SITE-RESPONSIVE. CRITICAL OF THE INTERACTIVE ENVIRONMENTS IN EXHIBITION DESIGN

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INTRODUCTION

With reference to the conference topics, this paper analyzes the emotive, perceptive and social effects of technology in the space dimension, referring both to design practices and user experiences. The aim is to suggest new design scenarios able to contextualize the exhibition design in the contemporary scenario.

For this purpose, examples of "interactive architecture"[1] are analyzed in order to extrapolate exhibition practices and strategies that include the communicative and educational component in experiences where users use their bodies in space. This implies: acknowledging the emotional, communicative and adaptive possibilities of interactive environments; assuming that the design of the exhibition space is oriented to the integration of advanced technologies – tangible and intangible – so that it is necessary to understand the importance of data and their multiple nature, according to a heterogeneous users that interact with a performative environment, which can make their experience unique.

This vital ability requires a level of phenomenological and design complexity that obliges designers to reflect on the meaning of our social nature and the mutable relationship with the world mediated by technology.

DESIGN OF INTERACTIVE SPACES

In complex interactive space design, digital technologies are adapted to an architectural vision and therefore various disciplines converge, such as Architecture, Interaction Design (ID), Human-Computer Interaction (HCI), User Experience (UX).

Using the concepts of space to look at user experience allows us not to split up the experience in terms of humans, computers and their interactions but to look at it as a totality and to think of people as being in social and technological environments. In this way, as David Benyon recalls, "*we look at user experience as a whole and interaction design as the design for those experiences*"[2].

Accordingly, designing interactive spaces requires an involvement with neuroscience, cognitive psychology and behavior, gestalt psychology and sociology. Knowing the processes that are the basis of the functioning of mirror neurons – which allow us to empathize with other people and the environment – is essential in the design of artefacts that are created to interface people, spaces and information.

The architectural environment has become inextricably linked to technological trends. Interactive architecture projects, where datasets are motors of buildings and environments, are based on a series of data that are perceived and then translated to the inhabitants, with different purposes, by providing new forms of sensorial, motor and spatial interaction[3]. These structures show real-time behaviour according to local and global changes caused by users. Each element of the system is a potential transmitter and receiver of data – in input – which is processed to give back – in output – an ever-shifting configuration of itself.

In the beginning of the 1970s, the sociologist Ivan Illich in *Tools for Conviviality* highlights the ability of objects to generate favorable conditions for the acquisition of information and social interaction or to obstruct it, but questions the possibilities that the industrial production system could fully satisfy cultural needs.

In the 1980s, Lucius Burckhardt[4] observed that all kinds of artifacts, even industrial ones, cannot be considered neutral, because they manifest the intentions of the designers, the companies that produce them, and the users who condition their relationships and behaviour. The design of artifacts and their related services consciously considers the overall invisible system composed of material and immaterial relations.

In the same years, the integration of electronics and information technology starts to give objects a smart dimension, opening up the prospect of interaction design in which artifacts – that previously were inert and "opaque" – acquire the capacity to perceive and react with people and to mediate interactions between people and environment.

This is a perspective, that following digital development, has evolved over the last decade into the "Internet of Things" (IoT), whereby objects provided with sensors and actuators capture messages, data and information from people and transfer them to other people via network. The result is a complex relational infrastructure with rich potential. Extending Ivan Illich's vision, this is a way to generate a parallel, digital and global culture.

IoT is now affordable to be integrated and connected to spatial design to help create hybrid and connected environments.

The design of these spaces has changed a great deal over the past decade and has found applications at several intervention scales by proposing different adaptations: some analogue, some digital; some audio-visual, some kinetic. It involves a variety of changing conditions, which include environmental changes, such as temperature, daylight, wind and sea, human behaviour (physiological including)[5].

CASE HISTORY

The case histories discussed in this essay have been selected for their exhibition character, not necessarily voluntary. Their common elements are engagement and performativity – essential aspects of contemporary exhibition design. At present, exhibition practices tend to significantly increase the process of user engagement, most often using interactive devices and systems.

This is an experience perspective that places the body at the centre of the use project and considers it, in relation to other bodies and to the space/time relationship: actor, communication and performance tool, education and learning tool, social relations vehicle, contexts appropriation tool[6].

The corporeal dimension consequently introduces the performative one[7]. The significance of this implication is underlined by David Dernie: "*performativity is one of the most significant developments in contemporary exhibition design as it goes beyond exhibition semiotics to develop the notion of experience design. Because of the fundamental function of the body in communication and learning in the performing space, new methods of interaction are introduced: the body and its movements within*

the exhibition represent a vital interface between the content of the exhibitions and the personal associations established by the visitor. The visit becomes an encounter with the body in motion, a space of events"[8].

Performative methods and tools are not limited to a specific technology. Performative design, in fact, is characterized by a spectrum of interactive possibilities and methods of engaging visitors, who are invited to establish new ways of interacting with the exhibited artifacts, with the spatial layout or with other visitors.

Observation of the following examples suggests three design scenarios that introduce different exhibit design thematics. These are identified by looking at spatial interaction and are: Interact to adapt; Interact to explore; Interact to visualize.

Interact to Adapt: Cupra's Booth

The first example is the Cupra's booth - a Spanish automotive company - by Leva and TODO studios at the eighty-eighth Geneva International Motor Show (2018).

The 139 "petals" that make up the kinetic wall are based on Kinect sensing and can move simultaneously to open dynamic "windows" in order to show users what is on display behind the wall (Figure 1).

The movement of the petals is output to the stimulus received as input from the Kinect system. This result is the outcome of the interaction between the user, who acts on the sensors, and the wall, which changes its configuration according to the input received.

The company's goal was not only to use an interactive installation to communicate the technological identity of its brand, but also to attract as many visitors to the event as possible[9].

This installation, related to the fair scenario, brings out two fundamental exhibition design issues that are common in many exhibition contexts: engagement and spatial adaptation.

Trade fairs are in most part alienating events in which it is difficult to find one's way around, also because of the planimetric division of the booths – linked to the sale of space – which does not make it easy to recognise the individual booths and the transitional space. This is not always overcome by signs or graphics therefore it is often difficult to recognise the stands from one another. This, combined with the difficulty of managing lighting and acoustic comfort, makes users easily get lost and tired. Another aspect to consider when designing a fair stand is the difficulty dictated by the confines of your booth, which are very often violated by adjacent companies that display their logos more visibly.

In this sense the Cupra's booth successfully engages visitors through the playful and participative dimension, creating a moment of entertainment beyond the confines of its stand (Figure 2).

Engagement is a common practice especially in the public sphere. Art installations such as sculptures, fountains and facades adopt interaction as a vital component, inherent in the artworks, to capture passers-by's attention.

The use of spatial interaction can also be understood with respect to the needs of presentation and display of expositions and artifacts in other contexts in order to re-materialize the "frame" that has become an interface. Moreover, as Michael Fox points out, this kind of spatial optimization based on the combination of interaction and spatial adaptation is "*means for adjusting three-dimensional configurations according to the changing situations of both users and programmatic considerations*"[10]. This feature can be useful both to the temporal and ephemeral character of exhibitions – thus of their change – and to the interaction of visitors with them.

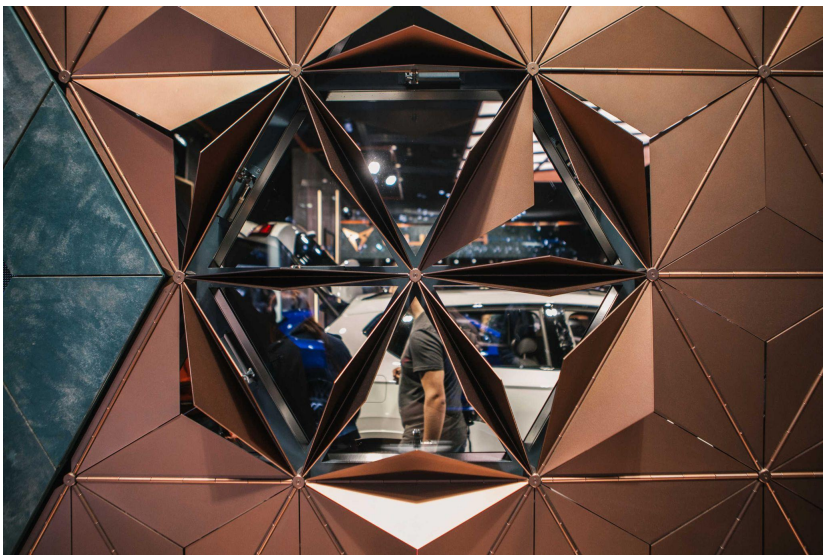

Figure 1. Stand Cupra, 2018. Kinetic variations generate "windows" and "frames". https://www.leva.io/projects/kinetic-wall.

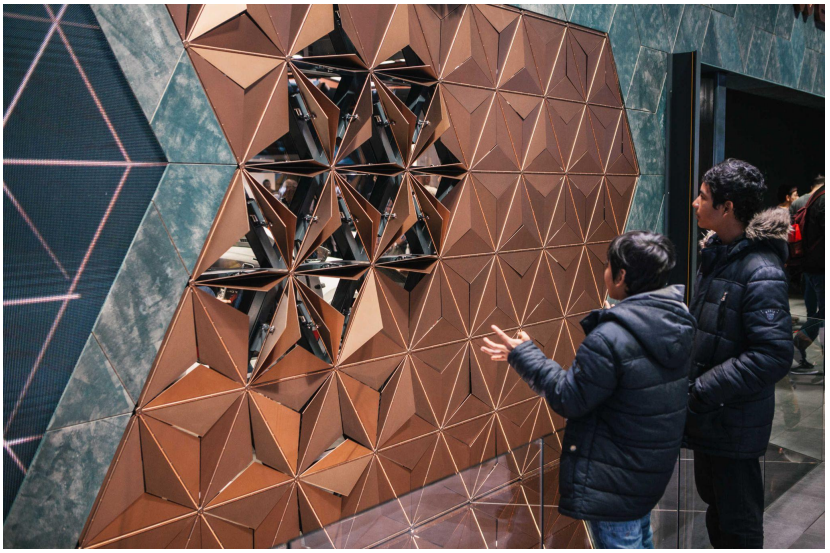

Figure 2. Cupra's Booth, 2018. Visitors interact with the kinetic wall from the fair hall aisle. https://www.leva.io/projects/kinetic-wall.

Interact to Explore: *Edge of Chaos*

Edge of Chaos is an interactive art installation, curated by Vasilija Abramovic & Ruairi Glynn[11], originally designed to understand the phenomenon of avalanches and the crystallization of liquids and inspired by the science of complexity.

Narratively, the authors describe the space as composed of three features: "*at its center, a kinetic tree that represents "Life" (the peak of the Edge of Chaos). It is surrounded by an inert "Cloud" representing the vast unorganized matter of an entropic universe (Chaos), and between them an interactive surface that represents the "Edge of Chaos*""[12].

The structure around the installation consists of five hundred items, four hundred of which are static and one hundred active, animated by servomotors and RGB LEDs representing the basic unit blocks of our chaotic universe. The surface - controlled by a custom Cellular Automata (CA) system - is powered by ultrasonic proximity sensors and is activated by local user interactions that trigger chain reactions through the surface. Depending on the level of interaction and the existing state of the

surface, it produces more ordered patterns or more chaotic sequences of kinetic transformations and chromatic variations (Figures 4 and 5). Increased movement triggers the tree of life performing a "choreography" complemented by light and sound. The sound, integrated in the tree, follows the chaos and order phases during the performance and improves the supernatural atmosphere.

Edge of Chaos makes the science of complexity tangible by showing its behaviors using sound, light and robotic motions, encouraging playful exploration and bringing out questions about the order of the universe[13].

This example allows us to reflect on the questions of emotional engagement and multi-sensorial exploration of phenomena.

These are themes profoundly linked to the performative exhibitions, in particular to the science centres. Still today, as Luca Peressut writes in *Museologia Scientifica Memorie*: "*the exhibition features of today's science centres are still focused on the experience-interpretation relationship that is activated during the demonstration or interactive action, by which an emotional and empathic impact is created on the visitors' multi-sensory perception*"[14].

Science museums are often places that allow visitors direct experience and physical engagement with phenomena to enable exploration and discovery in a collaborative dimension; examples are numerous of exhibitions in the physical, biological and social sciences asking visitors to interact with "hands-on" exhibits and digital interactions to learn scientific principles.

However, the use of the exhibit is often an end in itself and the flow of information is one-way and ineffective as a result of the very short time it is used. Moreover, they are usually intended for a school age group and therefore exclude a large target group.

In this sense, the *Edge of Chaos* experience seems to be functional in responding to these needs: the immersive and multi-sensorial quality of this interaction allows for a two-way communication between people and the environment and allows children and adults to learn by being conscious of the experience.

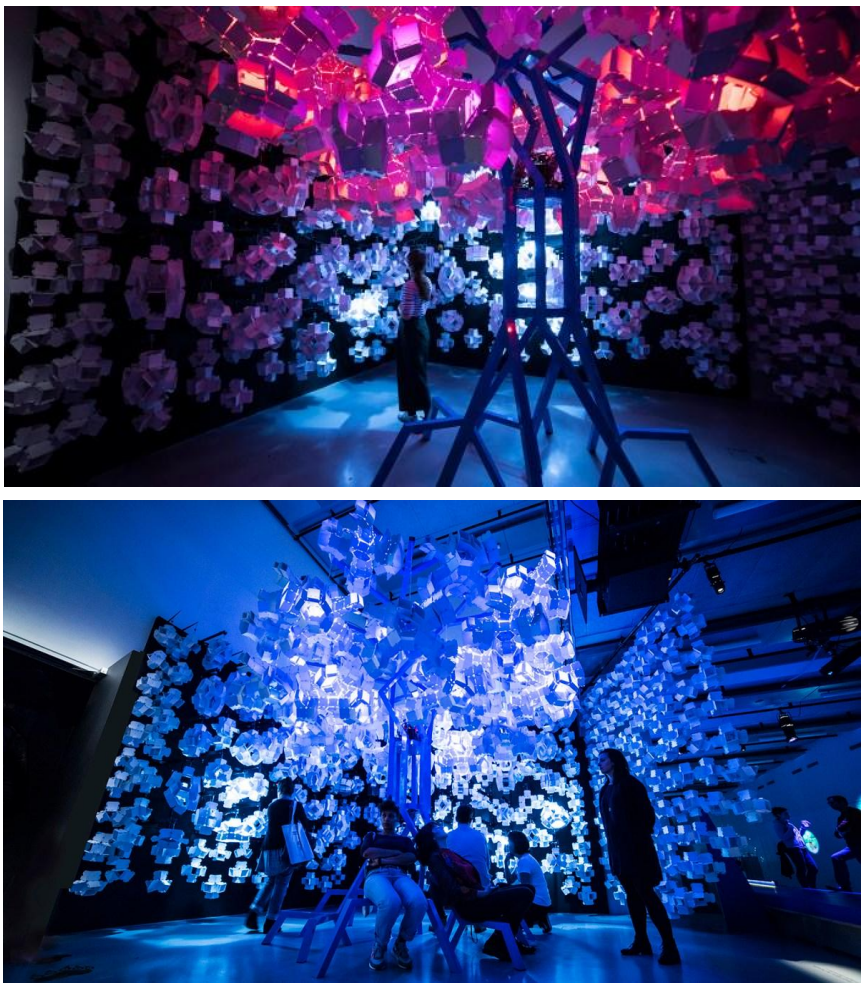

Figure 3 and Figure 4. "Edge of Chaos", 2018. Interaction with visitors triggers kinetic and lighting changes that generate an immersive experience. http://www.interactivearchitecture.org/lab-projects/edge-of-chaos.

Interact to Visualise Data: *Living Light*

Living Light by architects David Benjamin and Soo-in Yang[15] is a pavilion - permanently installed in Seoul (South Korea) in 2009 - that displays a dynamic "skin" that lights up in response to both air quality data and public interest in the environment. The Korean Ministry of Environment operates air monitoring stations which send air quality information to the pavilion in real time (Figure 5).

The pavilion is a reactive "gazebo" with a roof consisting of twenty-seven panels, each representing a district of the city. Each panel lights up if the air in the district is better than last year. Every hour the map darkens and the neighbourhoods light up according to the current improved air quality. Finally, citizens can request air quality reports via SMS and by using the postcode, the panels flash each time they are sent to pinpoint the request location on the map.

Conceptually, this pavilion served as a prototype for a building façade displaying information about the city's environment. Many buildings in Seoul are already illuminated at night by large billboards and the *Living Light* project suggests a façade that makes citizens more aware of pollution, the consequences of consumerism and environmental issues[16].

This example allows us to reflect on three issues related to contemporary exhibition design: engaging to raise awareness, narrating data and using devices for interaction.

Living Light, like the above example, highlights the possibilities of interactive spaces to translate and make very large or very small phenomena, information and concepts more accessible from real-time data collection, or data archives, engaging the public in an interactive and participative use.
In exhibition situations where data and information are displayed – and therefore the narrative subject is the visible representation of the non-visible obtained by conceptual transference actions – a problem often emerges regarding the relationship between scientific precision and making the data understandable to the public. In this sense, more accurate representations are targeted at a specific audience to show data related to an explicit topic while representations that simplify content are targeted at a wider audience and the data visualization can be more open and attract attention to a problem.
The aim of an exhibition is to help users understand the data behind phenomena so as to encourage not only investigation of the specific subject matter but, above all, critical interpretation and productive questioning by illustrating methods and results of research processes.
The use of a support device – as shown in the example by the sending of the text message – suggests another way of interacting with the environment. On the one hand, the user contributes to the data collection and on the other hand, the installation provides access to contributions that would otherwise be unknown[17].

Figure 5. "Living Light", 2009. http://www.thelivingnewyork.com/index.html.

CONCLUSION

The case studies and design experimentation described demonstrate how interactive architecture can communicate information, about objects, phenomena and behaviours, by interacting with groups of users, although not with an exhibition purpose – even if placed in exhibition spaces, as in the first two cases, they are still independent elements. Many of them incorporate an educational component in which kinaesthetic learning is combined with entertainment experiences; they allow for data visualization and subsequent learning; they engage users; they stimulate reflection; they display objects as showcases.
In the contemporary museum scenario, the technologies most commonly used for this purpose are usually multimedia video installations sometimes augmented by digital interactions. Furthermore, the use of technology can offer the user customized experiences. Using Rfid, Nfc, QR-code reading and 3D models, guides are digitized to give visitors a new way of orientation. In addition, technologies

such as Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (VR) offer additional content and immersive, interactive visitor experiences.
These design experiences are configured through de-materialization that is to say an instrumental reduction of the display in preference to the electronic medium which becomes the narrative system. Digital technologies take exhibition systems towards an intangible virtual dimension in which space is a metaphor for UX.
Instead, this contribution suggests a use of digital technology linked to materiality to identify the possibility of designing "*Places for experience*"[18] in which digital technologies do not reduce space materiality but adapt to an architectural vision. As previously introduced, thinking in spatial terms allows us to look at the user experience from a different perspective. Already Paul Dourish at the end of the last century identified in "*Tangible Computing*"[19] an area of research aimed at bringing the interactive interface off the screen, in the real world.
This is an approach that supports the association of motion and sensorial engagement with understanding and perception and so it is profoundly related to the concept of "*embodiment*" and that is, that the creation and sharing of meaning is happening through interaction with an artifact.
"*Embodiment*" is the set of physical, social and cultural phenomena that happen around us at a specific time and in which we interact with each other, with technology and with other species[20] and then, as Harry F. Mallgrave writes, "*we are organisms within environments that continuously evolve and self-organize and relationships between mind, body and matter configures our cognitive understanding of the world*"[21].
In this regard, it is useful to explore new design scenarios starting from the identified exhibition concepts – that are only briefly mentioned in this paper.
Interactive architecture at the exhibition scale makes it possible to re-read the relationships between object/concept, place and user that converge and join in the contemporary combination of exhibition-communication – which is becoming unitary in the medium and in the message – so that it does not become subject to that instrumental reduction which is driving the exhibition space to become a "*black-box*"[22].

NOTES

[1] See Michael Fox, ed., *Interactive Architecture: Adaptive World* (Chronicle Books, 2016).
[2] David Benyon, *Spaces of Interaction, Places for Experience* (John M. Carroll, 2014), 1.
[3] See Michael Fox, ed., *Introduction to Interactive Architecture: Adaptive World* (Chronicle Books, 2016).
[4] See Lucius Burckhardt, "Design ist unsichtbar", in *Design ist unsichtbar. Publikation anlässlich der Ausstellung Forum Design*, ed. Helmuth Gsöllpointer et al. (1981), 211-217.
[5] See Nils Jäger, Holger Schnadelbach and Hale Holger, "Embodied Interactions with Adaptive Architecture", in *Architecture and Interaction*, Nicholas S. Dalton (Springer, 2016), 186.
[6] See Raffaella Trocchianesi, "Nuove prossemiche museali e culturali. Corpi, gesti, relazioni, comportamenti/New Museum and Cultural Heritage Proxemics. Bodies, Gestures, Relationships, Behaviour", in *Design & Cultural Heritage. Immateriale Virtuale Interattivo/Intangible Virtual Interactive*, Fulvio Irace (Jumpstart request for Mondadori Libri Electa Trade, 2014), 115.
[7] The performative approach is applied in several exhibition scopes: projects for educational tools where importance is attributed to the relationship between learning and playing – many applications can be observed in scientific museology; spaces developed by interactive software that encourage reflection on contents – more used in high narrative contexts.
[8] David Dernie, *Exhibition Design*. (Laurence King Publishing, 2006), 46. Translated by authors.
[9] See Sandra G.L. Persiani, "Design of Autoreaction, Case Studies", in *Design of Autoreaction*, ed Sandra G.L. Persiani (Springer, 2020), 157-192; see "Kinetic Wall", Leva, accessed August 19, 2021, https://www.leva.io/projects/kinetic-wall.

[10] See Michael Fox, “Mediate”, in *Interactive Architecture: Adaptive World*, Michael Fox, ed. (Chronicle Books, 2016).
[11] The art installation is designed in partnership by artists Vasilija Abramovic & Ruairi Glynn (Interactive Architecture Lab, Bartlett UCL) and scientist Bas Overvelde (AMOLF/Studio Overvelde) and was exhibited throughout 2018 at La Gaîté Lyrique gallery in Paris, KIKK Festival in Namur, and Cinekid Festival in Amsterdam.
[12] Ruari Glynn, Vasilija Abramovic and Johannes T.B. Overvelde, “Edge of chaos: Towards Intelligent Architecture Through Distributed Control Systems Based on Cellular Automata”, in *Recalibration on Imprecision and Infidelity-Proceedings of the 38th Annual Conference of the Association for Computer Aided Design in Architecture* (ACADIA, 2018), 228.
[13] See “Edge of Chaos”, Interactive Architecture Lab, accessed August 19, 2021, http://www.interactivearchitecture.org/lab-projects/edge-of-chaos.
[14] Luca B. Peressut, “Musei scientifici e science center: la comunicazione fra architettura e allestimento”, *Museologia Scientifica Memorie* 8 (2011): 124. Translated by authors.
[15] Aka The Living. See “The Living New York”, accessed August 19, 2021, http://www.thelivingnewyork.com/index.html.
[16] See Marcella del Signore and Gernot Riether, *Urban Machines: Public Space in a Digital Culture* (ListLab, 2018), 134-141; see “Living Light” Interactive Architecture Lab, accessed August 19, 2021, http://www.interactivearchitecture.org/living-light-2.html; see The Living New York, accessed August 19, 2021, http://www.thelivingnewyork.com/index.html.
[17] Currently in museums, extra devices are often used to support the fruition of augmented and virtual contents accessible by Rfid, Nfc, the reading of markers such as QR-codes or by scanning pre-mapped objects. This approach frees the communicative system from the exhibit, allowing the information to be reached and systematized on multiple levels in order to reach many different audiences by means of direct and personal questioning and consulting the objects/concepts.
[18] See David Benyon, “Places for Experience” in *Spaces of Interaction, Places for Experience*, David Benyon (John M. Carroll, 2014), 97-101.
[19] Paul Dourish, *Embodied Interaction: Exploring the Foundations of a New Approach to HCI* (Unpublished paper, 1999), 8. accessed August 19, 2021, http://www. ics. uci. edu/~ jpd/publications/misc/embodied. pdf.
[20] See Paul Dourish, *Where the Action is: the Foundations of Embodied Interaction* (MIT press, 2004), 16.
[21] Harry F. Mallgrave, *Empatia degli spazi: architettura e neuroscienze* (Cortina, 2015), 12. Translated by authors.
[22] See Marco Borsotti, *Tutto si può narrare. Riflessioni critiche sul progetto di allestimento* (Mimesis, 2017), 15.

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