Narrating Urban DATA

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Abstract

Vibrant Fields is an artistic research project that seeks to explore the impact of climate change through an artistic lens. The project's central hypothesis posits that urban nature is a dynamic amalgamation of biological and human-made technological elements, interconnected in a symbiotic life cycle within the urban environment. By meticulously observing and deciphering these intricate relationships, we aim to construct a comprehensive portrayal that sheds light on the influence of climate change. Our research focuses on understanding how atmospheric effects influence both living and non-living entities in the urban realm, and conversely, how these diverse particulate matters affect the climate. The project's objective is to present a holistic depiction of climate change and its impact on urban nature by elucidating the intricate relationships among the diverse interacting entities. The Vibrant Fields team consisting of Zeynep Aksöz Balzar, Mark Balzar, Galo Moncayo Asan, and Bernhard Sommer is based in the Energy Design Department at the Institute of Architecture at the University of Applied Arts Vienna, and endeavours to transform human perceptions of their immediate urban environment by creating digitally mediated narratives, offering an accessible and tangible perspective on climate change through the lens of energy flows. To achieve this, we employ high-resolution surveys of urban environments under extreme climatic conditions, utilising custom-developed multi-spectral sensing machines. By mapping the dynamic exchanges occurring within urban environments, we investigate the interplay between natural and artificial elements within the urban realm, focusing specifically on energy flows. Integrating these instruments into immersive experiences, the Vibrant Fields team provides an alternative viewpoint that transcends the human sensory spectrum, generating an interactive environment that enables visitors to engage with and influence energetic exchanges, perceiving the built environment and its inhabitants as vibrant matter (Bennett, 2010). Through their mere presence in the same space as the sensors, participants can actively shape the environment by interacting with sensory tools. This transformative space becomes a site for interacting with environmental information beyond our conventional senses, offering novel embodied experiences.

Keywords

urbanism; architecture; energy; climate change; arts-based research.

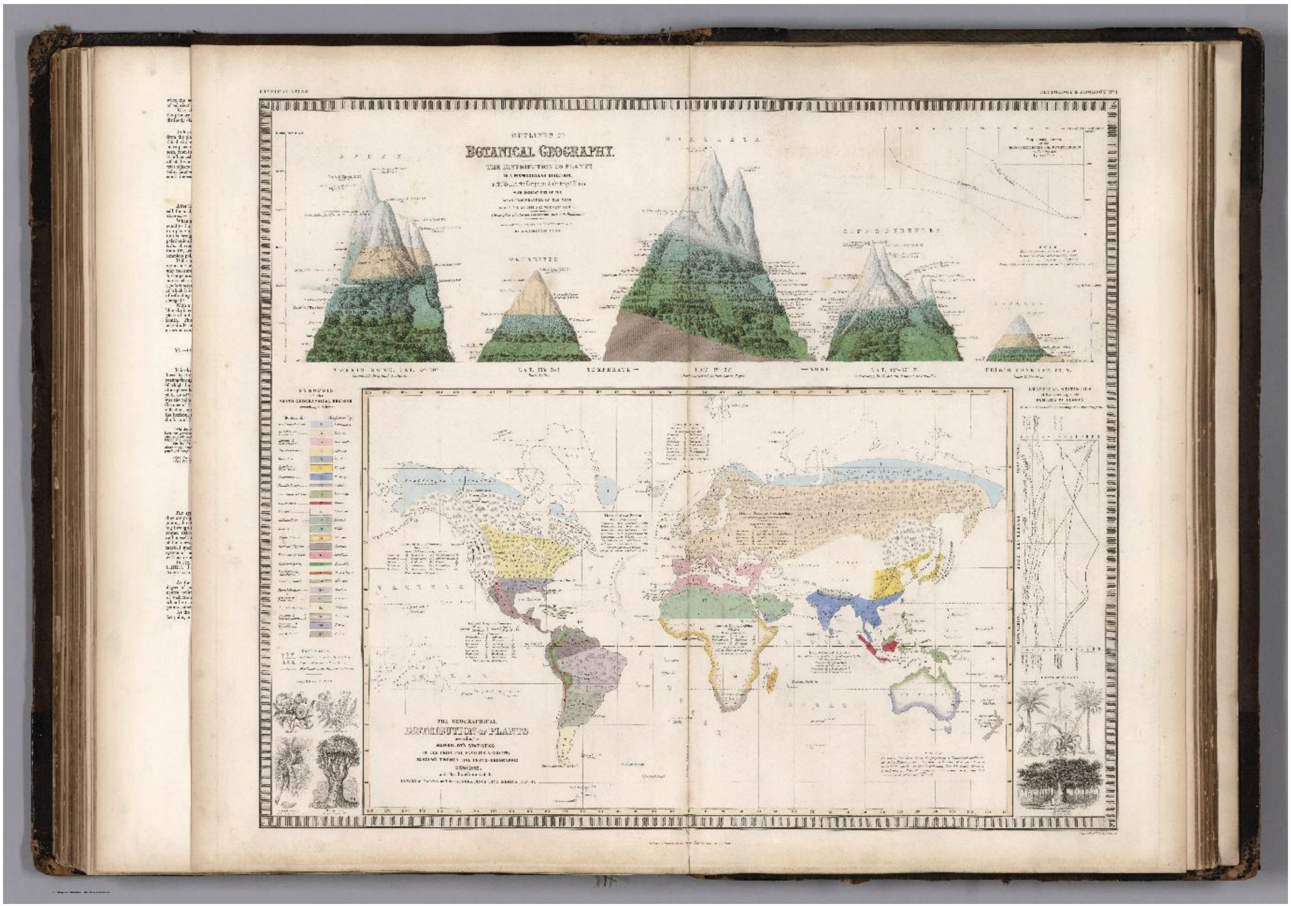

Figure 1. Alexander von Humboldt Geographical Distribution of Plants. Image Source: Humboldt, 1850.

1. Introduction

Our research starts from the premise that the current approach to attaining knowledge about urbanisation processes requires a significant re-evaluation to shed light on emergent forms of complex modern cityscapes. In contrast to the traditional urban research and design paradigm that relied on the separation of architecture, (infrastructural) technology, and the biodiversity of nature that has long substantiated selective data collection, and the cartographic and diagrammatic practice of representation, we argue that the contemporary urban environment has evolved into a unified bio-technological superstructure. Within this framework of the global system earth, all aspects of politics, economics, society, the environment, technology, and biology converge into a non-hierarchical uniform mesh. The global net of urbanisation conditions itself non-intermittently, transcending geographical boundaries (Terra) or morphological formations. In the same manner, the global climate disseminates its local effects across the planet, transferring the earth's energy and interrelations from distant sources to create interconnected, ecological phenomena in various regions. Local milieus interact harmoniously with this overarching global system. Urbanism is linked to non-local conditions that are uniformly entangled globally through factors such as food production, economic production, ecologic (re)creation, and infrastructure for transport, goods, and services. Those forms are expressions of the intensive interrelated flow of energy and information on the biological and ecological nature of the earth's life system (Zhang et al., 2021; Brenner et al., n.d.; Moe, 2017).

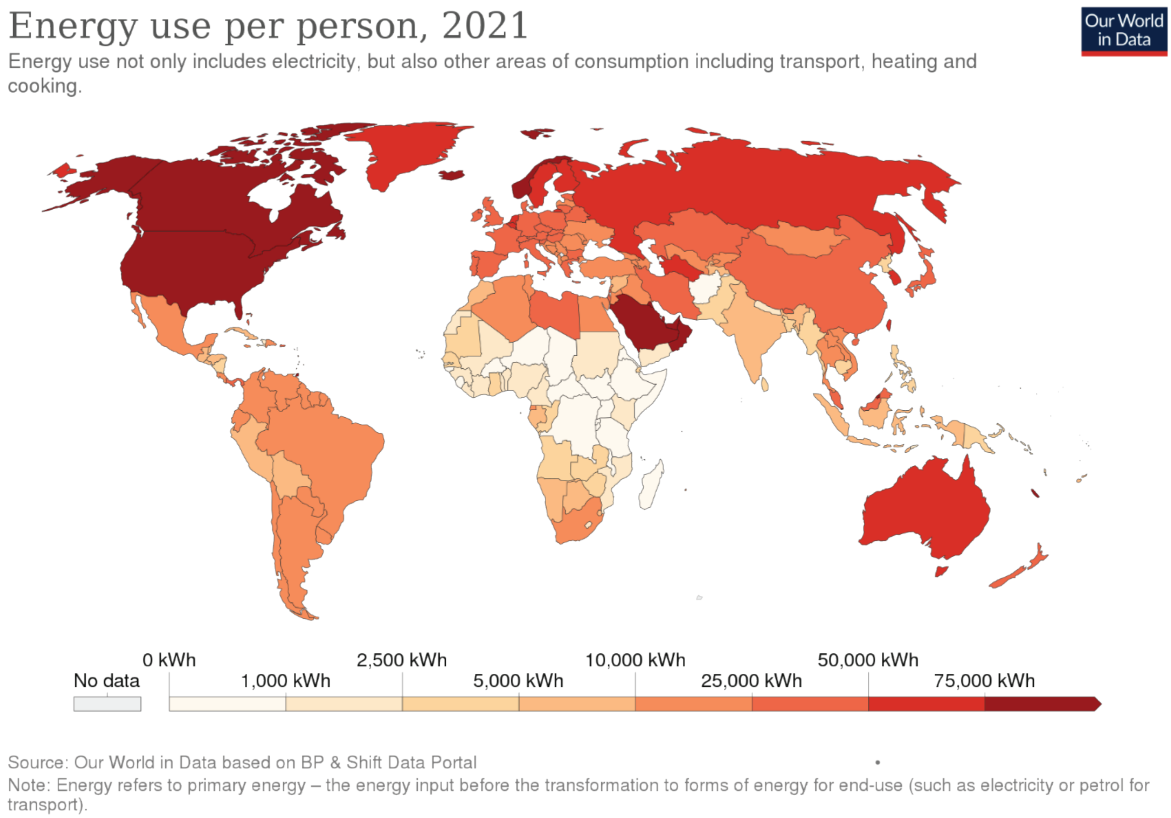

Figure 2. Energy use per person in 2021. Image Source: OurWorldinData, 2021.

Vibrant Fields strives to craft a novel theoretical cartography aimed at comprehending the materiality of forms and the genesis of the urban realm as the outcome of a complex information system in intra-action (Barad, 2007) with energy cycles (Schneider & Sagan, 2005).

Urban formations are condensers of energetic resources and potentials. Innumerous satellites oversee the global changes of elements that contribute to global climate in various intervals and geolocations. The global system of the earth is consequently observed and analysed by a scarce stream of information resulting in imprecise datasets for local conditions. Vibrant Fields therefore developed a set of tools as a complementary family of devices that try to fill the gap between global and local datasets to gain a better understanding of small-scale conditions and phenomena.

Vibrant Fields investigates multiple simultaneous realities of an urban field in relation to its ecological milieu. It is an operational investigation and observation of architecture, technology, animal species, and plants in relation to their geographic, geologic, and ecologic conditions (also represented by isotherms) bringing to the fore climatic conditions of urban sprawl. Isotherms delineate layers or regions offset by 2 degrees Celsius across the globe, characterising the average temperature during a specific time period. These isotherms also correspond with various ecosystems and wildlife habitats. While isotherms were originally discovered by Alexander von Humboldt, the historical Russian geographer Lev Mechnikov found out that those layers were also linked to the process of urban sprawl during the 19th century (Reclus, 2013).

In the early 20th century, Geologist Vladimir Vernadsky approached the terminology of the “biosphere” (Suess, 1875), considering it as a planetary system of multiplicities of interconnected, interrelated, and interdependent events. Cities can be regarded as organic entities, or urban metabolisms, where metabolic processes, or flows and fluxes of energy, matter, water, organisms, technology, transportation, and human movement as well as social and economic activities determine physical forms and spatial configurations (Vernardsky, 1997). A key figure of the mereological approach to describing the organismic/biological, ecological, and technological conjoined world as complex interrelated *systems*, was the ecologist Howard T. Odum. Odum (1983) is widely known as the founder of systems ecology which grants a view on dynamisms of the physical, chemical, economic, and social forces in ecological environments, including cities. In his model(s) he considers the passive potentialities in the form of energy storage and the active transgressing forces of energy transfer and energy transformation.

Odum, who was inspired by Lotka’s (1965), and Vernadsky’s (1997) ideas and who refers back to the systemic concepts of Norbert Wiener (Cybernetics, 1965) and Ludwig von Bertalanffy (General System Theory, 1969), states that the biosphere is the largest ecosystem, but argues further that all of its parts (or organisms), including forests, the seas, or even great cities, are ecosystems too. All these different flows within subsystems and parts of parts (Odum, 1971) operate on their individual budgets of energy, attributed to the second law of thermodynamics. Considering thermodynamic principles, climate change is likewise an expression of an imbalance within the earthflow system of matter and energy – or change in element ratios (Odum, 1971)– affecting the meteorological atmosphere. A steady state of climate therefore implies a constant pattern of energy flow into the system, constant cycles of energy within systems and subsystems, storage of energy for potential use in terms of resting qualities and quantities, and diverse complex structures and substructures of different gradients of energy distribution. On the global scale, factors such as the streams of wind and flow of water transport energetic loads through

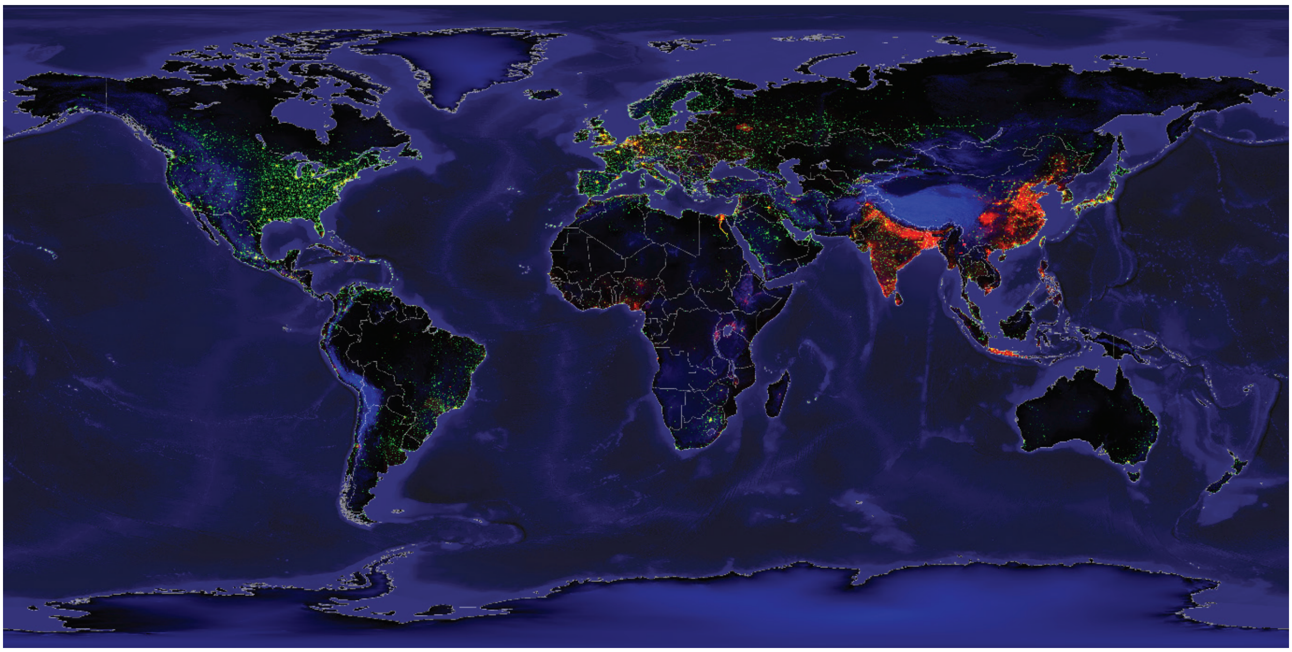

Figure 3. Overlay of earth lights in comparison to population density. Image Source: NASA, 2023.

the troposphere. The worldwide disruption of our climate is a truly planetary issue that has been significantly influenced over the past century by biopolitics within the Anthropocene era, a concept articulated by Elizabeth Povinelli (2016) as an intricate interplay of biopower (pertaining to living matter) and geontopower (relating to non-living matter). However, it remains exceedingly challenging to accurately anticipate the myriad consequences of climate change and the intricate processes unfolding in the chemical and force-binding reactions beneath the surface of the phenotype, primarily because of its shape-shifting characteristics.

In addition to multi-scalar levels of effects of climate change and related energetic imbalances, another level of complexity is added through multiple temporalities. Different effects of climate change can be observed in different synchronous time periods. As Vernadsky (1997) states, these multiple temporalities – the different scalar domains of time – can be observed at the historical time frame and the geological time frame. As the geological scale adapts its domain to changes of the earth's planetary system covering a larger period, the historical time domain is adapted to the changes of human life. In this dichotomy it was hard to follow the changes of the earth's system during the relatively short time period of one human life. Therefore, the discovery of the ozone hole was an important event in the Anthropocene, merging these different time scales in one event. The city, like any complex form of life, is centred around the problem of becoming form and formation through the interaction of its many vibrant object(ive)s and interacting multiplicities.

The focus of Vibrant Fields lies on urban environments as well as its infrastructures and organisation within the urban periphery and rural landscape. Instead of observing these systems as isolated aggregations, the project focuses on holistic perspectives using a metabolism-oriented approach of energy cycles. We conclude that our built and non-built environment is the outcome of a dynamic process between diverse contingent agents (Barad, 2017).

Current cloud-based multi-spectral data includes satellite imagery and geospatial information on a global scale. It detects long-term global phenomena but does not address the immediate impact of climate change on local urban energy flows. In our project, the challenge of getting high-resolution data on the micro- and meso-scale is addressed by using portable sensors. Several initiatives aim to gather urban data using extensive sensor networks (Diez Lareda & Posada, 2013).

To gain know-how about these different scalar events we developed the device family OTTO (stationary) and ANA (portable).

The ANA (Analytic Navigating Apparatus) devices can acquire data such as air quality, luminosity, humidity, and temperature. The urban environment is a dynamic and intricate entity, constantly evolving through the interplay of its living and non-living components, which varies throughout different phases of the day. This complexity can be observed through various layers of data. The data we perceive represents a historical account of tangible traces left behind by objects and events as they traverse space, leaving their imprints and residues. Through a continuous measured "experience", some of these flows can be traced back to uncover relations among particular elements.

Archiving, classifying, and indexing the earth's data of these events constitutes an act of understanding the earth as a geo-informatic construct, which helps researchers to observe synchronous events at different time scales and to draw predictions of potential futures. As these observations and data are publicly accessible today, we are able to achieve an advanced level of consciousness about the biosphere in interaction with humankind in the age of the Anthropocene.

OTTO (Orthographic Trans-territorial Operator) is a device that can be used to study and understand the urban environment by painting a landscape that not only records the visual but captures many other felt characteristics and unseen qualities in its immediate surroundings. It uses various sensors to survey, map, observe, and listen to the city, while analysing energy flows within. The goal is to understand how living and non-living parts of the city interact and exchange energy, and how the atmosphere affects these interactions. OTTO contains the following sensors that can acquire urban information in 36 dimensions:

- Air Temperature,
- Air Pressure
- Air humidity
- sound
- CO (Carbon monoxide)
- NO2 (Nitrogen dioxide)
- Versatile Organic Compounds
- C2H5CH (Ethyl alcohol)
- Air quality; benzene
- High Dynamic Range Digital Light Sensor [188 uLux sensitivity, up to 88,000 Lux input measurements, ambient light, infrared-light]
- Fine Particle Sensor
- UV Light
- Oxygen [0²]
- Methan
- Wind Speed
- Wind Direction
- Precipitation
- Ouster OS-1 64 (bit) LiDAR Sensor [angular vertical scan of 45° divided by the horizon = 22.5° up and down, 360° horizontal scan]
- Thermal Camera - FLIR C5 – monodirectional 160 × 120 (19,200 pixels) true thermal imager, MSX® (Multi-Spectral Dynamic Imaging), 5-megapixel visual camera
- 360° Camera

Table 1. List of sensors integrated in the stationary urban sensing device OTTO. Source: Author-made.

ANA (Analytic Narrating Apparatus) is a portable device that carries the core atmospheric sensors of OTTO and can be magnetically attached to any metal object. Both devices complement each other to cover a larger urban area. ANA itself can also be used individually and functions as a classic wearable citizen science tool.

Understanding geontopower (Povinelli, 2016) (a conclusive ontological framework for the abiotic earth and the biosphere) as a reciprocal interaction process of bio-power (power of life of animate things) and geo-power (power of non-life vital materialisation of inanimate things) is an essential basis for developing a conclusive understanding of energetic cycles of the earth's systems. Therefore, it is necessary to analyse biotic and non-biotic assemblages of climate agents at the level of local bodies and objects up to complex global patterns of weather systems with their turbulences of air and water streams, carbon cycles, and atmospheric sediments.

2. Multispectral Narratives

For the "Vibrant Fields" project, we define a multispectral narrative as a method for engaging with data and translating it into sensory experiences. These experiences serve the purpose of providing tangible means for connecting with energy flows. The narratives serve a dual function: first,

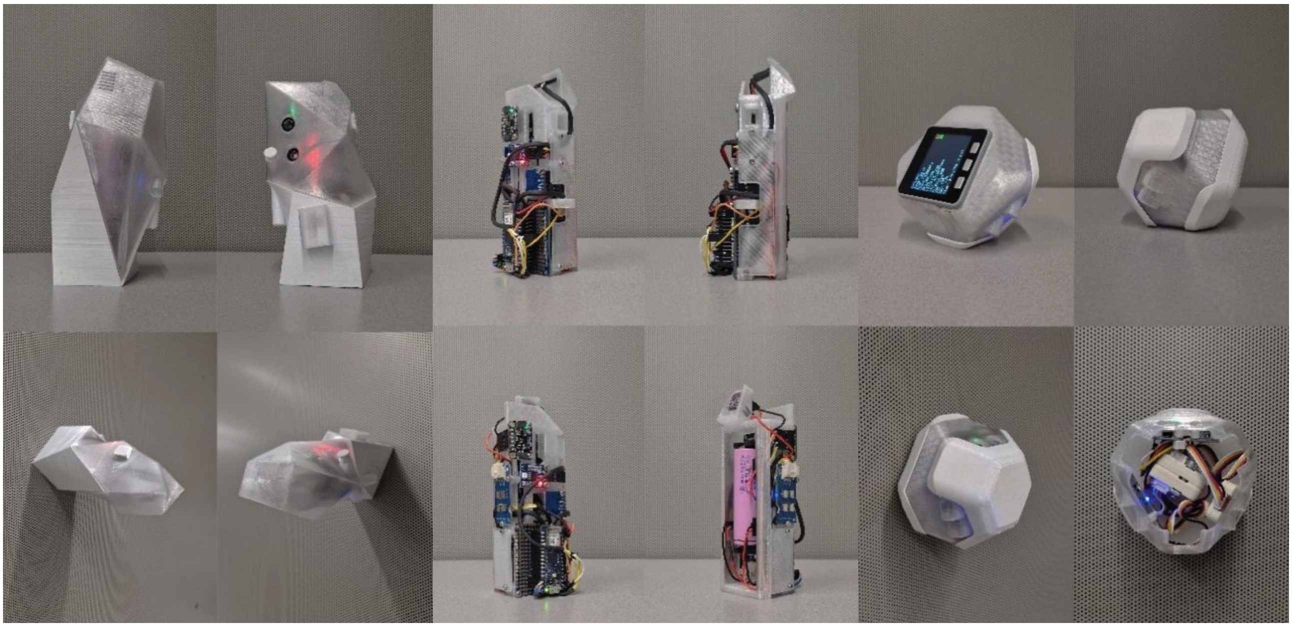

Figure 4. Different iterations of ANA's hardware and shell design. First iteration (left and middle) based on an Arduino System and second iteration (right) based on a M5Stack system with plug and play sensors. Image Source: © Vibrant Fields.

they are designed to capture the energetic essence of the environment they represent, and second, they establish experiential pathways for interaction by responding to the behaviours of agents inhabiting that environment. Through these immersive interactive experiences, multispectral narratives forge a connection to the realm of energy, rendering data that might typically escape their notice, discernible to human senses. We try to accomplish this through different means of artistic expression that imbue fresh significance into preexisting data related to energy and the urgent issue of climate change. Consequently, we aim to communicate the dynamics of energy and the consequences of climate change, which are closely intertwined with energy flows, to a broader, non-expert audience. In an exhibition environment, the local climate is limited to the surrounding conditions (indoor and/or outdoor). The prevailing micro-climate is subsequently shaped by the overall spatial atmosphere, the material intervention in the exhibition itself, and the presence of visitors, all together leaving a mark on the recorded data stream. We developed various setups to put these information processes in dialogue. The graphic output was intentionally designed to remain highly conceptual and simplistic. This approach was adopted to enhance accessibility for viewers and facilitate a rapid and intuitive learning curve.

As individuals actively engage with the intricacies of data transformation, they begin to grasp their integral role within an interconnected and unified system. Rather than passively observing the exhibition milieu, they evolve into empowered agents capable of shaping and influencing their own interactions with it. To achieve these objectives, we experimented on immaterial processes that continuously evolve, shaped by both inter- and intra-actions within their respective environments of the transmedia arts.

Consequently, multispectral narratives shed light on the impact of changing physiologies of climate through artistic methodologies.

Figure 5. OTTO during acquisition in Phoenix, Arizona, recording the nighttime effects of the overheating surfaces of the city. Image Source: © Vibrant Fields.

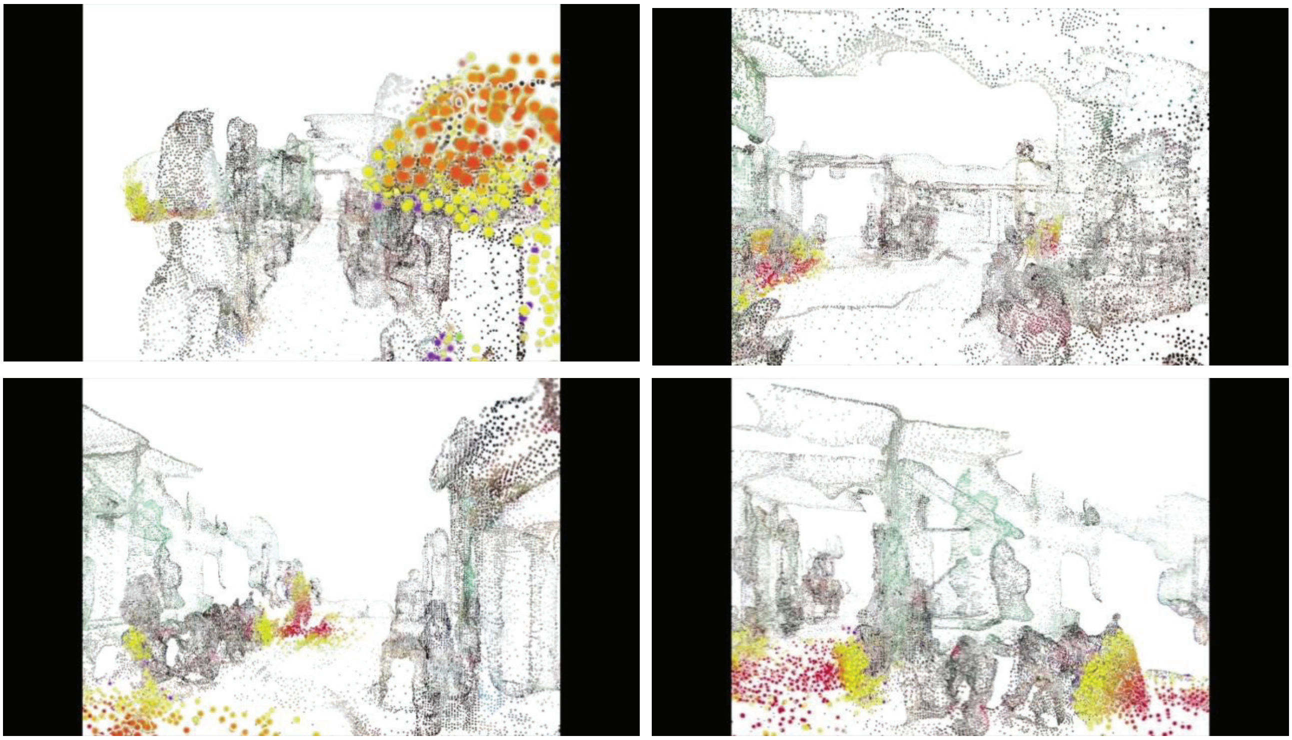

Figure 6. 3D point cloud from a scanning performance in Kampung Marlina in Jakarta, Indonesia. The colours represent the locally acquired thermal data from ANA. Image Source: © Vibrant Fields.

3. From Data to Space

The development and testing of multispectral narratives as an immersive form of communication has been a central focus of our work, particularly addressed in a series of public exhibitions. Over the course of two years, we have refined and expanded the immersive techniques that we have developed across five exhibitions. Throughout this process, we were guided by key research questions: How can we effectively convey various types of multispectral data? Which human senses should we engage in this communication? How can we document spatial data over time and make it perceptible? During our research, we defined three essential elements to construct these immersive experiences:

1. Interactive Projections: These projections dynamically respond to immediate changes in the exhibition space, engaging visitors in a visual dialogue.

2. Living and Non-Living Inhabitants: Living organisms and inanimate objects within the space both serve as agents documenting environmental changes within their own unique context.

3. Haptic Maps: We represent different data streams using AI-generated 3D-printed objects, enabling visitors to engage with data through touch.

In the subsequent sections, we will delve into each of these elements in greater detail.

4. Communicating Energy Flows through Interactive Experiences

In pursuit of conveying the dynamic nature of the synthetic ecosystem, a range of methodologies were employed to visualise energy flows. These methods encompassed real-time projections and dynamic sculptures, each meticulously designed to respond sensitively to the evolving climate within the exhibition space. The exhibition environment was equipped with bespoke sensory apparatuses, strategically positioned to capture and record energy flows at various key locations. The data acquired through these sensors was subsequently translated into compelling visualisations that were projected onto the walls of the exhibition space. These visual representations offered a dynamic, real-time depiction of internal climate variations, departing from traditional data visualisation methods in favour of an artistic and engaging communication approach, akin to an interactive landscape painting in motion, fostering participant engagement rather than presenting it as a mere video. When visitors moved within the exhibition spaces, they became part of the energetic footprint in the room, and simultaneously altered the painting.

Historically, moments were preserved through painting, later through photos and film, with each iteration enriched by additional layers of information. With the use of OTTO and ANA, we continue this tradition, while creating a comprehensive record that encompasses additional parameters such as temperature, humidity, geometry, or particle flows. This way, if places vanish due to the impacts of the climate crisis, we can retain a comprehensive and informative chronicle of their existence. By recording a specific place and time with OTTO and ANA and narrating these datasets, we intend to bring landscape painting into the 21st century. By bridging art and architecture, our goal is to provide alternative means of communicating and conveying scientific facts in urban planning and politics.

In an exhibition setting, real-time projections bring dynamic energy flows to life within the exhibition space, transforming the latter into an interactive canvas. These projections are driven by data collected from OTTO and several distributed ANA sensors strategically placed throughout the space. These digital paintings, projected onto the walls, comprise ever-evolving amalgamations of lines and point clouds that visually represent various data bands. As the energetic landscape shifts, these digital entities begin to morph, influencing the overall perception of the space (see Figure 8, Figure 11, Figure 12).

Two distinct projections offer contrasting views of the surrounding space, each focusing on different aspects of its energy dynamics. The first projection, characterised by its abstract nature, depicts variations across multispectral bands, encompassing gases, temperature, and humidity. Within this projection, linear contours are used to represent four distinct gas values measured by the integrated gas sensors in ANA and OTTO. Each line is assigned a unique colour to correspond to a specific gas (NO2 is represented in purple, VOC in orange, Ethyl Alcohol in yellow, and CO in magenta). As the concentration of each gas increases, the lines grow thicker, dominating the spatial atmosphere by the prevailing gas colour (see Figure 10).

Meanwhile, a point cloud of bubbles, rendered in various shades of red, represents humidity and temperature data collected by sensors within the devices. These bubbles undergo dynamic transformations in response to changes in the humidity levels within the space, and the red hue of the point cloud deepens with rising room temperatures. Each bubble symbolises the values obtained from different areas within the space, facilitating the interactive mapping of localised microclimates distributed throughout the exhibition area. This visually engaging representation allows viewers to perceive the intricate interplay of gases, temperature, and humidity within the environment.

The second projection offers a unique 3D representation of the space by overlaying thermal data onto it. This is achieved through a combination of active scanning and thermal imaging, which captures and displays changes throughout the entire area. These changes are then projected onto the walls, including the movements of visitors within the space. In a manner akin to abstract surveillance, visitors can observe themselves as a collection of points moving through the environment. The colour gradient of these points is determined by the thermal camera integrated in OTTO. This gradient transitions from violet to yellow, with yellow indicating higher temperatures and violet representing cooler temperatures. For instance, during exhibitions, yellow may correspond to temperatures ranging from 36 to 40°C, which align with human body temperature, while violet signifies temperatures between 10 and 16°C.As a result, visitors find themselves immersed in an extraordinary experience, perceiving themselves as temperature-defined point clouds navigating through the environment, ultimately becoming an integral part of the space.

Initially, visitors may not grasp the interactive nature of the exhibition. However, as their curiosity deepens, they gradually realise that the transformations in the digital paintings are linked to their own actions and movements. Surprised and intrigued, they begin to engage playfully with these sensory objects.

5. Documenting Long-term Energetic Changes in Physical Bodies

For the duration of the exhibition, the atmospheric changes of the space were vividly documented through the physical transformation of wax sculptures. These sculptures, meticulously crafted by students from TU Wien's Department of Structural Design and Timber Engineering, effectively manifest temperature changes by gradually melting and blending with other forms. Inspired by the fragile and intricate beauty of coral reefs, these sculptures serve as tangible depictions of the evolving climatic conditions within the exhibition space, albeit with a slight time delay. The ephemeral quality and recyclability of wax underscores a broader exploration of innovative materials, emphasising the concept of design as a versatile and adaptable system rather than a search for a rigid, fixed solution. The temperature-responsive wax materialisation reacts to the constantly fluctuating temperature conditions within a space, providing a tangible, physical manifestation of the transient aspect of time, giving it a visible and dynamic physiological form.

In conventional data mapping practices, systems are typically designed to describe, diagnose, or predict events based on data. However, the latest frontier in data analytics and evaluation lies in prescriptive analytics. This advanced approach involves the development of intelligent models capable of suggesting decisions based on the results of descriptive analysis. Haptic Maps delve into the realm of prescriptive systems, which not only map incoming data to describe surveyed locations but also prescribe responses in order to shape events.

Through the concept of haptic maps, we aim to redefine the communicative aspect of data. Instead of merely representing data, we are striving to create prescriptive AI systems that respond and adapt to data, forming new behaviours in the process. The outcome of this approach implies the generation of objects that not just represent incoming data but also exhibit behaviours in response to it. Additionally, a key objective is to make data more tangible, shifting away from relying solely on visual senses by creating physical objects that visitors can interact with through touch (see Figure 7). Unlike interactive projections, Haptic Maps primarily aim to depict enduring environmental transformations in specific locations, translating these changes into static objects. The varying densities or surface compositions of these 3D-printed objects act as a medium to convey the intensity of the represented data stream, by showcasing alterations in lattice densities or the textural roughness of the surface structure. Using satellite data, these objects are meticulously crafted and transformed into intricate 3D-printed representations. They capture a wide range of environmental attributes found within urban regions, offering a limited spatial resolution but a significantly enhanced temporal resolution. For instance, the 3D-printed lattice structures (see Figure 7) represent the distribution of methane gas in Yakutsk and Vienna over a five-year period from 2018 to 2022. Expanding upon this concept, another 3D-printed object features a textured, spiky surface. These spherical objects prove to be a proficient method for depicting the fluctuations in surface temperatures over a designated period within the particular urban landscape they symbolise.

The most intriguing feature of these Haptic Maps is that data differentiation is not merely observed through visual means but also experienced through touch when interacting with these objects.

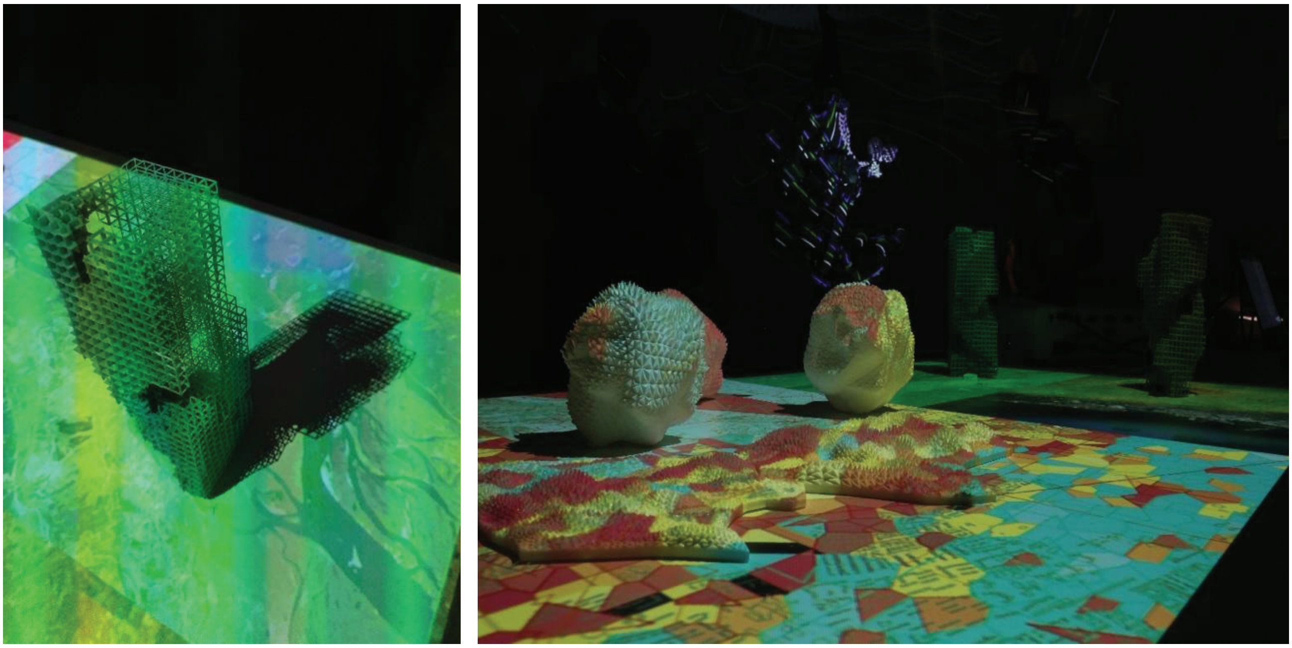

Figure 7. Haptic Maps designed by Orhan Hasanoff and Florian Zeif as part of the 'Design with AI-based Processes' course at the University of Applied Arts Vienna. Image Source: © Vibrant Fields-Zeynep Aksöz (left) ©Vibrant Fields - Afshin Koupaei (right).

6. Exhibitions

6.1 Vienna Design Week

To fully immerse visitors in the Vibrant Fields experience, our team designed and created an artificially constructed microcosm during the Vienna Design Week 2021. This microcosm featured a diverse range of indoor climatic zones, providing an opportunity to observe and understand the intricate interactions and responses of diverse agents when visitors engaged with the space.

Two contrasting zones were arranged in opposition to each other. To craft these distinct microcosms, we fitted the exhibition space with an array of living and non-living elements. These included plants affixed to space frame structures in one area, simulating a vegetation zone with a humid environment. Another area was equipped with an infrared heat panel, which was activated in intervals to create a hot and supposedly dry zone. Two technical sensory devices were embedded in this artificial realm to monitor environmental properties in this indoor space and to record shifting and changing conditions, also as a consequence of human interaction. Simultaneously, the hot area featured wax sculptures designed by students from the TU Wien. These sculptures responded to temperature changes in their respective environments and gradually reconfigured, shifted their shape, and finally deformed through the resulting differences in the viscosity of the wax – therefore representing long-term changes of temperature in their milieu.

This holistic approach allowed us to explore the dynamic relationship between living and non-living elements, sensory perception, and data representation, all within the context of our multispectral narrative experiences. Designed as a didactic feedback loop, we recorded exhibition procedures throughout the event on video, so that we could directly link different interactions to the effects on the sensor recordings.

Figure 8. The thermal 3D Scan (left) as part of the exhibition at the Vienna Design Week. Image Source: © Vibrant Fields (left) © VIENNA DESIGN WEEK/Kollektiv Fischka/Kramar (right).

6.2 Bratislava Design Week

For the Bratislava Design Week 2021, our aim was to explore a novel approach to using an existing space as canvas for representation. In contrast to the Vienna Design Week 2021, the exhibition space was a baroque setting that we could not transform into an artificial microcosm. The challenge, in this case, was to reimagine and repurpose this antique space to alter visitors' perceptions. In this case, our projection resampled the existing physical space with a rendered computational model of the digitally sensed environment, merging both.

The projection on the ceiling (see Figure 11) established a direct connection between the floor and ceiling. While the floor space exhibited physical devices and sculptures in the existing environment and spatially interacted with the moving audience through these objects, the ceiling simultaneously presented the same space in real time, including all the concealed information that was not immediately visible and sensible to the visitor. As visitors entered the dimly lit room, their attention was naturally drawn upwards, where they could see their own thermal 3D scans in motion across the ceiling, conjoining together with information about the gases, particles, and sound.

To bring this unique experience to life, several preparatory steps were undertaken. One of the most critical steps involved 3D scanning the exhibition space prior to the event. The data obtained from this scan was then processed to extract the essential geometric features necessary for creating the projection canvas.

6.3 Understanding Art Research – Uprum Prag

In this exhibition, we continued to employ our unique projection methodology, but with a twist—a fresh perspective on surveillance. Instead of the conventional approach of representing and mapping the immediate physical space of the exhibition, we ventured into uncharted territory. Our objective was to offer visitors a real-time glimpse into the energy dynamics at our studio in Vienna.

To accomplish this, we established a live stream that was projected onto the walls of the exhibition space. This live feed allowed visitors to peer into our studio as though viewing it

Figure 9. Melting Wax Sculpture designed by TU Wien students Mathias Heytmanek, Vilmos Toth, and Marcel Janisch (left). Image Source: © Vibrant Fields. Entire exhibition space (right). Image Source: © Vibrant Fields.

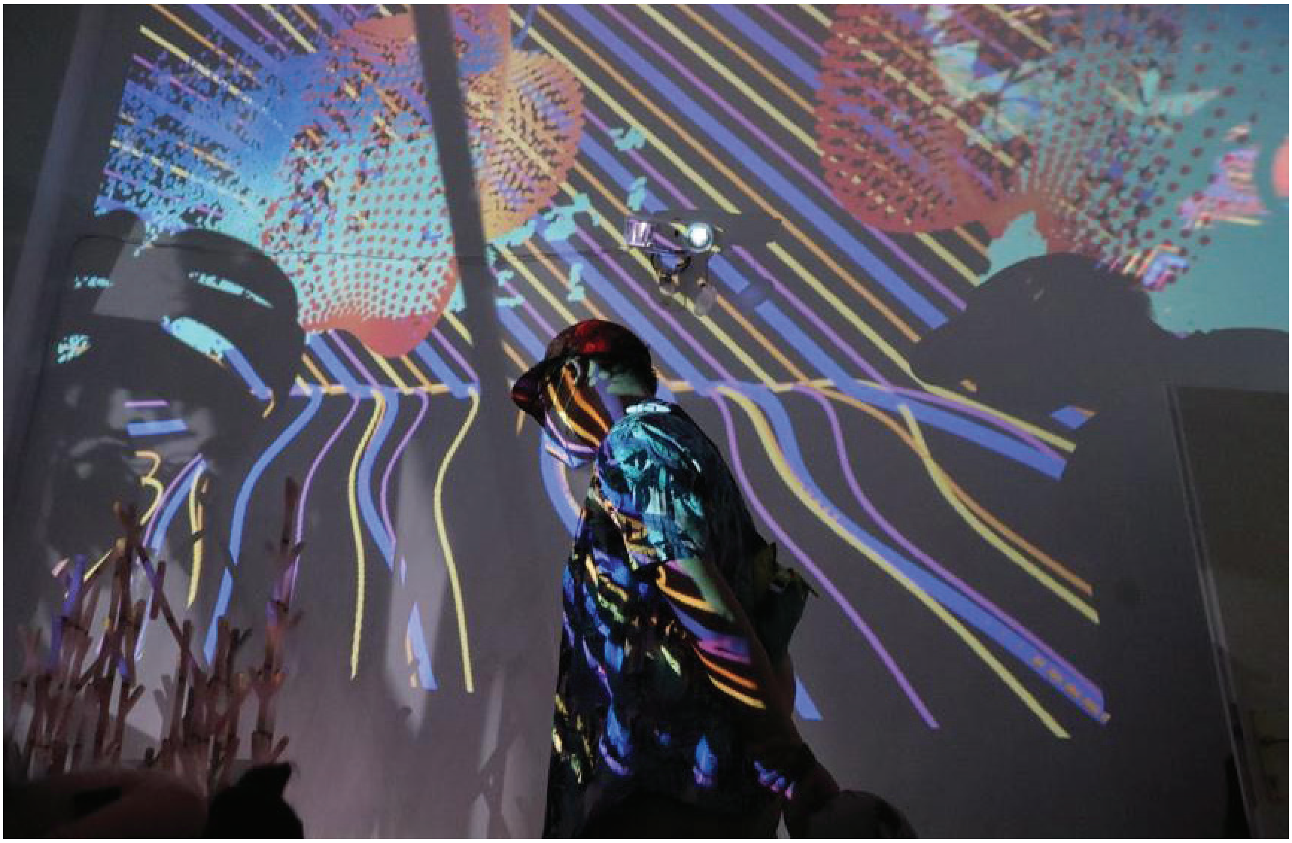

Figure 10. Projection 1 displaying data acquired by ANA and OTTO's gas, humidity, and temperature sensors overlayed with the spatial sound. Image Source: © Vibrant Fields.

from a completely different vantage point, transforming our team and our environment into abstract representations of energy. What they witnessed, were not conventional visuals of people and objects, but intricate bit patterns and ethereal point clouds of represented energy, as a manifestation of our team working and interacting in the studio at the department of Energy Design at the University of Applied Arts Vienna.

The core elements of this representation were derived from the thermal 3D scan and environmental data collected at our studio. Through our projection mapping, we shared only these aspects with the visitors, inviting them to contemplate the essence of energy flows and the hidden narratives they encapsulate. This approach challenged conventional notions of surveillance and encouraged a rethinking of how we perceive and interact with our surroundings in the digital age.

7. Conclusion

Climate change is a generally accepted prevalent challenge that deeply concerns our society. The lack of a comprehensive political agenda and slow political progress on this topic place the responsibility for climate action squarely on individual behavioural adjustments. There is no shortage of data and information about this challenging phenomenon; however, there exists a significant gap in communicating it from a scientific perspective into language comprehensible to the general public. Consequently, a deficit remains in the individual understanding of climate change and its future ramifications for the bio-technological realm, as climate change representation mainly relies on abstract statistical charts and diagrams. While climate change has gained widespread recognition as a pressing challenge with profound implications for social, economic, and ecological progress, a gap persists in our ability to connect the dots between numerical data and real-world effects. Yet, our daily

Figure 11. Projection on the ceiling as part of the Bratislava Design Week (left), ANA version1 acquiring data from the exhibition space (right). Image Source: © Bratislava Design Week (left) © Vibrant Fields, Zeynep Aksöz (right).

Figure 12. Projections displaying real-time data acquired in our office space in Vienna as a video stream in Uprum Prag as part of the Understanding Arts Research Exhibition. Image Source: © Vibrant Fields (top) / © Alexander Damianisch (down)

experiences abound with sensory information that unveils subtle shifts at the micro-scale, particularly within our immediate environment and its built morphology, which, in turn, influences the meso-scale.

Our project is an attempt to communicate the interrelated consequences of interacting energetic cycles from various sources within an urban context. The myth that climate change is a consequence of the Anthropocene since the age of oil must be redirected to a new general understanding of the relations of different environmental agents in (inter) action. Climate change is a highly complex process, for better or for worse, that affects the micro-scale as well as the macro-scale through different layers of interactions between energetic loads in the biosphere and the technosphere. In order to gain new insights, we need to shift the perspective of prevalent methodologies of representational data and push for innovation in measuring techniques and graphic interfaces that communicate represented processes of physical and chemical interaction from various sources at various time intervals as one thermodynamic flow (as a form of an information network).

Accordingly, our research examines the present-day impacts of climate change within the local context of the urban environment and develops ways to communicate these effects through an artistic lens and an aesthetic sensibility to foster a deeper comprehension of climate change and its effects on our environments and ourselves. With our research, we intend to bridge the gap between data and human experience by creating sensory experiences and, consequently, aim to empower individuals to take action in the face of this global issue.

Conflict of Interests and Ethics

The author(s) declare no conflict of interests. The author(s) also declare full adherence to all journal research ethics policies, namely involving the participation of human subjects' anonymity and/or consent to publish.

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