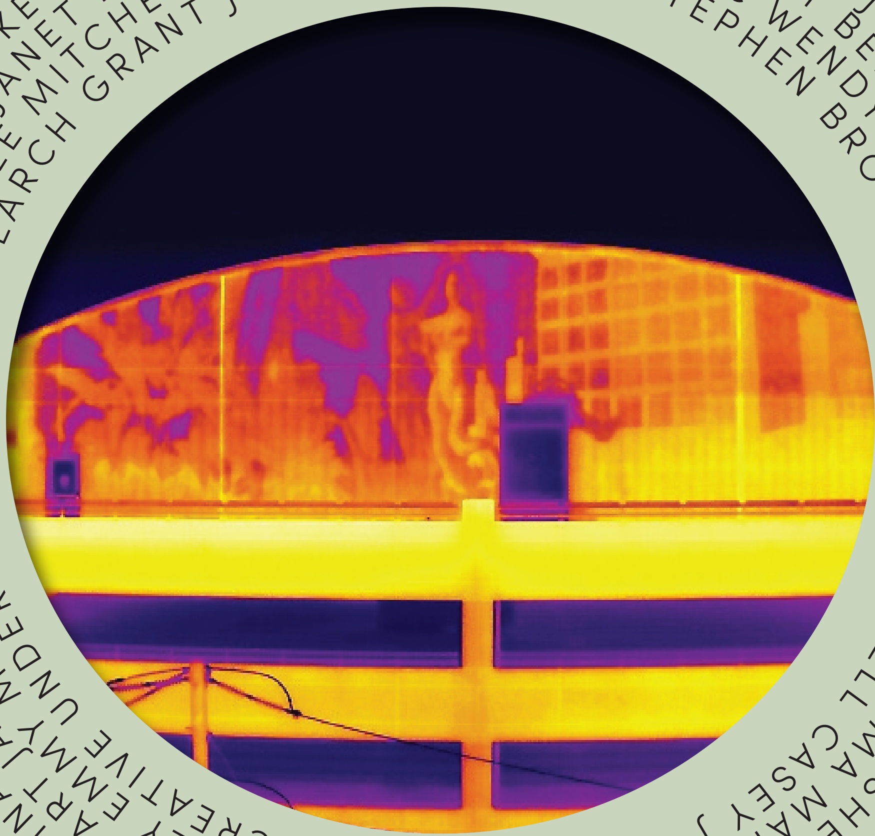
Moreover, the mural acts as a starting point for future public art projects aimed at reducing heat retention in urban spaces. It provides insights for muralists and public art creators on how to incorporate solar reflective materials, vegetation, or shading into their designs. By encouraging artists to consider the environmental implications of their work, this project contributes to the development of public art that not only beautifies cities but also helps mitigate the urban heat island effect. Through these efforts, art can play an active role in

CONCLUSION
HEAT ISLAND

The "Urban Heat Island Effect Mural" project set out to visualize and communicate the often-unseen impacts of rising urban temperatures. Through the integration of art, science, and interactive technology, it transformed complex thermal data into an accessible visual narrative.

The research and findings highlight practical steps to mitigate the urban heat island effect—such as using solar reflective paints or incorporating more vegetation—and emphasize the urgency of sustainable urban development. By illuminating the disproportionate burden placed on historically redlined neighborhoods, the project also underlines the social and environmental injustices inherent in uneven urban design.

Ultimately, this mural and its accompanying data encourage dialogue, inspiring communities, policymakers, and stakeholders to adopt informed strategies for creating cooler, healthier cities. While the mural itself is complete, the conversation and actions it sparks can ripple outward, driving positive change in how we envision and build our urban landscapes.



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Sirena and Roberto (Source: Emily Komornik)

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Scan the QR code or visit the URL above to explore additional data, time-lapse animations, augmented reality overlays, and documentation collected throughout this project.