

Design and science hybrid approach for material experiences: reinterpreting Napolitan tuff

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Abstract: The paper proposes the story of an experience of research and experimentation in the field of upcycling the tuff, a natural and iconic material for the city of Naples, demonstrating how the intelligence of nature understood as an integrated system of porosity, ribbing, stratifications, colors can be used by design as a vehicle to communicate the identity of a place and its history.


In the Euploia project, tuff has been regenerated as a precious material, a material that bears witness to the ancient history of the city, since its first foundation by the Cumaeans Greeks in the 7th century BC (Greco & Giampaola, 2022). By means of material experiments, the chemical-geological identity features were set off with the historical-cultural ones, translating them into lamps, tables, installations to bring visitors closer to the deeper identity of the city.


Some of the projects were based on the reinterpretation of tuff from building waste as an upcycling material to produce new materials that conceptually 'contradict' the traditional idea of stone, in order to highlight the importance of reducing the extraction of virgin stone by favouring design-driven forms of recycling of discarded stone. The indoor and outdoor furniture projects and installations were developed by proposing a contemporary conception of reinterpreted tuff that abandons its usual properties, becoming soft, transparent, textile, luminescent.

Keywords: Product design material teaching - Sustainable material practices - Speculative design - DIY materials - Design and science - Upcycling materials - Design and territory - Design practices

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Introduction

The use of raw materials has been part of the process of creating artefacts present in our daily lives, and important criteria and practices are being adopted, improving the relationship with natural resources. The scarcity of these resources is being exposed with greater vehemence in society, in this article, we have as a macro theme: the sustainability of the extraction of virgin stones, specifically the tufo giallo napoletano (Neapolitan Yellow Tuff). The material choices made by designers affect how a product will be manufactured, how it will function, and how users will experience it. Concerning user experience, the visual and tactile properties of the materials used, and how they are processed and combined, play a central role. More specifically, such choices strongly affect how users will use a product and the personality and aesthetics attributed to it.

In product design processes, the selection of materials can be complex, as it depends on many factors, such as functional requirements, manufacturing constraints, economics, life

cycle aspects, ecological sustainability, sensory and aesthetic properties of the material, and cultural representative meanings as well. Furthermore, these choices are usually inter-related (Zuo, 2010). Thus, the designer needs to balance different factors in the material selection process to ensure that the designed product meets aesthetic and functional goals while also considering the expenditure of energy, labor, and other resources (Haug, 2015). Traditionally, the technical (or engineering) focus on materials has been dominant. However, studies of descriptive and associative characteristics of materials, which transcend their physical properties, have emerged as a global research interest since the early 2000s (Pedgley, 2010; Rognoli, 2010).

The impetus of the circular economy strongly influences the ‘design’ of materials for future products. “Bringing new material objects into the world will increasingly require a considerable assessment of ethical responsibility” (Langella, 2021). The materials with which new things will be made must be cyclical, like those in nature: produced with waste materials and reusable at the end of their life. It will be even more necessary to treat post-production and post-consumption waste from an upcycling perspective (Santulli & Langella, 2013; Langella, 2022), by valorizing the materials resulting from recycling. In the past, recycled materials were seen as chip materials, as it was common for recycling to negatively affect their technical performance, degrading them and reducing their possible subsequent applications (Langella, 2021).

This paper proposes a research and experimental experience conducted within the Euploia project¹, a project that intends to highlight the ancient and hidden origins of the Greek city of Parthenope to the inhabitants and visitors. As part of the project, a workshop was developed which involved experts in the humanities and sciences and young designers². This paper describes in particular the part of the workshop which was concerned with evoking the ancient history of the city through the stone with which it was built: tuff. Within the Euploia project, tuff has been interpreted as a precious material to be valorized, both because it is a witness to the city’s ancient history dating back to its establishment by the Cumaeans in the 7th century BC and because it is a non-renewable stone material. Through innovative and sustainable processes, new materials with high scientific and narrative value have been developed to create furnishing products, lamps and installations that serve to tell stories about places, cultures and matter and through matter.

The results of the project were shown in a widespread exhibition³, which involved public spaces, shops, restaurants and private gardens. The exhibition was visited by hundreds of visitors in October 2023 and was extended into an indoor version in an international design gallery⁴ in December 2023. This article describes the outcomes of the research, workshop and exhibition.

The research and experimental workshop have been focused on upcycling tuff, a natural and emblematic material of Naples, showcasing how nature’s intelligence, manifested through its integrated system of porosity, ribbing, stratifications, and colours, can serve as a conduit for communicating the essence of a locale and its historical narrative (Migliore & Langella, 2023).

Through material experimentation, the chemical-geological characteristics of tuff were harmonized with its historical-cultural significance, resulting in the creation of lamps, furnitures, interaction design installations aimed at acquainting visitors with the city’s deeper

identity. Speculative and experimental design artefacts that aim to make the invisible visible, giving light and voice to the matter and memory of places; new products that propose the stone of the future: a hybrid stone made from demolition waste that subverts the idea of common tuff, applied to functional objects that solve contemporary problems.

Several initiatives involved the reinterpretation of tuff derived from construction waste as an upcycled material, yielding new materials that conceptually challenge the conventional notion of stone. This approach underscores the importance of minimizing the extraction of virgin stone by promoting design-led methods for recycling discarded stone. The projects encompassed both indoor and outdoor furniture and installations, presenting a contemporary interpretation of reimagined tuff that departs from its customary properties, transforming it into soft, transparent, textile-like, and luminescent forms.

In this article, the concept of natural intelligence also refers to the human capacity to perceive the state of the environment, drawing inspiration from nature (its properties, systems, etc.) and joining this with the natural human self-critical intelligence that, in search of survival, looks to the Pacha mama and makes use of all resources (natural and artificial) for self-preservation. The latter is linked not only to productive ends, but also to maintaining collective harmony across the globe.

The article, therefore, aims to discuss approaches that designers use to select materials; the relationship between the concept of Natural Intelligence and the context addressed here; DIY - Design and circularity; Tufo Giallo Napoletano, input for material experiments; presentation of the workshop and comments on the processes of the products resulting from the material experiments.

Sensory suggestions

In the user's interaction with a product, the sensory properties of materials influence whether a product provides adequate feedback and a pleasant emotional experience (van Kesteren *et al.*, 2007). So, when designing for a specific user interaction, the designer must choose the right materials to support that interaction. However, this can be difficult, as the perceived stimuli of materials are often subjective (van Kesteren *et al.*, 2007). In other words, it can be argued that people live in different sensory universes because they perceive sensory qualities differently (Le Breton, 2006). Some factors, such as cultural background, tendencies, associations, and emotions, influence a person's reaction to a material. For this reason, the selection of materials considers the perceptual mechanisms of the culture and the conditions of experience (Le Breton, 2006; Rognoli, 2010).

Haug (2019) has deeply researched how designers deliberately use materials to create sensory perceptions. This involves a wide range of sensory properties. Several studies have explored how various sensory modalities shape our experiences. It is argued that richer experiences can be obtained by stimulating different sensorial modalities simultaneously (Schifferstein & Spence, 2008). When it's about interacting with the product, aspects related to visuals and tactile perception are stimuli of primary importance (Sonneveld, 2007; Nefs, 2008; Schifferstein & Spence, 2008). However, Schifferstein (2006, p. 60) points out

that “the function of the senses is likely to depend on the specific products used, the frequency with which they are used, and the importance attached to the activities carried out”.

The situation in which interaction with the product takes place is also relevant because of the importance of individual senses. For example, vision is usually dominant during the purchase of a product, while the importance of other sensory modalities usually increases significantly after the purchase.

Therefore, investigations into the sensory properties of materials need to consider some variables, such as the singularity of the user, the context where the product will be placed, and environmental conditions. According to Harvey (2000), the terms “sensation”, “perception” and “aesthetics” are, to a certain extent, conceptually overlapping. More specifically, sensation concerns the first contact with objects and refers to certain immediate, fundamental, and direct experiences, such as “soft”, “rough”, “warm” and “blue”. Sensation involves a transformation of sensory stimulus, translated into nerve impulses to be transmitted to the central nervous system. The term “perception”, on the other hand, is generally used to refer to the result of psychological processes in which meaning, relationships, context, judgment, latest experiences, and memory play a role (Harvey 2000).

According to Karana (2010), we may differentiate between the literature on ‘materials selection’ versus the literature on ‘materials meaning’. In the first literature, sensory properties of materials, shape, function, and manufacturing processes are recognized as the most important factors affecting designers and their material decisions; on the other hand, ‘meaning’ literature emphasizes the role of user, use, and context in the attribution of meanings to artefacts.

In this context, it should be noted that using materials to incorporate meaning into products is increasingly challenging, as traditional understandings such as “wood is cozy”, “metal is distant” or “plastic is cheap” are becoming less rigorous in current design practice (Karana, 2010). For example, Lefteri (2006) explained how the understanding of plastic has changed from “environmental criminal” to a material that comes from nature and returns to nature with the emergence of ecological plastics.

According to Karana (2010), meaning-making finds three main perspectives in the literature: (1) the object as the center of meaning-making, (2) the individual as the center of meaning-making, and (3) the interaction between the object and the individual as the center of meaning-making. Following the last notion, Karana (2010) states that the properties of a material are the basis in which people conceive their own ‘material meaning’, besides those, other conditions to be observed are the product chosen to incorporate it, the way people interact with it, the conditions and context in which the interaction takes place. One’s repertoire of memories, associations, emotions, culture, previous experiences, and so on, can influence people’s perception in specific situations.

Intense material experiences and narratives

In this context of exploration and advances in the area of materials in design, Hasling (2018) emphasizes the diversity of functions/roles of materials, and presents four future perspectives:

1. Materials as environmental impact agents - pointing to efforts to minimise environmental impacts from obtaining raw materials to processing, use, and disposal with a view to the closed loop system; examples include the product life cycle and technological development, including tooling.
2. Materials as re-establishers of the connection between humans and artefacts - this can be done by emphasizing the origin and use of materials through narratives that present the recognition that a particular material requires, this can be done by communicating the trajectory of materials and artefacts and the value that this narrative represents.
3. Materials as moderators for social innovation - A way of empowering 'designers' and end users (Manzini, 2015), such as creating Makerspaces (Smith, 2017) and when used for design and well-being purposes.
4. Materials as a channel for critical and speculative design (material speculation) - A way of raising awareness about actions in society (Dunne & Raby, 2013), through design processes orientated towards the Do-It-Yourself (DIY) (Rognoli *et al.*, 2015) and Material Driven Design (MDD) (Karana *et al.*, 2015) approaches.

The research proposed in this paper intends to pursue the second and the fourth approach, with particular attention to the possibility of using matter to narrate stories towards which we want to raise awareness in society. Specifically, through upcycling experiments, we intend to make people aware of the historical roots of the city of Naples and of the importance of considering non-renewable materials such as precious stones, even when they are disused and which must be reused to create value. The approach used has a learning vocation because it intends to teach people something in a form of material story-telling. Material storytelling introduces numerous and substantial layers of complexity to learning by attributing agency to spatial, material, and bodily dimensions. The main objective is facilitating collective and personal development by engaging with the reconfiguration of narratives and stories (Jørgensen & Strand 2014).

This approach can be defined radical in its emphasis on the relations and mutual influence of meaning and matter, offering innovative ways to conceptualize memory, cognition, action, existence, reflection, and so forth. These domains were traditionally considered the exclusive realms of individuals or, at the very least, of culture as an intersubjective discursive construction.

In this scenario, the post-humanist agential realist perspective on matter proposed by Karen Barad (2007) holds significant implications for comprehending intentionality, memory, and learning within society and organizations. The adoption of a diffractive methodology of material storytelling (Strand, 2012) for collective and individual learning, offers an alternative to conventional narrative and storytelling approaches. This approach involves

considering individuals as material-discursive of-the-world becoming, rather than as narrative entities or historical-discursive constructions.

Today, the value of a new material is no longer linked only to its technical performance, but also to its perceptual, evocative, experiential and learning characteristics. This offers new and unprecedented possibilities for the regeneration of waste. The materials designer with input from design must therefore be orientated towards identifying the most “troublesome”, difficult, and expensive waste to dispose of, reinterpreting and regenerating it, while increasing its value, to make recycling a sustainable and convenient industrial process.

This process of expanding the development of materials has also generated the phenomenon of maker culture and Do It Yourself (DIY), these have great merit in bringing designers closer to experimenting with materials, inducing them to enter into the perspective of researching materials and their applications, but from a different perspective to the scientific process. DIY has this nomenclature because it is a culmination of self-production, and also because their “recipes” are usually shared in open digital communities (Rognoli *et al.*, 2015). Insert DIY into design teaching allows students to familiarise themselves with concrete physical components (Parisi *et al.*, 2017).

Although it is a valid approach, it’s insufficient to aid designers in having a concrete impact on innovations in materials. After familiarising themselves with the experimental aspects, designers must seek an ever greater connection with the science of materials; immersing themselves in the technical-scientific dimension. And in this process, scientists are also clarifying the experiential dimension of materials. This represents a real revolution, as their interaction with designers points to a future in which materials are technically advanced, but also have more density from a psychological and neuro-cognitive perspective (Langella, 2021, pp. 259-277).

If traditional form-focused design previously determined designers’ limited knowledge of materials, a change is now taking place through the direct action impelled by the designers themselves. They are engaged in the conceptualization of material, where the material becomes the real project driver (Karana *et al.*, 2015; Bak-Andersen, 2018), a shift also noticed among fashion designers (Ribul, Goldsworthy & Collet, 2021).

A focus on the materials experience offers alternatives where designers can be sensitized to the unique qualities of novel materials, potentially leading to meaningful applications (Karana, Pedgley & Rognoli, 2015).

The role of the materials experience in sustainability has already been investigated using the concept of “Materially Yours” (Karana, Giaccardi & Rognoli, 2017) which indicates strategies for using materials at different experiential levels to assist in the design of longer-lasting products. By expanding the territories of the materials experience, the aim is that it will be possible to improve the ability of designers to address environmental considerations.

A significant motivation for encouraging designers to undertake the DIY-Materials approach is to find more sustainable and eco-friendly material solutions. However, this methodology doesn’t ensure a sustainable material outcome at the end of experimentation. Instead, it is necessary to consider that such an approach leads the designers to make decisions that help them improve their sensitivity toward sustainability challenges as they

become increasingly aware of their role as facilitators and pursuers of sustainable solutions.

This first session was important for understanding some tools and mindsets that enable designers to apply their skills to propose new solutions. Fashion and product designers in particular are demonstrating that it is possible to go beyond the usual limits of their discipline in testing materials; hybridizing with science, engineering, and biotechnology; and embracing an increasingly transdisciplinary approach (Oxman, 2016; Langella, 2019; Migliore, 2019).

Raising awareness of history and sustainability through the intelligence of nature

Leen Gorissen (Centre4NI, 2022) defends that despite endless change and disruption, massive upheaval, and cosmic collisions, nature has survived the worst of times and thrived in the best of them for 3.8 billion years. Therefore, it's safe to say She knows what works, what lasts, and what contributes to the future of life on Earth. She is the undisputed master of continuous innovation, adaptation, and ultimately, regeneration. She follows with a question:

“What if we would tap into the NI that stood the test of time to fast track innovation so that we can develop new capabilities, and build agile, creative, and responsible organizations and healthy and resilient cities and landscapes?” (Centre4NI, 2022).

She shares with the public that we might learn to become life-friendly and self-renewing right where we are and transform our current degenerative value system into a regenerative one, enhancing the world through benign innovation.

She states that NI offers a whole new lens to approach the world, to look at innovation, organizations, development, and design. It unlocks pathways to shift from degenerative to regenerative value creation, upgrading the world through nature-inspired innovation.

In this context, the natural intelligence approach presented in this article fulfils the desire to provide designers with the practice of fast-track innovation. As mentioned above, the workshop is aligned with the parameters of natural intelligence due to the effort of transforming current degenerative values. The book also illustrates that once you understand how life works, you will see that sustainability is the by-product of regeneration. Regeneration is a biological process of renewal that leads to a higher order of health, wealth, vitality, and viability. Because in the long run, innovations will only last if they leave the world better off.

In this way, the workshop was inspired by the need for actions encouraging regenerative acts while collectively problematizing and proposing solutions materialized by artefacts.

It was about the unsustainable use of virgin stones and the provocative proposition of alternatives to change social perspectives. Changes in options presented to end consum-

ers, by improving professional performance through a change in the status of designers, who were initially seen as adapters and translators, only using already available materials. However, the new era brings a transdisciplinary impulse, generating new functions in conjunction with different expertise.

The intelligence of nature in the Euploia project becomes a tool to highlight the material characteristics of the tuff, which through analogies evoke characteristic cultural and historical values. The porosity that is described by Walter Benjamin and Asja Lasic in 1925 refers to the characteristics of Naples and the Neapolitans of hospitality, depth, change. The stratifications of the tuff refer to the layers of history and dominations that the city has had. The color due to the chemical composition recalls the preciousness of gold. The geological nature evokes Vesuvius and Solfatara, volcanoes of Naples that keep citizens in perpetual tension, giving them that character of fragility and at the same time of fatalism and recklessness.

Making the invisible visible, Neapolitan yellow tuff (NYT) as an input for material experiences: workshop and exhibition

The workshop was conducted in collaboration between the Hybrid Design Lab research group of the University of Naples Federico II and many other actors from different contexts and disciplines. As mentioned, the workshop was a moment to collectively think of solutions to the unsustainable use of virgin stones, proposing innovative solutions to the discarded NYT. To achieve this, the workshop applied the following methodological steps:

1. introduction to the archeological value of tuff (through the collaboration of museology and art professionals);
2. geological processes, chemical, mechanical and physical properties of tuff (through the collaboration of engineering, chemistry);
3. independent research, integrating the scientific aspects with the possibilities of stone upcycling and presentation of representative concepts and products;
4. creation of five groups: Material design, Relational design, Interaction design, Digital design, Graphic, and multisensorial exhibit;
5. material experiments of do-it-yourself, and follow up with scientists;
6. exhibition.

In the first phase of the workshop the designers met archeology experts⁵ who explained the ancient history of the city and the relationship with the tuff quarries, the material on which and with which the ancient city of Parthenope was built by the first Greek settlers. Subsequently, two materials scientists⁶ introduced the geological and chemical characteristics of tuff, and also the upcycling opportunities based on incorporating waste powder into bio-based matrices, providing a scientific paper that the designers had to study in depth (Liguori, *et al.*, 2015; Verdolotti, *et al.*, 2008).

Some of the projects were based on the reinterpretation of tuff from building waste as an input material to produce alternatives that conceptually 'contradict' the traditional idea of stone, to highlight the importance of reducing the extraction of virgin stone materials by favoring design-driven forms of recycling of disused stone. The indoor and outdoor furniture projects and installations were developed to convey a contemporary conception of reinterpreted tuff that abandons its usual properties, becoming soft, transparent, textile, luminescent.

Strati project (*See Figure 1*) is a double example of upcycling tuff. In this case the waste material becomes valuable, as a jewel, and at the same time educational, because it communicates scientific information. A wearable infographic showing the composition of the layers of Neapolitan yellow tuff in the city's subsoil. In particular, it is possible to perceive the complex transformation of the stone over time. The representation is divided into 9 layers of different sizes according to the type of material. In sequence, starting from the lowest layer, we find: Pumice (0), Ash (10), Piperno (20), Yellow Tuff (60), Pumice (70), Breccia (80), Upper Pumice (90).

Another way to valorise tuff waste is suggested by Light Tuff (*See Figure 2*). The project proposes an installation of suspended transparent and luminescent tuff elements made of bio-resin, tuff stones from demolition and phosphorescent paint. Through these elements, the intention is to illuminate the historical relevance of the site by using tuff, a witness to the history of Naples, and, at the same time, to use it as a precious symbolic stone, demonstrating that it can be transformed from a cheap building material to be conceived as a valuable and memorable material.

Soft tuff (*See Figure 3*) incorporates tuff by upcycling technique and by regenerating a disused item, to experiment with its application in the furniture industry. The coffee table is covered with a layer of new material made ad hoc as a site specific material with tuff scraps and natural latex, offering a non-slip and thermally insulating approach to resting very hot dishes. Conceptually, the material evokes the concept of the eruption of the city's most intimate material, a soft tuff that overflows and covers things to protect them.

Another way of conceiving the enhancement of tuff has been to focus on the historical end evocative memory of this material. For example, Fàros (*See Figure 4*) is a site-specific installation aiming to create a link between people and place. It consists of a tuff column which, as if by effect of a volcanic explosion, seems to project towards the sky the most intimate matter of Monte Echia and thus its most ancient memory. The Echos of Time project (*See Figure 5*), on the other hand, redevelops tuff without using it. It consists of a sound installation telling stories related to tuff by combining chemical-geological characteristics of this material with historical-archaeological ones, by personification of the material to facilitate understanding of Naples' heritage. Users approaching the installation can hear the voice of tuff, in first person and in different languages, telling these stories and features. The workshop activities were displayed in the Euploia exhibition. Euploia is a wish for good navigation, used by the ancient Greeks to indicate Mount Echia. From 4 to 14 October 2023, Euploia becomes a diffuse exhibition action of art and design in which, crossing the dense urban landscape of Chiaia, one moves from the sea to the mountain guided by works and projects that invite one to cross the caverns, gardens, and streets, where the step and the gaze range from suggestive grafts between nature and artifice to relics of that

ancient material culture that still nourishes the artisan and manufacturing production that emerges in contemporary research.

Euploia is a diffuse urban operation (*See Figure 6*) that presents the results of a plural work referring specifically to the places where the first settlers around the 7th century B.C. quarried tuff and built Parthenope, the first settlement of the city prior to Neapolis, and where today there are important artisan and manufacturing activities and contemporary art production spaces that, as a whole, are icons and common heritage of the 'made in Italy'.

Euploia's temporary and permanent installations spread throughout the urban space and in the shop windows of commercial and productive activities, trace an itinerary that aims to reveal to the inhabitants and visitors of these places the ancient origin of the city and to awaken a civic sensitivity necessary for a concrete human, urban and social regeneration. Many of the projects on display focus on the material tuff, its porous and stratified characteristics, its symbolic meanings, and the opportunities to recycle it from a sustainable upcycling perspective. Tuff is known as an emblem of the city's most intimate identity, as an eternal witness to the oldest history of Pizzofalcone.

The primary intention of the installations and design products is to make visible the invisibility of the pre-existing and historical stratifications due to the inaccessibility of the excavation areas.

The proposed artefacts employ methods and languages of contemporary design and art, experimenting with approaches such as upcycling design, interaction design and relational design, augmented reality, and artificial intelligence.

The exhibition is therefore proposed as a laboratory of awareness and innovation, an opportunity to reveal the historical and cultural roots of places in the city of great value but little exploited through which new forms of urban regeneration are triggered based on the encounter and collaboration between art, design, technology, history, and archaeology. The design products and installations created for the exhibition fall into the strategic categories: Material design; Relational design; Interaction design; Graphic and multisensorial exhibit.

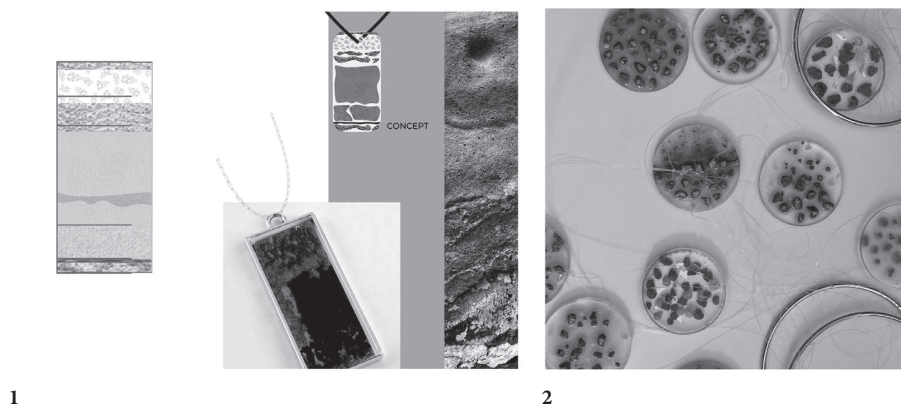
Regarding the material design section, there are many contributions that manipulate tuff by upcycling practices in jewellery and furniture applications.

Aggregation (*See Figure 7*) is a Collier that emphasizes the beauty and preciousness of tuff in its original natural state. Fragments of stone from building waste come together on a very fine white gold wire to resonate their evocative power of the city's ancient histories. Another interesting example is Fragments collection (*See Figure 8*) that is made with tuff fragments from demolition waste that emphasize the value of tuff as a precious witness to the city's memory and as a non-renewable material. The scope of the jewellery ensures an increase in the economic value of the material by making the recycling process economically sustainable.

The Gea memoriae bench (*See Figure 4*) is a good example of the integration of tuff with other materials and, also, of attention to the impact of raw materials by local producers. The bench is made of sintered expanded polystyrene, generally used for packaging, and tuff waste powder. The combination of these materials gives the products lightweight and durability. Sensory characteristics and shape echo typological-structural features of the Cappella Vecchia/ Pizzofalcone area, evoking layers of tuff, memory and identity. Just as

the ramp now connects the cavities to the upper city, it connects to the origins of the site by recycled tuff, for a new way of living spaces of the city. In the Magma seat project (See Figure 9), on the other hand, tuff waste from demolition is used in such a way that it is immediately recognisable and relatable to its first use. It is another way to understand the re-use approach. The seat consists of an iron grid and tuff cubes and the caption states “Porous, just like a memory. Please, have a seat here. Make yourself comfortable in this story made of essence and absence, and be lenient when, inevitably, it will leave its mark on you”; in order to emphasize the memory aspect of the material.

In the Euploia exhibition, the upcycling approach is not only about tuff. The metal food retail stool Violet (See Figure 4), for example, combines latex and powdered mussel shells from catering waste for the top sitting. The ethical value of the upcycling operation is reinforced by the soft reinterpretation of the shells, generally perceived as hard, which induces a reaction of surprise in the user. For the Echino side table (See Figure 10), the shelf is made of echinoid powder and spines from food waste embedded in resin. The morphology is inspired by the lobed structure of sea urchin spines. The marine origin of these materials evokes the journey that led the colonists to found Parthenope.



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Figure 1. The project was designed by Daniela Castiello, Laura Sasso, Fatemeh Fatipour, Veronica Sabino. Located at Classico restaurant **Figure 2.** Light Tuff. The project was designed by Afhida Fathima, Claudia Lavopa, Ludovica Siciliano, Xiaoyu You, Zijun Chen. Located at the Old Chapel.



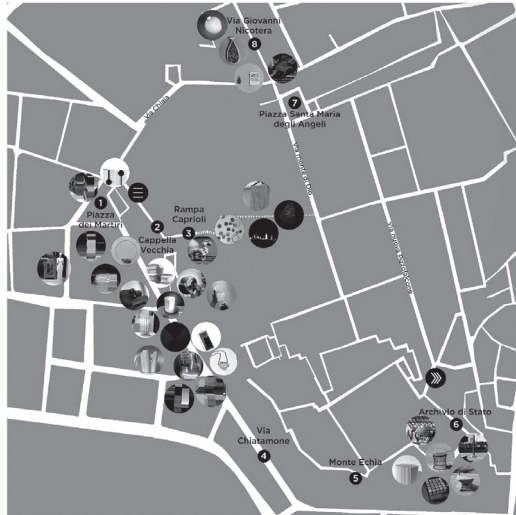
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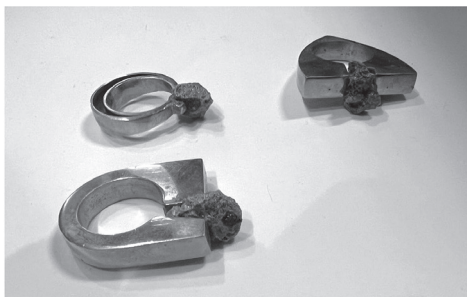


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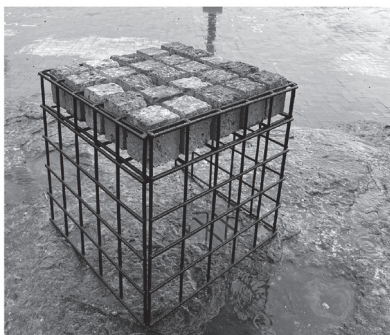
Figure 3. Soft Tuff. Designed by Meysam, Faezeh, Sajad, Rayehe, Himanshu. Located at Classic Restaurant. **Figure 4.** Fàros, designed by Anna Corrado, Immacolata D'Aniello, Sirio Emanuele Palescandolo, Alesia Petrozzi, Margherita Ziviello; Gea Memoriae, designed by Mariateresa Petrosino with collaboration of Francesca Castanò, Carla Langella. Located at Monte Echia; Violet, designed by Martina Del Vecchio, Francesco Gaudino, Michele Artellino, Salvatore Muzzillo. Located at Monte Echia. Located at Monte Echia. **Figure 5.** Echos of time. Design: Sainandan, Nader Shaji, Harnish Kumar Devrani, Armita Zaman, Sooraj Kottakkad Mothedath with collaboration of Dario Aquilina Barbara Liguori and Letizia Verdolotti. Located at the Old Chapel. **Figure 6.** Map of the location of the pieces and the planned route of the exhibition. Graphic by Giovanna Nichilò, Annamaria del Prete, Maria Capasso.



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Figure 7. Aggregation. Designed by Carla Langella. Located at Cappella Vecchia restaurant. **Figure 8.** Fragments collections. Designed by Francesca Liquori and Carla Langella. Located at Classico restaurant. **Figure 9.** Magma. Designed by Pietro Trattino. Located at Monte Echia. **Figure 10.** Echino. Designed by Giovanna Bava, Martina Buonomo, Emmanuela Murolo, Gabriella Palomba in collaboration with RICCI-cliamo project. Located at Monte Echia.

Conclusion

The artefacts developed in the research and experimentation process described employ methods and languages of contemporary design and art, experimenting with approaches such as upcycling design, speculative design, material storytelling and interaction design. The experience conducted was a laboratory of awareness and innovation, an opportunity to reveal the historical-cultural roots of places in the city of great value but little appreci-

ated through which new forms of urban regeneration based on meeting and collaboration are triggered between art, design, technology, history and archaeology.

The projects were based on the reinterpretation of tuff coming from building waste as an upcycling material to produce new materials that conceptually “contradict” the traditional idea of stone, in order to highlight the importance of reducing the extraction of lithic materials virgins favouring forms of design driven recycling of disused stone. The interior and exterior furniture projects and installations were developed by proposing a contemporary concept of reinterpreted tuff that abandons its usual properties becoming soft, transparent, textile, luminescent.

Besides the physical results from group Material Design, findings point to the relevance of the connection of the designer to the scientific context. It was also noted the importance of this multidisciplinary relationship to advance in the processes of experimentation, since the DIY is an experimental process that requires technical approaches to be accessed from a professional and producible point of view. Furthermore, the artefacts represent new dynamic scenarios between the designer, territory, society, production and market, stimulating self-criticism and creative action while dealing with local “wasted” opportunities. In this sense, students and designers involved have responded positively to the call for ‘regenerative transformation’, with a view to benevolent innovation guided by a natural intelligence approach.

Innovative technological solutions, developed specifically for the project, were used to induce visitors to undertake virtual journeys through time and space. Some of the products created were conceived to translate from temporary site-specific exhibits to works and products intended for a high-quality international market, which prefigures new cultural economies based on tourism.

Notes

1. Euploia exhibition was curated by Carla Langella, Maria D’Ambrosio and promoted by F2Lab e Casa del Contemporaneo with Dipartimento di Architettura DiARC, Università degli Studi di Napoli Federico II, in collaboration with Soprintendenza della Città di Napoli, Museo Archeologico Nazionale Napoli, OBVIA, I Municipalità Comune di Napoli, ACLabs e IPCB CNR, FabLab DREAM Fondazione IDIS-Città della Scienza, Archintorno, Istituto Caselli-Real Fabbrica di Capodimonte, Liceo Palizzi Napoli. Under the patronage of Comune di Napoli, Unione Industriali di Napoli, ADI Campania and with participation of local companies.
2. The young designers were recruited as part of the master’s degree in Design for the Built Environment of the Department of Architecture of the Federico II University of Naples.
3. <https://www.casadelcontemporaneo.it/event-pro/euploia-materia-viva/>
4. Design Sulmondo. <https://www.sulmondo.com/>
5. Paolo Giulierini, Director of Museo Archeologico Nazionale di Napoli (MANN), Maria Lucia Giacco of Museo Archeologico Nazionale di Napoli (MANN) and Daniela Savy coordinator of Obvia.

6. Barbara Liguori, Professor at the Department of Chemical, Materials and Industrial Production Engineering, University of Naples Federico II and Letizia Verdolotti, Research Scientist at the Institute for Polymers, Composites and Biomaterials of the National Research Council of Italy (IPCB-CNR).

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Resumen: El artículo propone la historia de una experiencia de investigación y experimentación en el campo del reciclaje de la toba, un material natural e icónico para la ciudad de Nápoles, demostrando cómo la inteligencia de la naturaleza entendida como un sistema integrado de porosidad, nervaduras y estratificaciones, los colores pueden ser utilizados por el diseño como vehículo para comunicar la identidad de un lugar y su historia.

En el proyecto Euploia se ha regenerado la toba como material precioso, un material que da testimonio de la historia antigua de la ciudad, desde su primera fundación por los griegos de Cumas en el siglo VII a.C. (Greco & Giampaola, 2022). Mediante experimentos materiales, se contrastaron los rasgos identitarios químico-geológicos con los histórico-culturales, traduciéndolos en lámparas, mesas, instalaciones para acercar a los visitantes a la identidad más profunda de la ciudad.

Algunos de los proyectos se basaron en la reinterpretación de la toba procedente de residuos de la construcción como material de reciclaje para producir nuevos materiales que 'contradigan' conceptualmente la idea tradicional de piedra, con el fin de resaltar la importancia de reducir la extracción de piedra virgen favoreciendo el diseño - formas impulsadas de reciclaje de piedra desechada. Los proyectos e instalaciones de mobiliario de interior y exterior se desarrollaron proponiendo una concepción contemporánea de la toba reinterpretada que abandona sus propiedades habituales para volverse suave, transparente, textil, luminiscente.

Palabras clave: Diseño de producto Enseñanza de materiales - Prácticas materiales sostenibles - Diseño especulativo - Materiales DIY - Diseño y ciencia - Reciclaje de materiales - Diseño y territorio - Prácticas de diseño

Resumo: O artigo propõe a história de uma experiência de pesquisa e experimentação no campo da reciclagem do tufo, material natural e icônico da cidade de Nápoles, demonstrando como a inteligência da natureza entendida como um sistema integrado de porosidade, nervuras, estratificações, as cores podem ser utilizadas pelo design como veículo para comunicar a identidade de um lugar e sua história.

No projeto Euploia, o tufo foi regenerado como um material precioso, um material que testemunha a história antiga da cidade, desde a sua primeira fundação pelos gregos de Cumas no século VII a.C. (Greco & Giampaola, 2022). Por meio de experimentos materiais, os traços identitários químico-geológicos foram contrastados com os histórico-culturais, traduzindo-os em luminárias, mesas, instalações para aproximar os visitantes da identidade mais profunda da cidade.

Alguns dos projectos basearam-se na interpretação do tufo proveniente de resíduos de construção como material de upcycling para produzir novos materiais que 'contradizem'

conceptualmente a ideia tradicional de pedra, de forma a realçar a importância de reduzir a extração de pedra virgem privilegiando o design- formas impulsionadas de reciclagem de pedras descartadas. Os projetos e instalações de mobiliário interior e exterior foram desenvolvidos propondo uma concepção contemporânea de tufo reinterpretado que abandona as suas propriedades habituais, tornando-se macio, transparente, têxtil, luminescente.

Palavras-chave: Design de Produto Ensino de materiais - Práticas materiais sustentáveis - design especulativo - Materiais DIY - Design e ciência - upcycling materiais - design e território - Práticas de design
