

Forecasting Nets

Visions for interactive architecture have existed for decades. However, the majority of the proposals, such as those produced by Archigram in the 1960s,¹ were meant to be *only* speculative. Very few projects, like *Inter-Action Center* in Kentish Town by Cedric Price, were materialized as physical and interactive architecture.² In many cases these provocative proposals relied on cybernetics and computing technologies to sense *user's* needs or desires and make the architecture adapt to them.

PAOLA ZELLNER-BASSETT

Virginia Tech

JOHN KNUTESON

Virginia Tech

THOMAS MARTIN

Virginia Tech

Responses were limited to the functional performance of a machine-like architecture, and were centered on the kinetic and mechanical adaptation of a flexible architecture toward a variety of uses, and comfort.

In spite of the architectural paradigm shift advocated for in these proposals at the time, the invitation to interact was more valued for its social and political impact than for the spatial experiences it could afford. Nowadays, the technology-savvy public (replacing the user) *expects* to interact and participate, is thirsty for information and effect, and seeks total involvement in the making of the work, the environment, and the resulting experience, actions that, as a consequence, are challenging established conceptions of space and architecture.

Rapidly developing computer technologies have become ubiquitous through myriad manifestations, deeply changing our societies and our contexts, and facilitating the pervasiveness of digital media. Social networks and instant communication, moving astounding volumes of data, have fundamentally changed the social disposition toward disclosure and exchange. The traditional boundaries between private and public realms have become soft and transparent, and the evanescent volumes of data have become the medium through which one experiences and sustains connectivity. As McLuhan states, “[t]he family circle has widened...[n]ow all the world’s a sage,” and the city participates in this shift.³ Promoting the percolation through the porous boundary, the home, the private “space for daydreaming,” populated by technology becomes virtually public, and the city becomes the urban *living room*.⁴ What was once the home TV has radically scaled up to match urban scales attaching itself to architecture, or to take the form of architectural digital surfaces; in one case (for example, Times Square) relegating architecture to a “support structure for corporate communication,”⁵

in the other, embedding media to activate and illuminate what has traditionally and for millennia been physically still, the wall, and as a result, creating what Thomas Schielke describes as “an astonishing hybrid between billboard and architecture.”⁶

Addressing current trends in architecture, Adam Caruso states that, “material innovation and new methods of production cannot lead directly to a new architecture.”⁷ What magnitude of change determines architecture as ‘new’ is unclear, yet, beyond the development of urban media facades, it is relevant to also consider the impact that the current ubiquity of media has on our daily lives. More than being accessory, they are deeply engrained in our habits and are therefore radically changing how we dwell. These changes, if not yet making a new architecture, are expanding the boundaries of architecture and the city.

Alternatively, Michael Fox and Miles Kemp encourage, “[a]rchitects, designers, and users to understand the foundations of the subject matter in order to extrapolate a vision of architecture to come,” and assure that, “[a]dvancement will only be accomplished when interactive architectural systems are addressed not primarily or singularly, but as an integral component of a larger vision that takes advantage of today’s pervasive, constantly unfolding, and far-reaching technology.”⁸

Although these technologies are already unquestionably established and embedded in architecture as systems for its efficient performance, the larger vision Fox and Kemp suggest may not yet have clearly emerged. Possibly because the focus, distant from the physically adaptive proposals of the 60s, is placed closer to “human emotion and human impulse,” than to what is an essential component of architecture: space.⁸ However, when these technologies are engaged as *ideas* of space, challenges intrinsic to that path of inquiry and related to the notion of *time* become evident. One of these generative challenges is the bridging of time scales from the centuries of architecture on one end, to the nanosecond of computing technology on the other, with the time scales of human perception—seconds, minutes, days—in between. Another challenge is the bridging of their disparate design life spans, which ranges from the desire for permanence in architecture to the immediate planned obsolescence in technology. Additional challenges with regards to time arise from processing, that is, the time required for reflection and assimilation of information or effect; and aesthetic opportunities that emerge from slowing technology down.⁹

The paper explores these questions, through temporary installations within media architecture, and will present *Nets 1.0*, one in a series of projects that aim to discover effective implementations of responsive technologies in architecture. *Nets 1.0*, is a long-term, interactive installation in the Moss Arts Center, in Blacksburg, VA. Although interactive installations are mediated environments and the terms may sometimes be used interchangeably, an installation is considered to be a “one-off exhibit fabricated in relation to the specific characteristics of a gallery space” that invites, in order to complete itself, the participation of the spectator in some manner and measure.¹⁰ *Nets 1.0* was designed in relation to the specific characteristics of the space and interweaves multiple scales (body, wall, space, building, city, planet, time) to enhance the pre-existing architectural condition. The work suggests an alternative form of interactive architecture, one that, beyond expressing or informing, aspires to intensify the experience of the *space* of architecture and to renew human connection to the physical environment.

The Moss Arts Center, designed by Snøhetta, is sited along the main entrance to Virginia Tech's campus and offers the side concrete wall of the fly tower for the performance hall to the town's Main Street. In front of it, the 62-foot tall by 51-foot wide glass facade encloses a ten-foot shallow service space appropriated for the interactive installation. The installation amplifies both the space and the pre-existing spatial phenomena (light and shadow) and, offering an alternative to human emotion or behavior used as input data, is animated by Blacksburg's weather live feed. Scheduled to open in 2015, *Nets 1.0* will be installed for one year. Fabrication is complete and has been tested through full mock-ups in preparation for the final installation.

THE LIVED EXPERIENCE

Dean MacCannell, defines *experience* as a short time span event where in response to the direct involvement with some data, an original lack transforms into a belief, feeling, or insight. He looks further into the subclass *cultural experiences*, and affirms that in order for them to occur two parts must be combined: a model and its influence; where a model is the embodiment of the spectacle, and its influence is the resulting belief or desire. He then adds that, "[a] medium is an agency that connects a model and its influence," in a seemingly neutral way.¹¹

In *Nets 1.0* weather is incorporated not as an end but as a means, as a *spatial* idea, and the implementation of responsive technologies searches with the visitor's interaction to increase contextual and environmental consciousness and heighten the awareness of the spatial experience. Following MacCannell's diagram several models and desired influences become manifest and are connected through the installation acting as the medium. The weather (model) and the increasing consciousness of global climate issues (influence) are one example. Others include the physical context (model) and the reawakened connection to it (influence), and space, both architectural and urban (model), and its enhanced perception (influence). Unlike the abundant amount of examples presented by various authors, (8) which are focused on the human senses and in sensing human behavior (therefore returning self-centered responses and privileging the constructed object), the project reclaims space as active and essential part of architecture and the city, and by augmenting its perception, consequently enhances the "lived experience."¹²

THE SPACE

"*Spaces*" was the first group installation show ever to occur in a museum setting, and was organized by curator Jennifer Licht for the Museum of Modern Art, 1969-1970.¹⁰ The theme, *Spaces*, a reference to NASA's accomplishments that year, was concerned with highlighting the importance of the *space* in installation work. Besides being a container for the art piece whose presence many artists until then attempted to efface, Licht presented space as integral to the art piece, not separate from it. Licht proposed that space be "considered as an active ingredient, not simply to be represented but to be shaped and characterized by the artist, and capable of involving and merging the viewer and art in a situation of greater scope and scale."¹³ The space occupied by *Nets 1.0* is challenging not only for its size and unusual proportions, but also for its impact on the existing urban condition. The newly constructed arts center exposes the brightly lit glazed space that reveals an empty seven flights of service stairs, contributing little to the streetscape. The building, deeply recessed from the sidewalk offers no public access from Main Street and is separated from it by a steep down grade to

allow for a loading dock. As a result of this moat-like configuration the sidewalk on Main Street is devoid of city life by the building, which offers only its side to it. The installation engages the height and prominence of this space to create an interface between the campus and the town proper.

Nets 1.0 could be considered a hybrid between an interactive installation and a media facade. It is located in an interior space without public access, yet provides a high degree of public exposure. As a result of the indirect physical interaction the design, responsive not to people but to scales of climate and weather, prompts the spectator to reflect and act.

Benefitting from the qualities and the scale of the space the installation acts as a 'deep' interactive facade activating the surrounding urban space. The effective space of the installation involves the street and the town. Due to its location and size the work is best engaged from the street and the sidewalk across Main Street, rather than from campus. Furthermore, the height of the space relative to the surrounding buildings, in addition to the topography of the town, give the installation visibility from several city blocks away, thereby extending its impact and strengthening its ties to the urban setting.

NETTING

String is described by Gottfried Semper as an "aesthetically neutral band and...[p]robably the oldest artistic product. It is the first actual manifestation of the sense of beauty striving to bring about the expression of unity through multiplicity, to combine it in eurythmic form." Paired with the string, Semper presents the knot as "perhaps the oldest technical symbol." Used to join strings, the knot "led to the invention of netting." He explains that the system "has the advantage that damage to one mesh does not affect the whole system and is easily mended. This is in fact the criterion of netting."¹⁴ Netting was selected as a construction method not only for the aesthetic qualities and performance as described by Semper, but also for the simple logic of assembly, and for the analogies it evokes with regard to society and the environment.

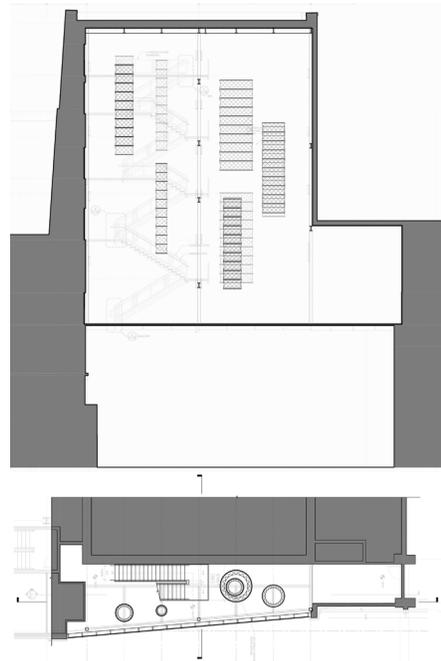
The dynamic construct consists of five 20-foot tall cylindrical netted volumes, ranging in diameter and net density to achieve a broad range of visual and interactive effects. Each suggested volume is shaped by a structure of rigid rings. The netting allows the cylinders to be read as a series of overlapping wire frames rather than independent volumes. This further contributes to the layering of space, adding the density of shadows cast on the wall beyond the nets to the density of the nets themselves.

The nets are constructed by hand. Individual strands of rope are joined with transparent cable-ties that are left intact to mark the intersection points, which are essential to the making of the net, and to allow the work to be understood at a smaller scale, the scale of the hand. The field of cable-ties alludes to the netted volume as a sensorial living organism, emphasizing the dynamic and symbiotic relationship between the object and space. The "cilia" evoke sensory receptors for external stimuli enhancing the responsive nature of the object.

Netting also suggests the social network and the connectivity between all things. Along with the communal aspect of the craft, animated by weather the project reminds us that climatic episodes occurring in isolated places affect, not only those point locations, but the system as a whole. For example, the melting of polar ice caps as a result of global temperature increase raises water levels



1



2

Figure 1: Installation space facing Main Street

Figure 2: Plan and section of the installation space showing nets in alternative positions



3



4

Figure 3: Nets casting wireframe-type shadows.
Full-scale final mockup

Figure 4: LED lighting changing color in response to atmospheric pressure. Full-scale final mockup

around the globe and equally impacts all coastal areas, not only ones that are directly geographically connected. Socially, networks have proven to be successful systems of survival. By raising awareness through creative work and tapping into social networks, communal awareness increases the likelihood of action and change. The fact that this process of netting is directly legible in the completed installation creates commonality between artist, constructor, and spectator alike; strengthening the social network with the presence of its physical counterpart, the augmented urban space for the community.

RESPONSE

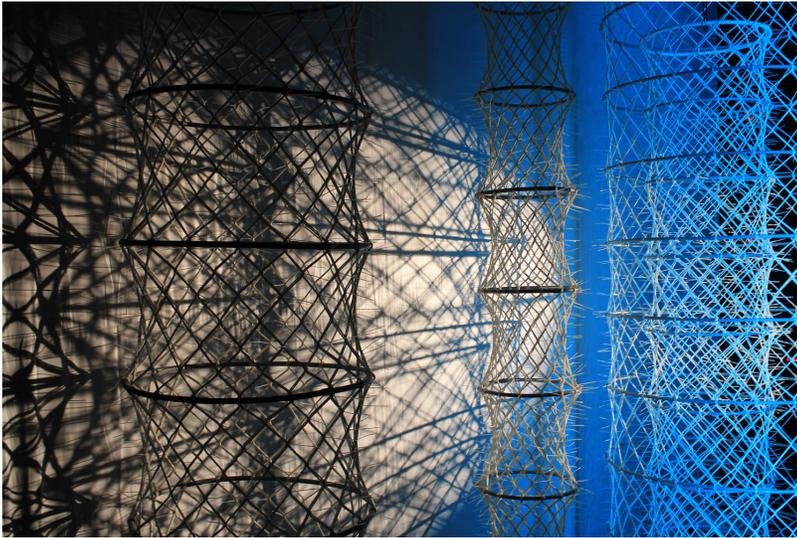
The physical response of the installation is determined by computation. The weather data feeds through code in a Raspberry Pi computer that actuates both the motors and the DMX controlled lights.

The work does not constitute a singular event but rather an ongoing and active part of the community, with different configurations throughout the day and the seasons. In the morning, the nets become evident by the sun casting shadows of the volumes on the back wall. The shadow is a product of the object and its context, highlighting both while manifesting the space between the nets and the back wall. During the intense light of early afternoon, the glass facade produces the strongest reflections, concealing the space behind it together with the nets, and mirroring live weather and urban conditions, the sky, the clouds, traffic, and the church across the street. These reflections give way to LEDs and flood lights in the evening, intensifying the shadow drawings on the back wall (an alternative to the morning monochromatic shadows cast by the sun), and illuminating the space to the street.

Color LED strip lights provide an even wash of color in the space that dynamically changes according to atmospheric pressure. Warm colors, red being the most extreme, indicate low pressure and appeal to a sense of alarm or urgency, with lower pressures usually indicating an approaching storm or precipitation. The cooler colors can be perceived as calm or temperate in conjunction with fair weather. In addition to the LEDs, four floodlights illuminate the individual volumes and vary in intensity in inverse relationship to the amount of daylight, recasting shadows.

Two of the netted cylinders are attached to individual motors, and travel vertically along the sixty feet of the space in response to humidity data. In order to ensure constant movement to emphasize the unusual verticality of the space, the rate of movement, rather than the position of the volume, is adjusted by the incoming weather data. As humidity increases and the air becomes more dense and palpable, the rate of movement decreases, as if the volumes were heavier, affected by the moisture in the air.

Usman Haque reflecting on the perceived objectivity of data and the apparent absence of bias in the manipulation of it says that, “[d]ata is not just “out there” waiting to be captured;” not unlike cartography, data is “crafted, collated and curated by someone” for a purpose.¹⁵ For *Nets 1.0* the selection of the weather data being collected is determined by the types of performance it can afford the installation space, where the desire to sustain constant gradual change needs to meet a level of unpredictability. Therefore temperature, perhaps the most expected weather characteristic, is avoided, and instead characteristics that give the region its capricious character are harvested: barometric pressure



5

and humidity. Physically present in this environment in the form of winds, fog, thunderstorms, snow, and ice, these conditions disrupt and affect daily routines enough to call attention to weather and overall climate trends, priming the public for one of the intended influences of the piece.

PRODUCTIVE SLOWNESS

Lars Hallnäs and Johan Redström, in *Slow Technology – Designing for Reflection*, describe calm technology and ambient displays as the technologies that “are designed to reside in the periphery of our attention, continuously providing us with contextual information without demanding a conscious effort on our behalf.” In the quest for implementations of these technologies in architecture this aspect is key. Architecture should allow the mind to engage on its dwelling rituals rather than occupying it with explicit interactive requests. The authors add that, “[e]xamples have been designed to allow for a smooth integration of digital information and physical space, taking advantage of human peripheral attention,” and this seems most feasible if “such technology is slow in nature.” It is important to clarify that the slowness the authors describe is not “in terms of time perception; it is a metaphorical distinction that has to do with time presence” within the experience; the inclusion of time as a design element that allows for reflection.¹⁶

Within this frame, the installation is conceived not as a performance of separate objects, but as an active reconfiguration and dynamic integration of space at numerous scales. These transformations, though constantly shifting, occur gradually, at almost imperceptible speed in contrast to the pace of the street, thus expanding the idea of a “performance” presented here as nuanced and embedded in the cityscape. The changes will be noticed only upon engaging the installation at one moment and returning to it, thereby entraining the work in the life of the town. A large number of interactive installations rely on momentary or short-term interaction, and offer a limited set of responses, as seen in several of the examples presented by Fox and Kemp.¹⁷ This project will remain installed for a year and requires incremental engagement over time, extending the idea of scale into the dimension of time, and inviting the presence of time into the experience. Prolonged, recurring engagement with it reflects the pace of change that occurs at the edges of human perception and is often dismissed. The installation seeks to bring awareness to phenomena, such as weather changes, that can

Figure 5: Increasing flood lighting effect in response to decreasing daylight, layering the nets with shadows. Full-scale final mockup

be overlooked as a trivial part of everyday life and the environment, but when transferred to the global context show the potential to drastically impact quality of life. Haque suggests that, “[t]he most important aspect of making data more meaningful is to experience it, somehow, in situ.” He explains that the availability of such experience is not limited to those who collect the data but, “by being near to where and when it was captured, you are far more likely to integrate all the unspoken, ambient, implicit, informal and unrecorded “metadata” that datasets and visualizations strip out for the sake of quantitative objectivity.”¹⁸ It is one of the expectations that the installation responding in situ to local weather will provide, beyond a cognitive perception of the issues, a more encompassing experience.

Similarly, Gaston Bachelard underlines the experience of space as essential in the full manifestation of space when he states that, “[i]nhabited space transcends geometrical space.”¹⁹ In the present context where the mind is actively engaged in hyper-connectivity, that feeds McLuhan’s “mass audience” with user-centered design, the experience of space requires higher definition, and the body sensing the physical space may not suffice anymore. For that reason the work strives for desirable ways in which the mind can be engaged, and contrary to the exponentially incremental stimuli of our present time that arrest our central attention, both slowness and peripheral nuance become essential.

Within media space, media façade, and media urbanism several examples have implemented weather or climate data as input to inform the response of the work. In *Weather Tower*, by LAB[au],²⁰ the façade of the Dexia Tower changes its color according to temperature readings, and its pattern display to represent wind or rain. The building affects its immediate urban space by flooding it with colored light, yet the instructive and literal rendition of weather does not allow “for a smooth integration of digital information and physical space.”²¹ The façade is clearly objectified, becoming an urban scale display of weather data, and requires the central attention of the passerby in reading and interpreting the information. In this regard *Nets 1.0* does not offer weather data, and is certainly not an urban scale weather application, but uses data to inform space and augment the experience of architecture. Rather than using architecture as scaffolding for the visualization of information, information is here *spatialized*, becoming a material component in the making of architecture. Where virtually any data can be spatialized, and the paper advocates for the exploration of spatialization as a means for the integration of data and responsive technologies into architecture, the particular choice of data ‘crafted, collated and curated’ should respond to the additional insight it can infuse the spatial experience with. Revisiting MacCannell’s diagram, climate and weather are the *model*, that through the *medium* of the interactive installation, aesthetically incorporates notions of time and weather change into architecture to imbue with them the qualities of space. The augmented perception of space is the *influence*, and the core architectural idea, which in this particular case seeks to revitalize a defective urban condition, while holding the potential to raise the awareness of our placement and role in the global environment.

Silo 468 Kruunuvuorenranta in Helsinki is another weather-informed project that activates the interior space of a disused silo located on the seaside. Similar to *Nets 1.0* the project shows stronger considerations toward its environment than *Weather Tower* does, by incorporating the sun in the design, coming through the field of small perforations in the wall, activating the interior space with the

patterns and spatial qualities of light and shadow. However, in the nighttime the silo distances itself from engaging the visitor's peripheral attention and draws instead the visitor's central attention to a field of LEDs on the interior surface of the silo displaying different patterns triggered by the prevailing winds that, "mimicking swarms of birds in flight," establish an indirect and metaphorical connection between the individual and the physical seaside environment.²² In spite of its beauty questions remain with regard to the potential for long-term engagement with the metaphoric scripted piece, and the abilities to "extrapolate a vision of architecture to come" from it, as prompted by Kemp and Fox.

Nets 1.0, aware of its long life span relative to other installations and responding to the research goals of exploring potential roles for responsive technologies in the enhancement of architectural environments, slows down. It does not offer groundbreaking technological insight, but with the focus on architecture and urban space offers a direction toward slowness and optimization of the media, to counteract the trending proliferation and exuberance of it. The slow speed and low rate of change within the installation intend to engage the community in peripheral ways during its daily rituals. Instead of soliciting personal interactions in a space of "play," which often results in the disconnection of the individual from the context (time and space), the installation aspires to strengthen the connection of the individual to a broader context, that bridges the local, immediate site and the global context.

Approaching responsive and interactive technologies from this perspective puts into question the perceived inability for these technologies to lead directly to a new architecture, as mentioned by Caruso.²³ Possibilities for media architecture are many. These technologies can certainly continue to find new implementations to greatly affect, inform, and augment our cities, our personal spaces and, to an even greater degree, our experiences of them.

ACKNOWLEDGEMENTS

The concept for the installation was developed in the course *Textile Space*, taught by Paola Zellner (School of Architecture + Design), in collaboration with *Introduction to Physical Computing*, taught by Dr. Tom Martin (Electrical and Computer Engineering). We would like to thank the students involved in the installation: Jesus Barney, Adam Burke, Trey Hoffman, John Knuteson, Nathan Artis, Camila Paggi, Saron Iasu, Kelsey Margulies, Sarah Rege, Joanna Cofer, Nikole Seavey, Matt Young, Brian Heller, Susanna Bradley, Matt Bock, Ari Horowitz, Justin Johnson, Kevin Kays, Evan Spillane. The work was supported by the Institute for Creativity, Arts, and Technology. We also wish to thank John Seminatore, Doug Witney, Ruth Waalkes, and Ben Knapp for their help in making the installation possible.

ENDNOTES

1. Cook, P. 1999. *Archigram*. New York, NY: Princeton Architectural Press.
2. Mathews, S. 2007. *From Agit Prop to Free Space: The Architecture of Cedric Price*. London, UK: Black Dog Publishing.
3. McLuhan, M., Fiore, Q. 2001. *The Medium is the Massage: An Inventory of Effects*. Corte Madera, CA: Gingko Press.
4. Bachelard, G. 1969. *The Poetics of Space*. Boston, MA: Beacon Press.
5. Ratti, C., Claudel, M., "The Disappearance of Times Square: From stone to billboard to smartphone", *Architecture and Urbanism*, 2014:11, No.530.
6. Schielke, T., "Urban Data as Light -- From Sensor-Driven Media Facades To Data Communication Through Visual Light", *Architecture and Urbanism*, 2014:11, No.530.
7. Caruso, A. 2008. *The Feeling of Things*. Barcelona: Ediciones Polígrafa.
8. Fox, M., Kemp, M. 2009. *Interactive Architecture*. New York, NY: Princeton Architectural Press.
9. Hallnäs, L., & Redström, J. (2001). Slow technology—designing for reflection. *Personal and ubiquitous computing*, 5(3)
10. Reiss, J. 2001. *From Margin to Center: the spaces of installation art*. Cambridge, MA: MIT Press.
11. MacCannell, D. 1999. *The Tourist: A new theory of the leisure class*. Berkeley, CA: University of California Press.
12. Leach, N. 1999. *The Anaesthetics of Architecture*. Cambridge, MA: MIT Press.
13. "Audience Information of SPACES Exhibition," press release, 15 December 1969. New York, NY: Museum of Modern Art library.
14. Semper, G., Mallgrave, H., and Robinson, M. 2004. *Style in the Technical and Tectonic Arts, or, Practical Aesthetics*. Los Angeles, CA: Getty Research Institute.
15. Haque, U., "Making Data, Making Sense", *Architecture and Urbanism*, 2014:11, No.530.
16. <http://www.mediaarchitecture.org/silo-468-kruunuvuorenranta-winner-mab12/category-of-media-facade/media-urbanism>.
17. Hallnäs, L., & Redström, J. (2001). Slow technology—designing for reflection. *Personal and ubiquitous computing*, 5(3)
18. Haque, U., "Making Data, Making Sense", *Architecture and Urbanism*, 2014:11, No.530.
19. Fox, M., Kemp, M. 2009. *Interactive Architecture*. New York, NY: Princeton Architectural Press.
20. Bachelard, G. 1969. *The Poetics of Space*. Boston, MA: Beacon Press.
21. Fox, M., Kemp, M. 2009. *Interactive Architecture*. New York, NY: Princeton Architectural Press.
22. Hallnäs, L., & Redström, J. (2001). Slow technology—designing for reflection. *Personal and ubiquitous computing*, 5(3)
23. <http://www.mediaarchitecture.org/silo-468-kruunuvuorenranta-winner-mab12/category-of-media-facade/media-urbanism>.
24. Caruso, A. 2008. *The Feeling of Things*. Barcelona: Ediciones Polígrafa.