The monographic issue describes design as inventor through narratives, illustrations of approaches and experiments. It is a mapping of the design culture useful to decipher the complexity of design, explore the boundaries and draw the possible lines of evolution.
Thinking, inventing and producing: reality - the physical and psychological world - becomes material for continuous investigation and interpretation.
In order to arrive at innovative results the research of design "disrupts to reformulate", through the propensity to re-discuss established paradigms, methods and schemes.
The orientation towards experimentation and the tendency towards disciplinary contamination allow the design to be defined as a "privileged place" not only for engineering invention, but also for the search for new behaviours, new material and sensorial universes which are capable of reformulating in a new and radical way the relations between man and artifacts.

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Index

Editorial
Alessandro Mendini > Tonino Paris 4

Think
The design of the invention > Mario Buono 20
Design, ingenuity, and imagination > Sabrina Lucibello 28
Design between invention, interpretation, translation > Lucia Pietroni 38
Futurecraft: Design as Mutagen and Inventor > Carlo Ratti 46

Think gallery > Extra-ordinary > Francesca La Rocca 54

Make
Sound in design: a new disciplinary sub-field? > Doriana Dal Palù, Claudia De Giorgi 70
Hacking Meanings.Innovation as Everyday Invention
> Umberto Tolino, Ilaria Mariani 78
Re-think through and for the senses. Growing design and design with materials
> Lorena Trebbi 86
Methods, phenomena and performative inventions > Renata Valente 94

Make gallery > Inventing materials and processes > Sonia Capece 102

Focus
The importance of being human > Andrea Di Salvo, Paolo Tamborrini 118
Office Landscape between avant-garde and tradition > Caterina Cristina Fiorentino 126
Sharing and creative contaminations in the London melting pot > Anna Gallo 134
Videogames on design: key elements of restrained creativity > Isabella Patti 142
The invention in everyday life > Viviana Trapani 150

Focus gallery > Inventions, interactions, bodies > Chiara Scarpitti 158

Maestri
Pierre Chareau. La Maison de Verre > Tonino Paris 172

Maestri gallery > 184

Make

Sound in design: a new disciplinary sub-field?
Doriana dal Palù, Claudia De Giorgi

Hacking Meanings.Innovation as Everyday Invention
Umberto Tolino, Ilaria Mariani

Re-think through and for the senses.
Growing design and design with materials
Lorena Trebbi

Methods, phenomena and performative inventions
Renata Valente

Make gallery > p.102/p.115

Hacking Meanings. Innovation as everyday invention

In a context where technology is growing ubiquitous, human and graspable, Thingk embraces the challenge of transforming simple and archetypical objects by technologically augmenting them. Seeking for primitive, geometric forms with advanced and smart functions, the startup follows an innovation of meaning that goes through hacking the meaning of apparently basic and minimal artefacts, making them "everyday objects with superpowers".
In the following we explore how such innovation, which starts with acting on aesthetics, affects the interface (UI), and impacts on the user experience (UX), influences the entire design process. In particular, we discuss the design-driven innovation, and how it benefits from revolving around the many opportunities and challenges that come from questioning some design conventions by including innovation as the ability to make the unexpected a driving force.
We focus in particular on data and end-users as sources of knowledge and innovation, as well as on technological variation as potentialities for experimenting and improving. From combining technological breakthroughs and design opportunities aiming at responding to contemporary and future market trends, to including interdisciplinary knowledge and expertise from Design, Engineering, and Marketing, to the identification of a community of practice and the involvement of prosumers in the co-design: each step of the process is unpacked, highlighting its design implications. As a result, the designer is no longer just an inventor and innovator, but also a researcher, interpreter, and entrepreneur.

[design process, design-driven innovation, smart objects, user experience, affordances]

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Technology is transforming everything. Between its advances and disruptions, the ongoing digital transformation is changing our industries, reshaping users (Turkle, 2017), and also the design processes. It is growing ubiquitous and increasingly pervasive (Kuniavski, 2010), but also human, enabling, and graspable, making contemporary products smarter, embedding sensors, network capacity, processing and computational power (Anderson, 2012). This feeds the development of interactive, augmented products that often embed electronics seeking desirability rather than functionality. In particular, the state of the art shows the traditional idea of interface as progressively questioned. Examples are products such as "BeoSound Moment" by Bang & Olufsen and "Osound" by Digital Habits, where the interface is respectively just hinted or absent (Natural User Interfaces or No User Interfaces).
In line with this trend, Thingk, a spin-off company of the Politecnico di Milano, makes the design process its main driver, alongside its ability to read contemporary phenomena to innovate everyday objects, rethinking established archetypes in terms of functions, starting from essential geometric morphologies. The field of reference is that of smart objects and digital environments; a field, that of Smart Home, which records a high growth rate (+35% from 2016) and a revenue of 250 million euros (Osservatori.net, 2018).
Harnessing the transdisciplinary nature of its team, the startup intertwines design and engineering to research and develop smart products that combine digital performance with significant aesthetic impact through in-depth research on materials and processing technologies. Exploiting this interdisciplinarity, Thingk follows a design-inspired innovation that leverages the ability to envision users' needs through user research and data analysis. This enables to rapidly respond to technological advances and market demands, converging technologies into distinguishing products. The outcome is a series of artefacts with an apparent analog look-and-feel, that once touched reveal their digital nature.
Considering how electronics and computer science can be enabling, ubiquitous and affordable, we are increasingly teased to imagine smarter and hybrid experiences that move among physical and digital dimensions (Ishii *et al.*, 2015; Krishna, 2015), affecting users' behaviours and habits in consequence. This condition fueled the desire for progressively more natural experiences (UX), leading experimentation that narrows the distance between user and artefact.

Everyday objects with superpowers

Thingk experiments with interactive technologies, introducing to the market products that "disguise themselves". Apparently simple and minimal artefacts (shape) get technologically augmented (function), following the slogan: "everyday objects with superpowers". If on the one side this approach translates into invisible technology and essential aesthetics, on the other side it empowers objects with unexpected properties, *hacking* their meaning, namely redesigning their aspect and functions

(affordances and interactions), playing with how they are perceived by users (Krippendorff, 1989; Heskett, 2002; Verganti, 2009).
Design means making sense of things (Krippendorff, 1989), and artefacts should communicate their function through their appearance that should provide the critical clues required for its proper operation (Norman, 1999, p. 39). Hence, the interface plays an operative role (phatic function; Jakobson, 1960), triggering the dialogue with the user (as a receiver). However, if on the on side meaning refers to the affordances of an artefact, on the other it points to something that goes beyond functionality, building the emotional and symbolic value of a product (Verganti, 2009). Therefore, re-designing meanings is a core aspect, that acquires further relevance considering that the startup pursues a design-inspired innovation where user's needs are acknowledged, technological opportunities are growing (Utterback *et al.*, 2006), but the form-function relationship of products is no longer so familiar. When objects change their meaning, their language becomes far from being taken for granted. The resulting products have no explicit interface (Krishna, 2015) and react showing their true colours only through interaction, revealing the quiescent functions living underneath the surface of an object apparently silent. The result is a series of objects for domestic use: a smart kitchen scale that looks like an ash parallelepiped (Slab!), a wireless smartphone charger that appears as a beech disk (Disc!) and a wireless charging plan integrated into a leather desk blotter (Desk!)
Because of their embedded technology potentialities, each object of the series required particular attention to the design of the interface, which often coincides with the product itself. In a perspective of formal simplification, while playing with embedded technology, Thingk researches for primitive forms (as highlighted by their names) and advanced functions. It experiments with the recognized fact that the interface should act as an interpreter (Norman, 1999), serving as a semantic filter that connects user and product (Bonsiepe, 1995). While the interface separates the object from the person, proving to be a barrier, it is also an element of translation that transposes the user's interactions into a language comprehensible to a product designed/programmed to react. However, the tangible interface (TUI) of this series of objects becomes somehow misleading, showing affordances that are reduced (formal simplification) if compared to real functionalities (semplexity). This produces implications that cannot be underestimated, both in terms of UI and UX.
When experimentation involves interfaces, leading to design apparently mute artefacts (such as Apple's "HomePod"), it grows paramount to investigate the patterns of use, namely how users interact with the object. In particular: What does it imply to base an R&D activity on the manipulation of meanings, acting in parallel on aesthetics and functions? How does it affect the UX?
In this regard, it was pivotal a crowdfunding campaign that accompanied the first series of products, leading to the identification and engagement in the process of a community of prosumers (active users) that contributed to critically unpacking how such artefacts get interpreted and used (Yoo, 2012).

Design interactions between users, contexts and production logics
Developing products oriented toward an innovation of meaning (Norman & Verganti, 2014) requires the adoption of technological solutions and opportunities able to respond to the contemporary and future market trends, and with the problem of obsolescence. The production process is indeed structured to vary its scale and geographical extent according to the market requests (Bianchini & Maffei, 2013). This flexibility is possible because the craftsman-made body allows rapid production variations in contrast to what happens when the production is based on standard series logic. Therefore, products can change and be updated (in their shape as in terms of re-programmability, if IoT objects) without changing their appearance, and without affecting the end user's perception.
That said, we unpack the implications of a design-driven process aimed at hacking meanings. This process is divided into two interconnected macro-phases. The first is oriented towards radical innovation and starts with the formulation of a research issue to nurture a design phase where prosumers are involved. The second regards development and production, and revolves around data and end-users (especially communities of practice) as continuous sources of knowledge as everyday innovation. In doing so, the full process transversally harnesses the different knowledge of the startup, tapping into the multiple fields of design and engineering, including practices of analysis that derive from the fields of sociology, anthropology, and ethnography, complemented with marketing activities aimed at strategically including signals from the market.

Research
Considering the impact of technology in developing innovative products and its key role in the market as well as in future economies (Dell'Era *et al.*, 2017; Porter *et al.*, 2004), this phase is crucial for competitive advantage. It starts from a desk research on technological and lifestyle trends to identify the design perimeter and the constraints of the context of reference, focusing on breakthroughs in the fields of electronics, interaction design, and material research. The experimentation extends from function to usability, and from language to meaning, defining an area of friction where the interface almost disappears to become embedded in the object or to become the object itself. Contemporary studies (Giaccardi, 2015; Kuniavsky, 2010; Ishii *et al.*, 2015; Norman, 2010; Ballmer, 2010) picture the presence of several trends in technology as dissolving into our bodies, the environment and the cloud (Sutton, 2015). Trends that are confirmed in the context of reference, fuelling appreciable experimentation. On the one side, interactive artefacts where the aesthetics explicits function and meaning, and the interaction uses Natural User Interfaces, as Digital Habits' speaker "P.A.C.O." that relies on gesture control to operate volume and playback. On the other, artefacts that hide their interface and disguise their function until users interact with them; an example is "Nuimo" by Senic, a wireless controller that manages different functions of several home devices. Lastly, when the technological component gets prominent, and the connection among devices, data, and internet (IoT) becomes a critical aspect,

interactive artefacts become extended systems that dialogue with apps and other objects. An example is Lapka's "Environment" concept where a series of environmental sensors communicate with the smartphone, translating complex data into user-friendly visualizations.

Design and prototype

An interdisciplinary team with knowledge and know-how in the multiple fields of design and engineering figures a design roadmap, exploring alternative models of interaction that lead to unconventional user experiences. Seizing the tenets of digital transformation (Kuniavsky, 2010), and following a technological hybridization, Thingk merges analog dimension and digital immateriality (Vitali *et al.*, 2017). The use of natural materials pursues a strongly haptic dimension that directs users' expectations towards habitual interactions (MacLean, 2008). The products' appearance declares an apparent simplicity that hides complexity (not complication) and unexpected smartness. A semplexity that results from archetypical forms (geometric and minimal objects), paired with the choice of high-quality but familiar materials such as milled wood, handmade leather, and polished stone.

While the research and design phases follow a design-driven innovation (Verganti, 2009), the prototype testing grounds on a Human-Centered approach. Using ethnographic methods, we draw particular attention to user's response (Herstatt & von Hippel, 1992) and to how such products blend digital and physical aspects. Hacking meanings also requires to comprehend and assess how users interact and "translate" the artefact. Concerning UX, it is indeed paramount to intercept recurrent problems in using the object to solve them. As a result, to obtain an efficient and reliable evaluation of the product that considers usability and aesthetics (in terms of materiality, proportions and shapes) but also the symbolic and emotional value aroused, leveraging our marketing and interaction design skills, we involved a community of prosumers in a qualitative enquiry (focus groups, interviews) as well as in creative brainstorming sessions. This late inclusion is due to the fact that users rarely contribute in anticipating/envisioning potential innovations: because of their socio-cultural context, they are stuck in the present (Dell'Era *et al.*, 2017). On the opposite, they are crucial in the testing and assessment moments of the iterative process (Tolino & Mariani, 2018).

Development

Embracing a model of innovation based on a flexible, reconfigurable manufacturing logic that encourages the constant and conscious updating of electronic components rapidly obsolete technologies guarantees competitivity and ensures high-rate adaptability to the market. Choosing flexibility rather than standardisation means engineering products' body and technology as adaptable to structural changes (shape and assembly), eradicating large-scale design constraints of scale - in a counter economy-of-scale mindset (Bianchini & Maffei, 2013). From an engineering and design perspective, the challenge is to develop objects able to reconfigure themselves: smart design for quick adaptability to the context of use and its requirements. Moreover, when objects are smart and connected to the Internet (IoT), their connectivity and computing capabilities are programmed to detect and record data about product's use and life-cycle.

Production, data analysis, improvements

Once the development and engineering of the electronic components are completed, the fabrication is entrusted to two different production chains: local artisans specialized in processing the material chosen for the product body, and companies committed to the production of the electronic components. After the realization of some study samples, a first limited series of artefacts is produced, promoted and tested.

A crowdfunding campaign and an explorer program (in progress) contributed to the identification, involvement, and study of a community of users. Such experimentation with end users (Herstatt & von Hippel, 1992; Bogers *et al.*, 2010) led to verify the usability and intelligibility of artefacts whose meaning has been redefined, triggering a precise re-design aimed at obtaining a progressive product improvement, in a process that anticipates rather than responding to needs. This also implied a specific research on user behaviour, benefiting from a traditional data analysis that, when an IoT system is present, is combined with information from sensors embedded into objects (Tolino & Mariani, 2018). In the case of "Slab!", the analysis conducted on uses via data collection and observation, appropriately interpreted by the designer, led to improvements such as the repositioning of the LED display transpiring from the wooden surface, from the front to the top (interface), and the modification of functions in relation to the orientation, indicating the weight of the food when the object is horizontal or the time when vertical (functionality).

Data shows how and to what extent artefacts are used coherently to the design(ers) expectancies. Quantitative data plays a crucial role in capturing, understanding, and assessing users' interaction and reactions to the product, turning habits into potential innovation of product. In the meanwhile, interviews, focus groups, questionnaires, and observations (ethnography) provide qualitative data useful for product implementing on the ground of uses as user's expectancies.

Designer as inventor

For Thingk, innovation revolves around the constant observation of everyday life and technological experimentation, in line with an aptitude to design that is flexible and in the making, with significant effects on the formal and aesthetic level of the product. The daily invention is therefore articulated in three different aspects that contribute to innovation. Embedded smart technology, observation of emergent use models and rapid adaptability to the market are the levers on which the design activity of the startup is articulated.

Relying on these assumptions opens up opportunities and challenges that come from questioning the aesthetic-functional conventions of some traditional domestic objects, contaminating the usual interpretative processes. The future scenario of the current research seems to encourage the experimentation of interfaces able to assume a dynamical character, that is to say becoming able to express different functions depending on specific contexts of use. In this perspective, innovation moves towards a further density of meanings coexisting in a single object.

The designer's role is to increase the cognitive references (perceived and real affordances) connoting the artefacts through the introduction of digital affordances triggered by interaction and activated by smart technology.

The resulting process is as innovative as critical since it relies on multiple variables that require constant experimentation, in which contamination and dialogue between skills are fundamental. In this context, the designer is more than ever challenged to become a collector of knowledge. As a result, the designer is no longer just an inventor and innovator, but also a researcher, interpreter, and entrepreneur.

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