



Architecture's Digital Divide: Post-Digital Formalisms and the Emergence of Cyberphysical Architecture

Guvenc Ozel

Lead Faculty and Program Advisor,
IDEAS/Suprastudio, UCLA Department of
Architecture and Urban Design
Principal, Ozel Office

MISAPPROPRIATIONS OF THE POST-DIGITAL

In his seminal 1995 book, *Being Digital*, Nicholas Negroponte talks about the popularity, economic feasibility, and future viability of various consumer technologies of his time. Focusing primarily on media and entertainment technologies of the '90s, ranging from CD-ROMs to cable broadcasting, Negroponte argues that it is futile to insist on a discourse of material intelligence, one that aims to encode information into matter, since all that can become digital will eventually become as such, through replacing "atoms" with "bits." It is the kind of argument that architects love to hate, as it poses an existential threat to many of the disciplinary pillars of architectural production. Negroponte predicts the emergence of immaterial systems of change and transformation, controlled by the collective and momentary decisions of the users, organized in the layered temporality of abstract space. Such an architecture as data is diametrically opposed to the permanent, made-to-last, static notions of what we consider to be designed environments negotiating between nature and the human body. He argues for a future where the artificial construction of space

through the disciplining of nature, as experienced through centuries of building practice, no longer prioritizes the organizations of matter but of ideas—a new kind of architecture of information that represents systems rather than nature, presented in experiential interfaces that no longer require the physical manipulation of land and depletion of natural resources but rather constant rearrangement of enclosures as energy, light, motion and information.

Many of Negroponte's predictions about the internet, disappearance of tangible media formats, the ongoing growth of artificial intelligence (AI), ubiquity of virtual reality (VR), and emergence of social media as the dominant public communication protocol have become true. Each of these developments poses a direct threat to the traditional concerns of architectural practice and production as it relates to *representation*, *agency*, *experience*, and *civic presence*. After the initial excitement of digital design technologies in architecture waned past the '90s, many of these existential questions were largely perceived as unwelcome intrusions into the disciplinary sandbox. Rather than critically considering massive technological developments

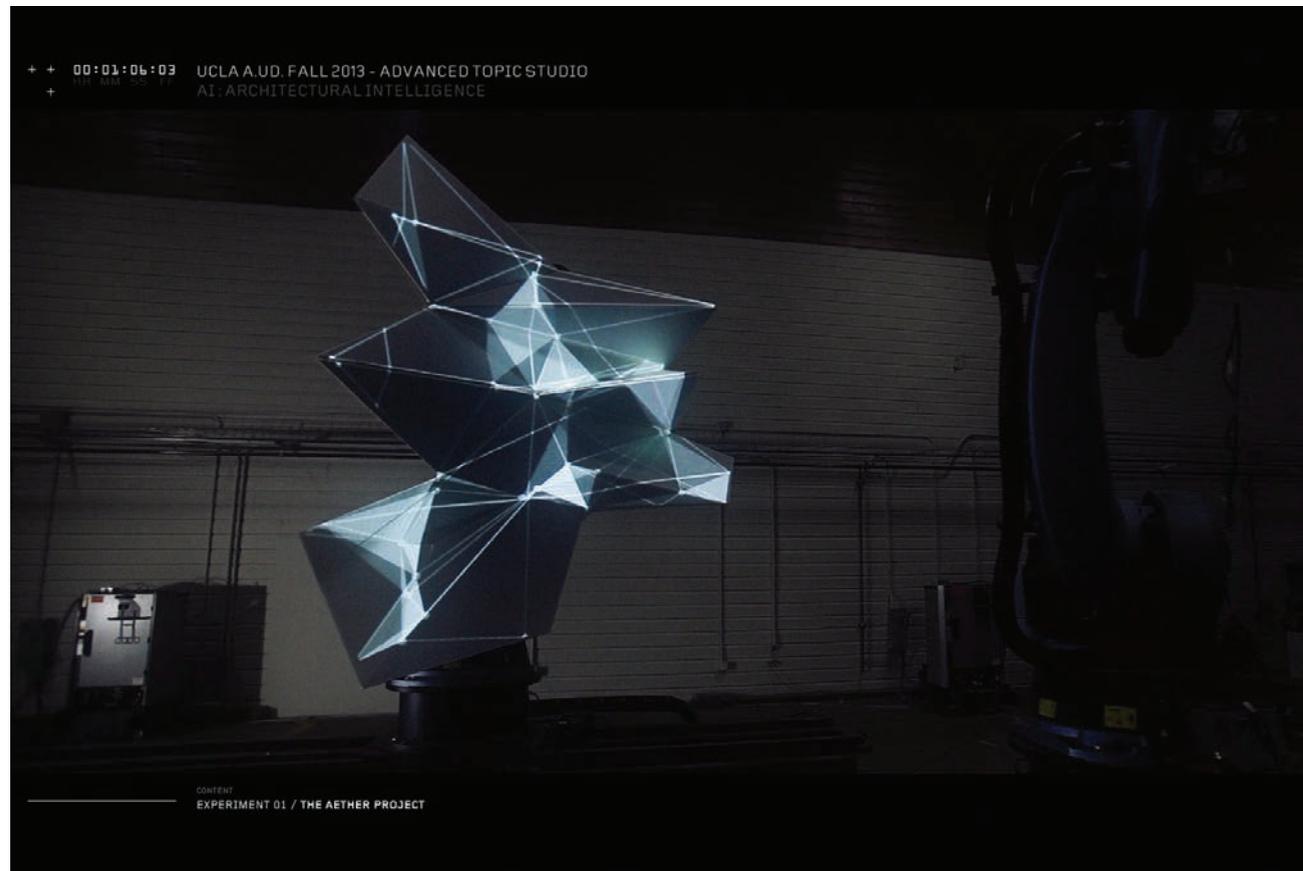


Figure 1: Aether Project, created as a part of "Architectural Intelligence: Exploring Space as an Interactive Medium," led by faculty Guvenc Ozel. Student team: Julietta Gil, Farzad Misfahei, Refik Anadol, Raman Mustafa. UCLA 2013.

as opportunities to transform architecture into a more culturally relevant discourse, the proponents of disciplinary autonomy resorted to the reoccurring operation of "returning to form," where copies of *Complexity and Contradiction in Architecture* were removed from their dusty shelves as the recurrent guidebook for the most recent post-postmodern reincarnation. In this regard, historicism becomes a reoccurring cultural trope that masquerades as radicalism in moments in which an external theoretical foundation that can guide architectural formal production is absent. In these cultural moments, the discipline of architecture is often late to the party and falls victim to misappropriations that are clarified much earlier and with much rigor and intent in other disciplines.

MECHANIZATION OF REPRESENTATION

It is important to note that, in the context of the debate on the post-digital, many other disciplines such as media arts, music, visual arts, and other pursuits use contemporary philosophical and critical devices of technology to break down existing structures with an updated set of tools in order to recalibrate the priorities of their own disciplinary production—since evolution of technology is dynamic and the possibilities,

challenges, and opportunities it poses for cultural production are variable. Since the '90s onwards, during the birth and application of CAD and CAM, technologies as they related to production of disciplinary devices (representation, theorization, methodology as it relates to formal production) and production of buildings (BIM, performance and construction simulation, fabrication optimization, and other tools as they relate to the economy of construction) were received as tools consistent with the Modernist ideations of architecture in academy and practice. Technology was perceived as a tool to make the more complex happen—faster, cheaper, and more precise. At that moment in the evolution of technology, contemporary tools and debates surrounding AI, extended reality (XR), and social media were largely absent as these technologies were aspirational and not yet at practical and operational maturation. Once the formal and theoretical possibilities were exhausted—and later on "stylized"—what once seemed original and cutting-edge within the confines of digital formalism started to look derivative, banal, and corporate. As it happened with postmodernism, the post-digital took a historicist turn, but this time, using the new digital toolset to reinterpret and mechanize some of the

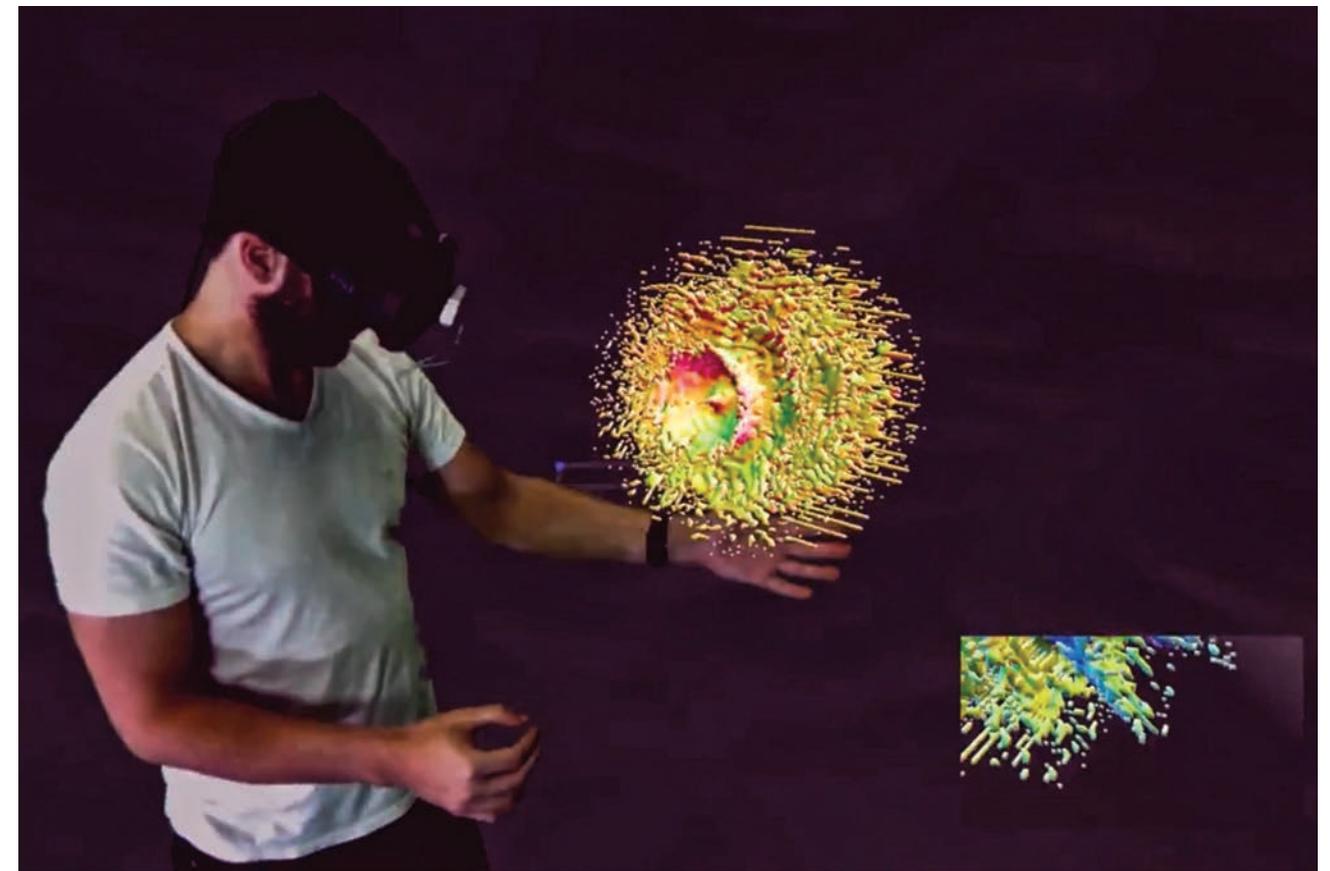


Figure 2: Virtual architecture as scalable interfaces, varying from object to space. UCLA Ozel Suprastudio 2016. Student: Yuanzhi Li.

fundamental traditional mainstays of architectural representation. As with most things contemporary, it is hard to draw the line where ingenuity starts and irony ends. One thing clear about these projects, however, is their deep mistrust of the evolution of technology and its ability to provide tools for facilitating novel formal and theoretical possibilities. For such musings of the privileged, architecture remains to be a self-referential pursuit that can always turn back time. For the rest of us, the post-digital is a time where the discipline moves forward from mechanizing the production of form and representation and starts addressing issues of presence and interaction in a world that is exceedingly less static and material, and potentially less human.

CYBERPHYSICAL ARCHITECTURE AND THE OBJECTIFICATION OF EXPERIENCE

As the most dominant platform for communication, the internet is often referred to as "cyberspace." Current forms of interface design and organizational logics of information over the internet, however, exist as environments only in the world of allegories, preventing the participants from interacting spatially with these streams of data. One design scenario is to utilize massive amounts of data through simulation

tools that would visualize and formalize information flows so that they can be observed, occupied, and experienced. Primarily experienced through architectural-scale media technology application or personalized through virtual reality systems, this method allows architecture to create new experiential environments through computer-generated graphics. This form of "virtual architecture" relies heavily on cinematic methods of representation through aligning simulations with the point of view of the observer and the boundaries of built form simultaneously, often through increasing the scale of the image to an architectural or spatial one. In these instances, the architectural surface is supposed to be devoid of materiality, and media becomes a vestige of cinematic displays for moving images. Often, the empty spectacle of such media mapping schemes suffers from an absence of interfacing with the architectural form in an evocative way since they are not conceived simultaneously as a cohesive design system.

Alternatively, viewed as an ecosystem of technologies rather than a tectonic assemblage of materials, architecture is shifting toward a non-static and non-physical form of experience, opening up potentials for it to be considered as a medium that merges

the worlds of media and materiality. Environmental sensor systems combined with automated building performance processes coupled with integration of robotics into built form for the actual transformation of environments based on programmatic, occupational, and ambient requirements allow for a “cyberphysical architecture.” In this scenario, data collected from the real world is used as a basis to create automated transformations of ambient, functional, and operational modalities. Alternative to material systems, architecture can be explored through environmental applications of media in the form of extended reality, sensor interaction with environments, and real-time

control and transformation of spaces as complete ecosystems which prioritize not only visual but also spatial conceptions of architectural experience. The shift in focus from viewing the role of digital tools from the production of form into production of interaction and experience is significant yet disorienting for the architects, since it does not necessarily provide tools for alternative aesthetics. In this absence of tool-enforced aesthetic roadmaps, architecture can instead explore the vernacular of the digital, looking into the culture of media, interfaces, gaming, and similar social manifestations of image-culture for mining alternate formal trajectories.

Figure 3: Cypher is a soft-robotic interactive sculpture. Ozel Office 2018.



Figure 4: Cypher and the VR helmet. Ozel Office 2017.

SOCIAL MEDIA, TELEPRESENCE, AND THE NEW REPRESENTATION OF SELF

Constructing architecture enhanced by and built with media, a post-digital architecture can investigate scenarios where occupants of such architectures travel seamlessly between the digital and physical worlds. Through the proliferation of social media, virtual avatars, sensory simulations, and holograms, current and future forms of technological communications can simulate experiences with precision and without exclusively relying on the physical presence of their subjects. In these radically different new social environments, architecture is conceived as a cyberphysical system, designed not only for the use of people physically present in a particular space but also for the digital occupancy of other beings and their representations. These new environments, occupied by human and non-human entities, take avatars, telepresence of other humans through robotics and XR systems, and other robotic or simulated beings as their new subjects. Although it might sound like science fiction to some, such environments already exist in social media platforms, fulfillment centers, and other emergent environments of the Fourth Industrial Revolution. For such systems of experiential immersion, the actors present in these digital environments no longer rely on image as the sole representation of their participation but on a more profound presence that allows them to initiate change in physical and virtual constructs simultaneously. By

questioning the role of representation in the process of designing realities and environments, such an architecture can focus on the potentials of cyberphysical tools to formulate a reformed agenda for the role of the digital in the contemporary practice of architecture.

INTELLIGENT ENVIRONMENTS AND LIMITS OF INTERACTION

In a world where simulations hold equal footing with physical environments, conventional rules that limit human experience no longer apply. Boundaries enforced by the natural world, such as scale, material, and physics, can be bent or broken. Such a world can only be bounded by the precision of presence, as the human subject experiences the physical and digital worlds simultaneously. Therefore, the perceptual boundaries of the human mind and body become the sole restraints for a cyberphysical architecture.

In my UCLA option studio in 2013 called “Architectural Intelligence: Exploring Space as an Interactive Medium,” the pedagogical objective was to free advanced architectural exploration from the tyranny of disciplinary conventions of form making and representation by blurring the boundaries of architecture and media art. By setting the scale of production to full scale, the studio speculated on interactive cyberphysical environments that develop intelligent interactions with their human subjects through synthesizing motion, sensor interaction, and media technology.

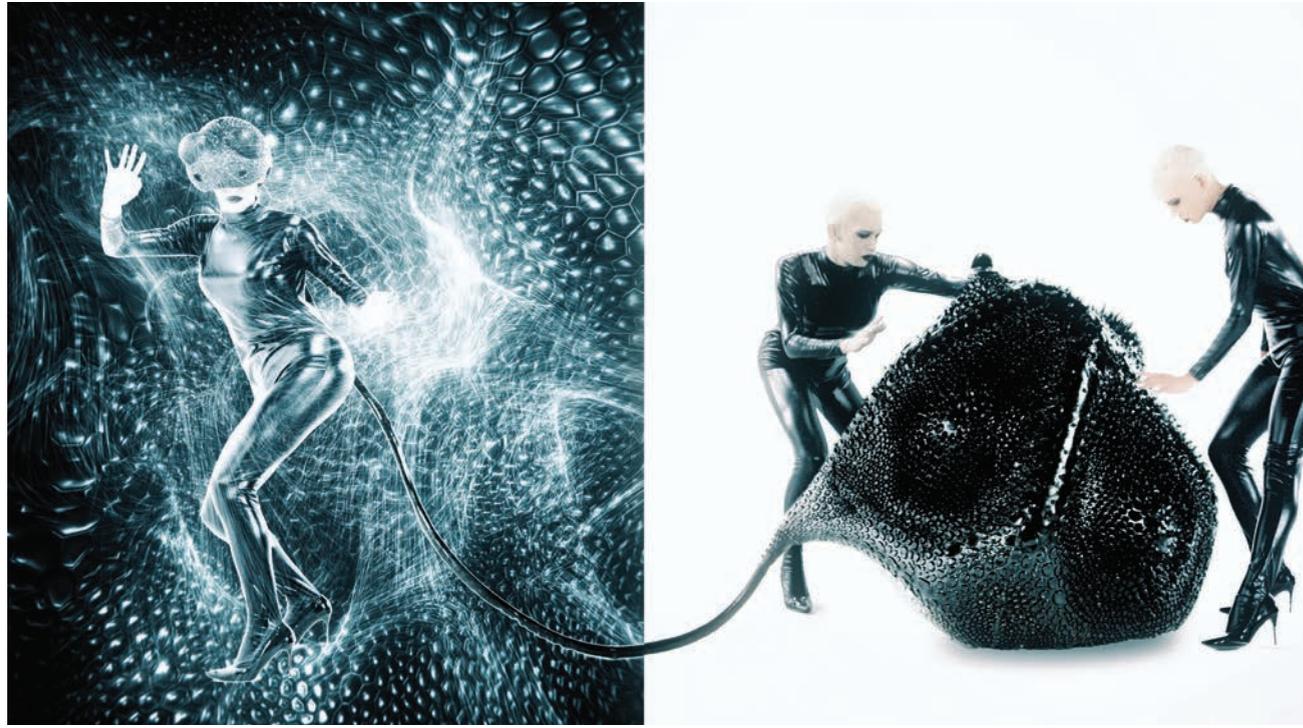


Figure 5: *Cypher's* teleportation scheme from robotics to virtual reality. Ozel Office 2017.

Each of the multidisciplinary project teams, consisting of architecture and media arts students, were assigned particular scales, actuating and sensing machines, and media devices to create controlled experiments on how the human body would alter and be altered by enclosures that can transform physically and affectively. One team that was assigned industrial robots, real-time projection mapping, and environmental sensors created a scheme that we later called the Aether Project, which synthesized the affects of motion and moving image to elevate and suppress qualities of depth, color, shadow, silhouette, and scale (fig. 1).

In this exercise, what was defined as intelligent was an emergent quality as a consequent output of interaction rather than a given or pre-programmed trait. Machine intelligence was not used to generate formal complexity but rather iterations of behavior as it responds to environmental factors and their surrounding human subjects. This kind of perception of intelligence defined as an advancing trait of a system that has an ability to move, change its properties, and adjust its physical and ambient qualities based on its context had its roots in evolutionary theory. The notion of "experience" was defined as twofold: first, as the cumulative presence of the system existing in the world, and second, as its ability to create variable spatial and aesthetic experiences for its observers. This approach of prioritizing behavior over form became the pedagogical focus of the various research projects and studios I have taught up until now.

Since then, this approach intentionally made a point

of differentiating between the performative aspects of machine intelligence and its ability to automate form-making processes. It exclusively focused on formal systems that can respond to outside contexts such as the environment, human occupation, and human psychology. Such programmed behaviors, through systems theory, allow for spaces to interactively respond to conditions as such through sensor interfaces while working in collaboration with formal systems that are conducive to physical and ambient transformation through mechanics and media. It treated the accumulation of contemporary formal systems and styles as pedagogical and methodological repositories which would act as inventories for further formal iteration. This approach yielded productive results in understanding the human presence as it relates to form in motion but has not resulted in unique spatial languages that can be deployed and explored further in order to pose alternatives to familiar models of computational form making, which are heavily constricted by the limitations of parametric design tools. The questions of enclosure as they related to motion, novel material science experiments, and variable modulations to strike a balance between static and dynamic qualities of space were explored through investigating the historic evolution of such forms in architectural and industrial design. The absence of a trajectory for a productive formal strategy became more prominent as we explored virtual reality as a platform for spaces that are not simulations of environments that would be

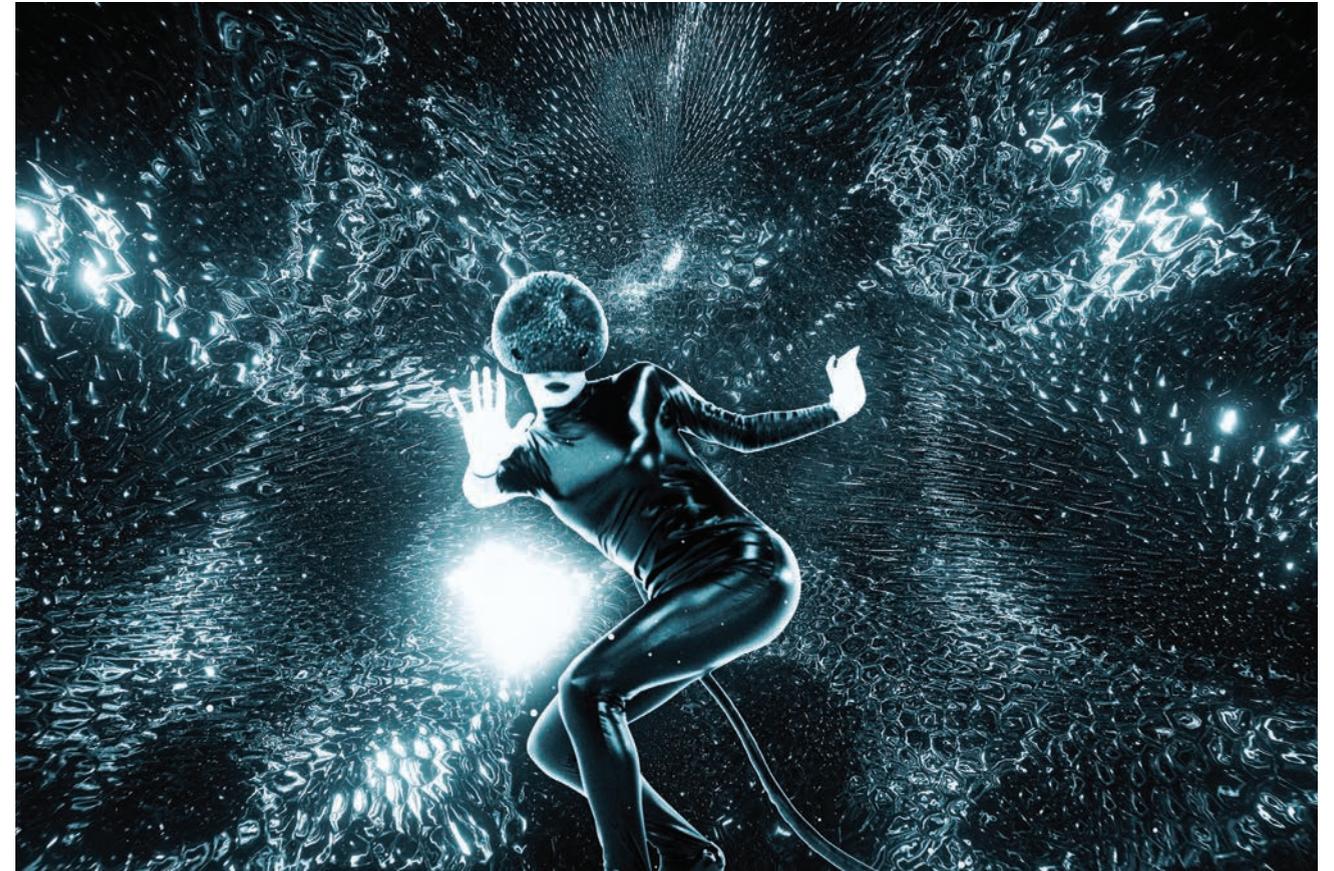


Figure 6: The interior view of *Cypher* through interactive virtual reality.

physically built in the future but interactive interface architectures that are meant to exist purely digitally, in their own right, in cyberspace (fig. 2).

Recently, in order to overcome this problem, we introduced an additional process to focus on the relationship between human agency and computational iteration by using machine learning (ML) as a design tool. By using basic ML tools in order to classify and iterate stylistic approaches that exist outside the discipline of architecture, we allow for ML to design, coordinate, randomize, and iterate qualities as they relate to pattern, color, proportion, hierarchy, and language. The human engagement in this design process is limited to the initial curation of input data that the ML system can learn from, and also in regulating and choosing the iterations as the final outputs of images such systems are capable of producing. An additional computational mediation process in the form of procedural modeling is deployed in order convert two-dimensional information into 3D geometry.

BRIDGING THE GAP: CYPHER AND THE POLYSEMY OF THE CYBERPHYSICAL OBJECT

The project where we combined machine intelligence both as a tool for formal invention and as an interface

for behavioral complexity is *Cypher*. *Cypher* is a sculptural installation that creates an interactive experience through robotics, virtual reality, sensor interaction, and machine learning. By combining an interactive soft robotic body with a virtual reality interface, *Cypher* creates a bridge between the physical and digital worlds, collapsing them into the same experiential plane by synchronizing a virtual reality simulation with human-robot interaction (fig. 3).

Triggered by infrared sensors and a lidar (similar to mapping technologies in autonomous vehicles), the sculpture has an ability to detect the proximity of the audience and change its shape accordingly. The exterior of the sculpture is made of flexible silicon, actuated through a network of pneumatic tubes and linear actuators. Running on a custom-made software, the lidar collects and stores periodic point cloud data from its environment. The software not only uses this data to change the overall mass of *Cypher* based on the proximity of the people around it, but also has integrated machine learning so that the sculpture can develop more natural motion patterns through time.

The appearance of *Cypher* was inspired by the variable skin patterns of many natural creatures, calling into question our aesthetic expectations of robots.

In its initial state, it is angular and crystalline, but as it interacts with humans and other creatures, it becomes curvilinear and organic. By recreating the appearance of an organism artificially, *Cypher* aims to question the relationship between the natural and the human-made, thus further problematizing the interactive and intelligent behavior of the sculpture. The black glossy color is used to enhance the mystique of the object further, therefore blurring the true morphological qualities of the sculpture through a play between absence of light and variable reflection.

The virtual reality headset tethered to the sculpture teleports the user to the interior of the sculpture, radically shifting the scale of experience from object to space. While in VR, the user has the ability to change the shape of the simulation through natural hand gestures. As the user changes the shape of the VR simulation, the robot moves in real time, aligning the physical and digital transformations. The helmet inflates and deflates due to the actions triggered by the user in the VR environment, fusing the user into the spectacular motion of the sculpture. Through this VR interface, *Cypher* blurs the boundaries between architecture, sculpture, and fashion, allowing them to be experienced interchangeably (fig. 4).

The relationship between VR and robotics is further negotiated through machine learning algorithms, allowing the sculpture to develop natural motions by learning to predict the way in which people are interacting with it. The AI component allows for the sculpture to become more “intelligent” the more it is exhibited, using the number of interactions it has with the audience to cumulatively shape its motion and behavior through time (fig. 5). The same application is also used to “evolve” the geometry of the VR scenes. By extrapolating various points in the geometry in synthesis with the archive of the audience positional data, the geometry visible in VR becomes more elaborate the more it is experienced. The gaming engine Unity is used in order to synchronize all the VR, physical computing, and additional custom software. This approach allows the computational system to develop behaviors in reference to all the other actors in the same environment. This method provides a platform to collapse physical and virtual actions into a streamlined interface, creating a continuity of experience between the digital and physical worlds (fig. 6).

With this combination of multiple technological systems working seamlessly, *Cypher* exists simultaneously in the digital and the physical worlds. It has an ability to respond to changes in its environment both as simulation and as material. Through the synthesis of these multiple technologies operating as an ecosystem, the sculpture challenges the notions of what is real vs. virtual, allowing the viewer to travel between multitudes of realities simultaneously. By merging the worlds of virtual reality and robotics, *Cypher* translates concepts

and experiences that are traditionally seen as opposite domains: architecture vs. sculpture, object vs. space, digital vs. physical, real vs. virtual, visual vs. tactile, machine vs. organism.

THE ACTUAL SUBJECTS OF THE POST-DIGITAL

When analyzed outside the domain of media art and interactive architecture, spatial reflections of big data are already apparent and prominent aspects of contemporary life. In the form of invisible low-level AI systems, living now already entails a constant interaction with non-human entities, and standard interaction with humans predominantly happens through digital and non-material domains. However, the majority of these systems are engineered to track, document, organize, and eventually streamline public behavior in digital and physical civic realms. In that regard, control and documentation of communal human behavior is the primary subject of the post-digital.

In the world of surveillance capitalism designed to collect and monetize data, digital representations of ourselves and our environments are harvested by CCTV cameras, drones, internet bots, and social media platforms for social, economic, and political manipulation and control. Since the modes of operation for these platforms and how they monetize our actions are opaque, how do we create useful and engaging methods to understand the impact of our digital behaviors? Data is inherently invisible, ubiquitous, complex, and intangible. It has no scale, no materiality, and no perceivable properties through our senses. Its impact can only be measured through its subjectivity and influence in the social sphere. Based on these contemporary questions, our Ozel Office installation called *Deep City* aims to explore the latent relationships between physical and virtual urbanities (fig. 7). Through instrumentalizing architecture and urbanism, the objective of the *Deep City* installation is to demystify the inner workings of the algorithms that hold increasing influence over our decisions, emotions, and sense of self by turning them into media that are comprehensible through our spatial perception. By subverting their innate purpose and objectifying them, the work aims to hack such computational systems of surveillance and control in order to exploit them for their creative potential for artistic production. Based on this premise, the title for the installation, *Deep City*, is a double entendre, one referring to the utilization of deep learning algorithms for their generative potential for creating novel architectural and urban form, and the other referencing a contemporary mode of “deep state” where the data of individuals are constantly collected, archived, manipulated, and weaponized.

As surveillance technologies and artificial intelligence proliferate, the way machines see our environments creates emergent reading of the urban form as it relates to human activity. In this new model of urbanism viewed



Figure 7: *Deep City* consists of a reflective sculpture actuated by an industrial robot. Ozel Office 2018.

through the optical and algorithmic lens of technology, physical elements of urbanity become the canvases and boundaries for data to be forged from. On the one hand, surveillance systems, whether software- or hardware-based, lack the sophistication to understand human constructs such as creativity, history, lifestyle, culture, and other nuanced concepts that are so fundamental to human life. They are geared toward analyzing human activity in the form of images and looking for patterns. The generative quality of such artificial neural networks is to imitate and copy existing outputs of human production, ultimately and ideally to a point of realism where they are no longer recognizable from the original. This notion of “imitation” and “fakeness” is fundamental to the MO of AI. On the other hand, training on vast amounts of data that document various natural and artificial morphologies of our world, such generative algorithms have the capability to decipher a meta-understanding of our physical world and autonomously deduct formal biases about it. These biases hold novel formal interpretations on reading physical objects and

carry immense design potential. Through these new technological frameworks, it is possible for machines to imagine images and generate landscapes based on considerations yet unforeseen by the human designer. As a radical diversion from the parametric mainstays of contemporary digital architectural production, these algorithms, called generative adversarial networks (GANs), allow machines to collaborate with human designers creatively, rather than by merely automating design schemes planned by the human designer. In this regard, deep learning algorithms represent the emergence of a “machine creativity,” or a machine mind where algorithms have significant autonomy from their human creators. This emergent reality allows for an unprecedented human-machine collaboration to create novel design agendas.

Based on this political framework of the city as image and data, *Deep City* is a cyberphysical ecosystem of robots and media where the audience experiences an immersive depiction of algorithmic and optical modes of surveillance and control in contemporary urban

environments (fig. 8). The work allows the audience to occupy a fictitious space between the “mind” and the “body” of the machine surveillance apparatus where artificial intelligence and robotics intersect. The project is based on the creation of a surveillance database consisting of four world cities with different socioeconomic, demographic, architectural, and urbanistic identities: Istanbul, Hong Kong, Rome, and New York. Hours of drone footage, CCTV videos, animated 3D models, maps, and other visual data from these cities are used to train deep-learning algorithms to generate a “meta-city,” a fictional urban environment that is resultant from the way AI perceives and interprets the various formal characteristics in its dataset. The algorithm is able to deduct semantic generalizations regarding the architectural and urbanistic features of the city. This video shows an idealized deduction of the city’s characteristics, stitched into a continuous

synthetic panorama, as a result of how AI perceives and interprets the various architectural and urban patterns in its dataset (fig. 9).

Working in synchronization with the video, a mirrored sculptural object with various reflective and optical properties is actuated by an industrial robot in an orbital trajectory. This shiny and seductive object, much like a mobile phone, constantly competes for the attention of the audience, demanding their narcissistic engagement. The more attention the audience gives, the more their data is collected and monetized. Positioned between the projection and the robot, the participants can see their own reflection on the moving sculpture—altered, distorted, and composited into the synthetic landscapes of the “Deep City.” Through this spatial setup, the project allows for developing speculative and experiential approaches toward seeing our cities as machines do in the world of surveillance capitalism.

Figure 8: Deep City at the Contemporary Istanbul Art Fair, 2018.

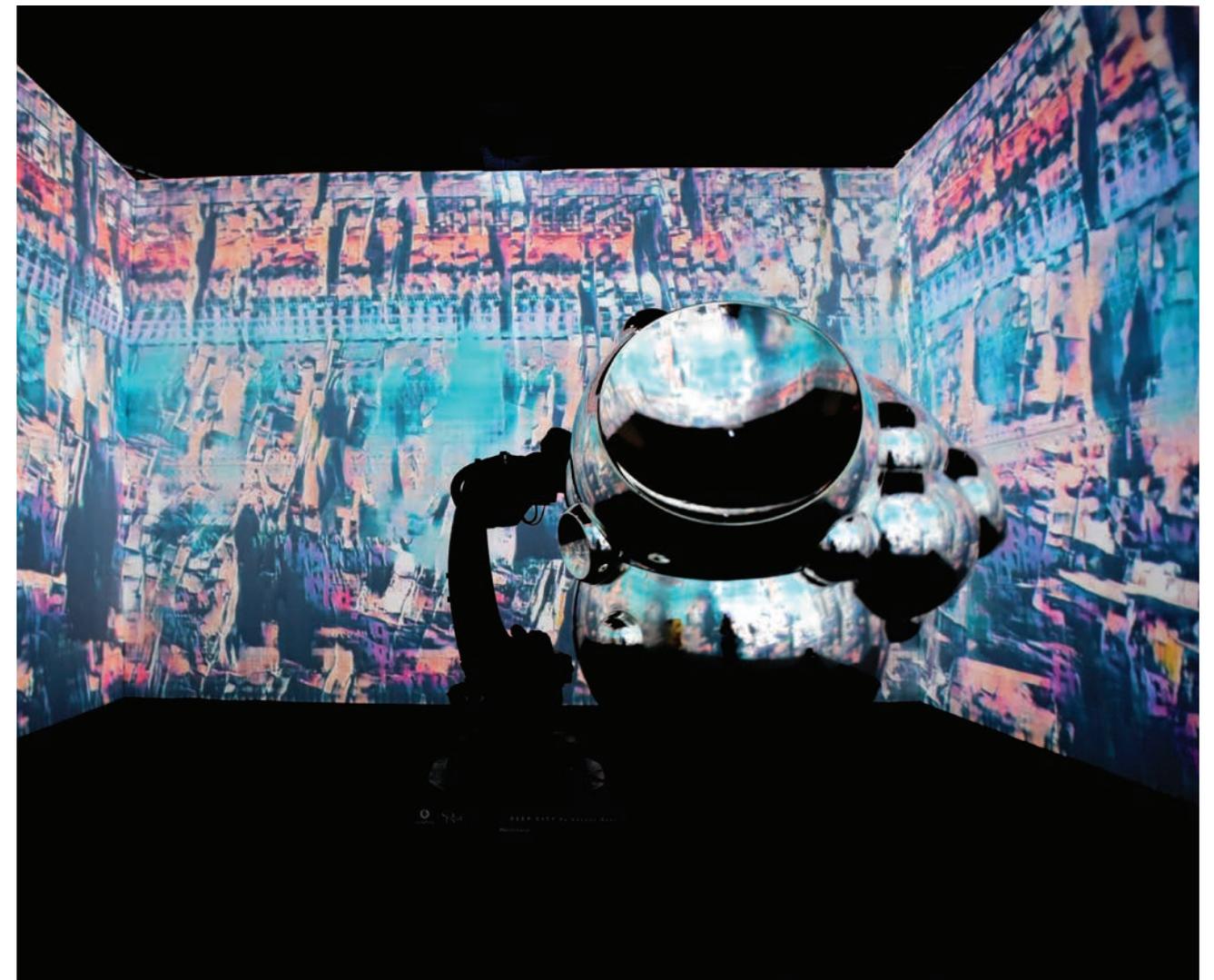
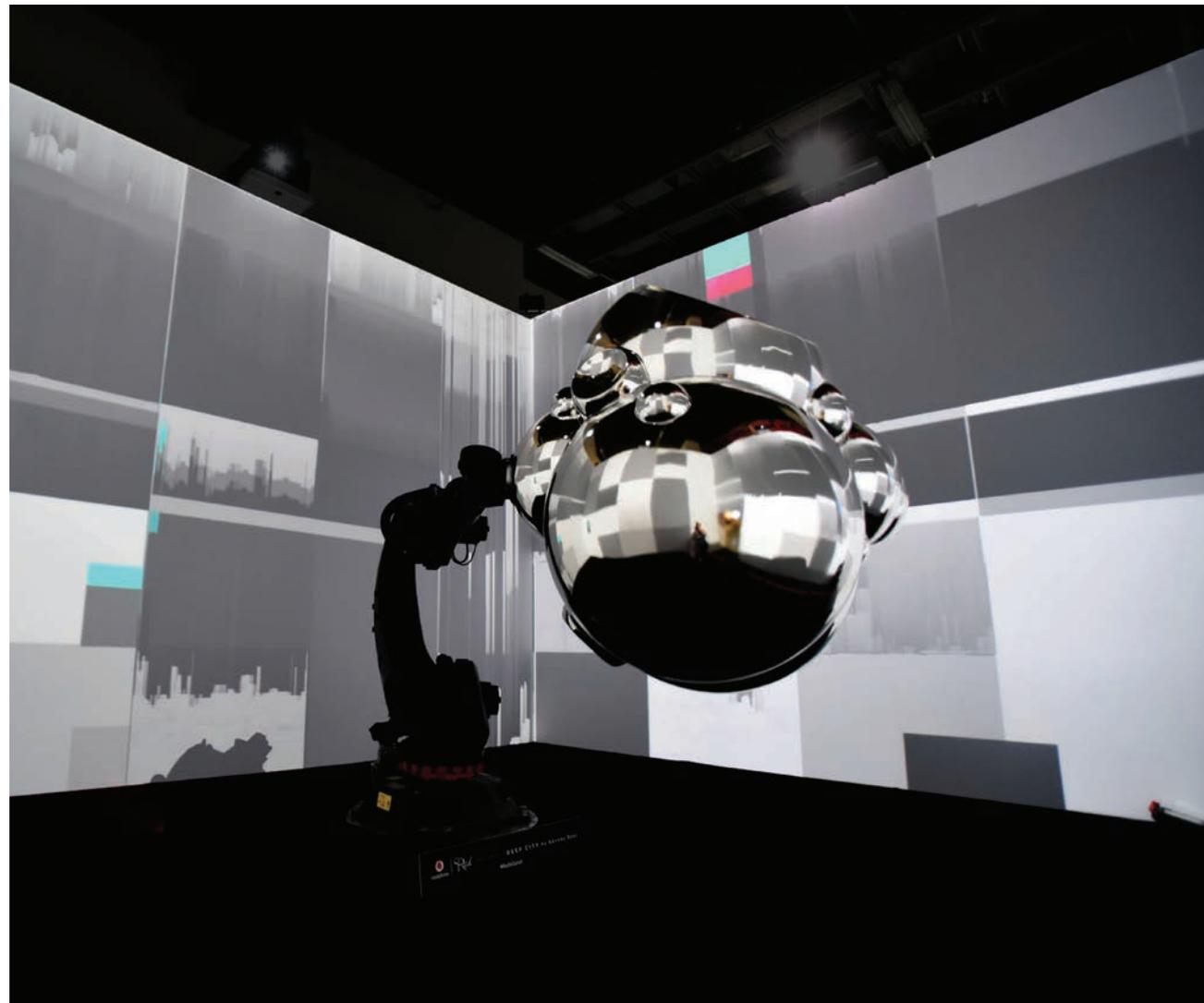


Figure 9: Deep City at the Contemporary Istanbul Art Fair, 2018. “Synthetic Panoramas,” or GAN-generated cityscape imagery as projected on the walls.

THE POST-DIGITAL AND ITS VARYING OBJECTS OF DESIRE

Contemporary sociology of technology refers to the “digital divide” as the gap of access to internet and other digital technologies in the human population. Determined by geography, political contexts, and other localized socioeconomic and ideological parameters, the “digital divide” might result in two contemporary societies with exceedingly hyperbolic trajectories. A similar kind of digital divide, this time by choice, is starting to materialize in architectural discourse within the context of the post-digital. The contested meaning of the term reflects two diverting ideological approaches toward what the role of technology should be in the ideation and construction of environments for human occupation. The contemporary challenges that automation, artificial intelligence, and extended reality pose on existing economic, social, and political structures are

unprecedented. Rather than hiding in the confines of disciplinary echo chambers, architecture’s current fight for survival requires an active and critical engagement with these ever-evolving techno-cultural forces.

This contemporary divide is perhaps the last cry of the heroic architect, a decaying stronghold of territorial individualism that has plagued creative production since the invention of architecture as a distinct discipline. This form of tribalism uses style as a way to divide and limit approaches to the particular confines of practice methodologies, seeking common ground with an exclusive few that have the luxury and interest to entertain theoretical priorities of bygone eras. For the rest of us, we need to march on to prepare for a future that might not need architecture as we have known it, a future where physical space might not even be necessary at all, let alone the biological bodies that are supposed to occupy it.