HYBRID DESIGN LAB - Design and Bio-sciences at University of Napoli Federico II

HYBRID DESIGN LAB

Università degli Studi di Napoli Federico II

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The evolution of sciences, technologies, and new materials is happening so rapidly, pervasively, and overwhelmingly that it presents an infinite universe of new tools and knowledge that design cannot overlook. It is both a challenge and a responsibility, as design is understood as a discipline that, through the design process, is capable of implementing new knowledge and bringing it into people's lives, translating it into products and services that present themselves as "devices of the new." These artifacts influence people, their behavior, and their thoughts towards the implementation of innovations that address emerging needs and the complexity of contemporary lifestyles.

The *Hybrid Design Lab* is a research and design experimentation laboratory dedicated to mutual collaborations between Design and Bio-sciences. Established in 2006 at Vanvitelli University, it operated at Città della Scienza Incubator until 2022 and is currently located at the Department of Architecture of the University of Naples Federico II. The primary aim of HDL is to transfer the results of theoretical and experimental research in the fields of bio-sciences (contemporary biology, synthetic biology, biomaterials, medical sciences, bioinformatics, neuroscience, biomechanics, pharmacology, nutraceuticals, biophysics, biomathematics, psychology) to the design dimension of innovative and sustainable products and services, in order to meet the needs, requirements, and desires of users.

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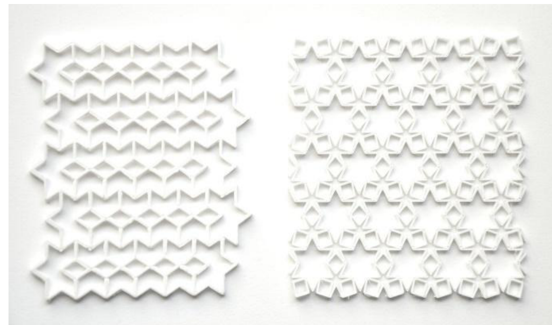

Auxetic Neckbrace, Auxetic collar for postural re-education; Design: Martina Panico; Scientific Coordination: Carla Langella; Co-tutor: Carlo Santulli.

In the research, teaching, and design experimentation activities of *HDL*, design, hybridized with science, brings the dimension of advanced scientific research closer to individuals' lives with the aim of improving their quality of life and making them aware of the possibilities and achievements.

HDL is supported by funds from international and national research projects, which are granted funding through competitive public calls that involve peer review, as well as third-party agreements with *design-oriented* companies. The research results are disseminated through the organization and realization of conferences, seminars, courses, workshops, and national and international exhibitions. Some notable venues include events held at Città della Scienza, the Festival of Science in Bergamo, the *Shenzhen Convention and Exhibition Centre* in Shenzhen, China, the *Campus Center Galleries at the College of the Arts* in San Francisco, California, the *Makers Faire* in Rome, and the Rho Fair in Milan.

The research and experimentation activities of HDL explore the interfaces between design and biology (*Diatom De-science , Auxetic structures, Parametric bio-design*), materials science (*Porosity, Functionalized bio--materials, Designers in Lab*), biomedical field (*Design for tech pathology, Biomimetic Biomedics*), and physics (Design and optics for augmented reality in the enjoyment of cultural heritage and behavioral therapies).

One of *HDL*'s areas of intervention is the design of scientific *exhibits* for science museums, where design interprets the results of scientific research developed in advanced fields such as materials science or synthetic biology, making them understandable and engaging for different types of audiences.

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Left: Loofa Light, a lamp that integrates a component made from reused discarded lamps with a vegetal component through a grafting device; Design: Piera di Marino; Scientific Coordination: Carla Langella.

Right: Flora, a biodegradable vase made from biobased materials that integrates dairy production waste and floriculture waste; Design: Maria Petrillo, Lorenzo Villani; Scientific Coordination: Carla Langella.

Hemp-bench, a bench made of aluminum and raw hemp fiber;
Design: Angela Buonanno; Scientific Coordination: Carla Langella.

Customized design protocols: bijective relationships between Design and Science

In the *Hybrid Design Lab*, the opportunities for intersection between Design and Science are investigated and experimented with through a bijective approach. The roles and skills of designers and scientists merge and evolve through mutual contamination, in order to achieve shared advancements in their respective fields. Science contributes to design by providing inspiration for the creation of innovative and original artifacts. On the other hand, design aids science by translating its advancements into products useful in people's lives. Through *envisioning* and modeling capabilities, design provides interpretive models and design-based visions that offer alternative and unconventional perspectives, facilitating the attainment of new knowledge and research paths aligned with the demands of contemporary society.

The *HDL* has developed and is progressively testing and validating a hybrid design methodology specifically designed to foster the integration of skills involved in the hybrid project. The goal is to uncover common languages, objectives, as well as affinities and empathies that lead to transforming scientific research into product and process innovation.

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The designer is not always the mediator between disciplines in the design process, as is the case with design-centric approaches. Due to the complexity of the scientific topics involved and the need to pursue progress in both design and science, the design process in the *HDL* is managed dialectically and interchangeably by designers and scientists, who constitute the nodes governing the bijective process. The guiding role, therefore, tends to "migrate" between different disciplinary nodes as the project progresses, based on the issues, fields of application, and specific expertise required for each phase of the project. For this reason, the design process can be understood as a "customized" process, based on a flexible and adaptable method that aligns with the ever-changing nature of hybrid design and its areas of intervention. This method can dynamically and continuously evolve, fueled by the diverse experiences and the scientific and design backgrounds of those involved. The method acts as a common reference point where individuals from different fields, with different languages and approaches, can recognize themselves and merge their contributions.

The *HDL* laboratory brings together diverse expertise, represented by research groups and researchers who are an integral part of the laboratory, as well as knowledge that is specifically involved when the need arises for specific contributions related to a particular project. Among the methodological tools developed and tested in the *HDL are intersection meetings*, which involve designers visiting and immersing themselves in research centers. This allows them to directly experience the environments, contexts, protocols, and approaches of scientific research. This approach enables designers to better understand the complexity of research and to closely observe "human" aspects such as enthusiasm, empathy, and relationships, which enrich purely rational scientific information and data. *Intersection meetings* aim to define shared objectives and languages while experientially acquiring research data. During the initial meetings, a program of joint activities to be carried out in the laboratory is developed. In these activities, designers work alongside scientists in the laboratory to gather information on factors such as experimental cycles, technical, environmental, and perceptual data, as well as the phases and development processes of the research (laboratory tests, experiments, microscope observations, analyses) related to the scientific topic at hand.

Samples of materials developed within the research project PIER, by Francesco Amato and Clarita Caliendo; Scientific supervisors: Carla Langella, Mario Malinconico.

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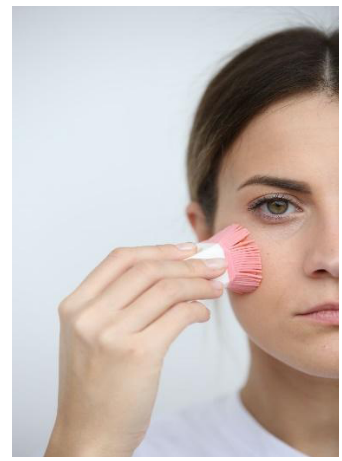
The difference in approach and perspectives that characterize designers and researchers allows them to grasp stimuli and identify potentials that they would have diffculty appreciating fully when working individually and according to their usual methodologies. This approach has been defined as *Designer in Lab* and characterizes the majority of activities conducted in the *Hybrid Design Lab*.

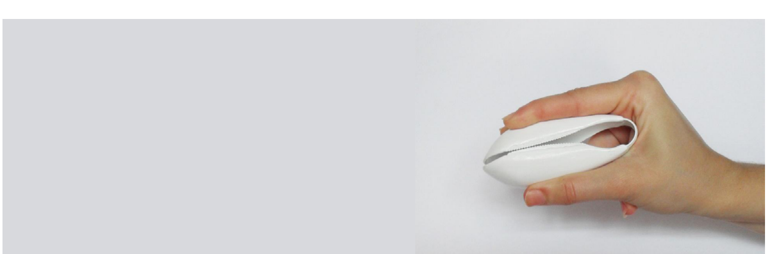
Thumbio, a splint for immobilizing the thumb and wrist, made of bio-blasted functionalized materials infused with phytotherapeutic ingredients. Design by Clarita Caliendo; Scientific coordination by Carla Langella; Co-tutor: Carlo Santulli.

Bioplastics based on agro-food waste, integrating plant fibers and textile waste fibers. Design by Clarita Caliendo; Scientific coordination by Carla Langella; Co-tutor: Carlo Santulli.



CYR. Care in Your Ring is a wearable device for self-facial massage with therapeutic, relaxing, and lymphatic drainage purposes. Design by Giuliana Di Taranto; Scientific coordination by Carla Langella; 3D modeling and printing coordination by Gabriele Pontillo; Biology by Valentina Perricone; Prototype production by Nicola Corsetto; Shapeways.

Bioplastiche a base di scarti agroalimentari che integrano fibre vegetali e fibre tessili di scarto, design: Clarita Caliendo; coordinamento scientifico: Carla Langella; Co-tutor: Carlo Santulli.



Salad utensil design by Teresa Iavarone; Scientific coordination by Carla Langella with the collaboration of Antonio Ladarola.

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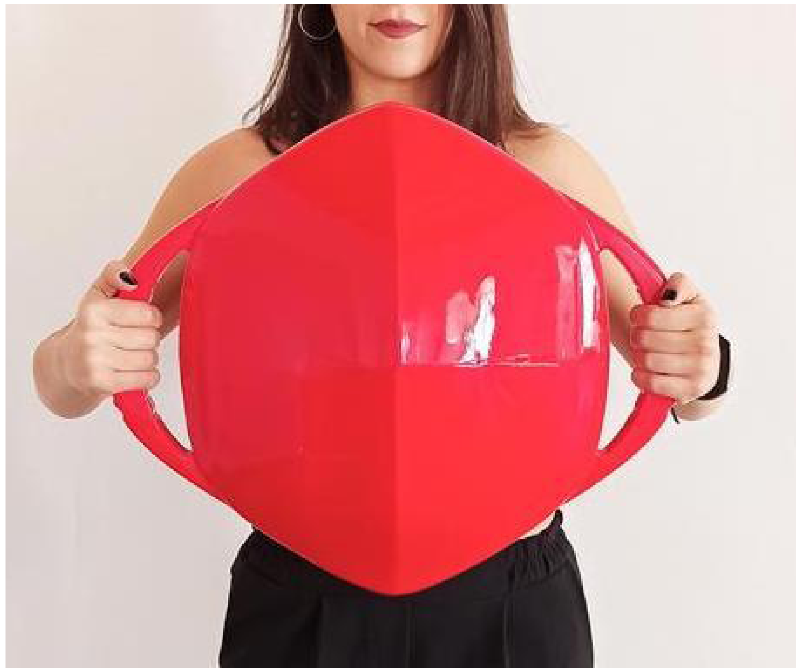

Mau Mau-inspired physiotherapy board design, inspired by the movement of the mola mola fish. Design by Nicola Corsetto; Scientific coordination by Carla Langella; Biology by Valentina Perricone; 3D modeling coordination by Gabriele Pontillo.

For these meetings, facilitation formats are defined to make dialogue and convergence towards common interests easier.

During the *intersection meetings* and joint research activities, new forms of dialogue and relationships between designers and scientists are experimented with, based on points of contact and affinity. Ideas and information are exchanged more easily. To solidify these processes, data is acquired and decoded using an integrated and meta-design approach. It is then presented through various languages and approaches, including visual science models, *textual storytelling* and protocol notebooks, digital 3D models of key concepts, videos, empathic and relational maps. Innovative tools such as *sociometric badges* can be used to map relationships between people and between people and the environment, along with biometric data related to emotions and perceptions. This allows for the creation of relational and emotional maps of interactions between designers and scientists, enabling methodological monitoring and speculation.

The representation and decoding of science are crucial steps as they already anticipate design directions. They must be conducted with a critical and conscious approach regarding the desired outcome. The design research conducted in the *HDL* in recent years represents hybrid paths that may appear distant but are closely interconnected through the common thread of the intersection between design and sciences. This is observed from different perspectives and through collaboration with experts from various scientific fields, including chemistry, engineering, biology, physics, neuroscience, and medicine.

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Nature Details

To facilitate the acquisition of biological language and scientific tools by designers in the *Hybrid Design Lab*, a workshop format called *Nature Details* was developed in collaboration with Valentina Perricone. In this workshop, a biologist and a designer present natural "objects" such as shells, flowers, leaves, carapaces, skeletons, or insect wings to a group of designers. The participants are invited to observe the details of these objects at different scales: with the naked eye, through magnifying lenses (ranging from 5X to 12X), and with a portable digital microscope (ranging from 40X to 400X). The morphologies and structures of organisms and natural s ystems are explained, analyzed, and compared by the designer and the biologist through a cultural dialogue, taking into account their respective perspectives.

The details are thoroughly examined in relation to their biological and evolutionary functional motivations, and based on these, they are analyzed in terms of their transferability to design projects. During the discussion of stratifications, porosities, connections, grafts, and articulations, participants are encouraged to contribute their personal viewpoints by asking questions, making observations, or offering interpretations. The purpose is to understand the generative processes and functional motivations behind these details, in order to identify possible affinities with the world of artifacts.

At the end of the workshop, participants are invited to choose the observed specimens that have sparked their greatest interest and to fill out a form. The form includes the name of the biological system, a description of the observed details, comments and graphs related to naked-eye observations, comments and graphs related to observations through the magnifying lens, comments and graphs related to microscope observations, transferable biological characteristics for artifact design, a schematic graphical interpretation of the nature model, a textual concept, and accompanying prefiguration *sketches*.

Through the *Nature Details* format, it is possible to experiment with and compare the distinctive approaches of designers and biologists in their understanding and interpretation of biological systems. This fosters dialogue and the sharing of ideas and insights, which are essential foundations for building a strong and proactive collaboration.

Images of natural details captured with a digital microscope.

Right: Nature Detail Workshop.

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Diatom De-Science

One of the most complex and articulated research projects developed in the *HDL* is Diatom De-Science, the result of a two-way collaboration between three research units in biology, design, and physics. The study, which involved scientific research activities, design experimentation, technological innovation, and exhibition, was initiated in 2009 with the project "Photonics and Micromechanical Properties of Diatoms," funded by the FIRB program, as part of the Futuro in Ricerca call promoted by the MIUR (Ministry of Education, University and Research). The main objective of the research was to investigate the relationship between the optical, structural, and morphological characteristics of diatoms, single-celled microalgae that produce oxygen through photosynthesis.12

The collaboration among the involved researchers continued even after the completion of the funded project and is still ongoing. It has also involved young researchers such as Valentina Perricone and Gabriele Pontillo. Diatoms are ancient single-celled microalgae, known since the Lower Cretaceous period, with sizes ranging from 10 to 200 µm. They play a crucial ecological role as they contribute to carbon dioxide absorption and oxygen production through photosynthesis. They represent an important example of biodiversity, with over 200,000 different species found in nature. They occur in both freshwater and saltwater environments and significantly contribute to the food chain. Diatoms consist of shells called frustules, which are generated by extracting silicon from the water and characterized by morphologically complex porous ornamentations that seem to have optical, micromechanical, and hydraulic functionalities.

The evolution of microscopy and other imaging investigation tools now allows for a more defined visualization of the details of the perforated, ribbed, and layered structures of the frustules, providing insights into their functional motivations.

Throughout the project, these microorganisms, so small yet valuable for the environment, have proven to be ideal models for describing the potential of biomimetic approaches. Stratifications, hierarchical porosity, interlocking, self-organization, and adaptability to changing conditions are the result of a long evolutionary history from which design can draw by collaborating with biologists to derive innovative design strategies and solutions.

The *Photonics and micromechanical* properties of diatoms research provided a valuable opportunity to experiment with the biomimetic methodology developed in the *HDL* and test it in different fields of application. This collaboration can be described as two-way, multicenter, and cyclical since designers, through their modeling and interpretation skills, assisted scientists in reaching new knowledge, while scientists helped designers gain inspiration from this knowledge to design innovative and sustainable products that translate biological research into useful artifacts for people's lives.

In the first phase of the research, starting from the dimensional and geometric data obtained from Scanning Electron Microscopy (SEM) images by biologists coordinated by Mario De Stefano, designers developed three-dimensional digital models of some diatom species using parametric software to capture the complexity of morphologies and ornamentation details.
These 3D models were then used in digital simulations of photonics and mechanics to understand how frustule morphologies and the arrangement of porosities influence the focusing and propagation of light radiation for photosynthesis (De Tommasi et al., 2014), as well as the mechanical-structural and hydrodynamic functioning. Designers worked alongside physicists and biologists in these simulation and data interpretation activities, employing their modeling skills and functional understanding of objects to deduce the functional motivations of the forms from instrumental morphological analyses.

The digital models were also used to create physical models through additive 3D printing processes, allowing for the observation of morphological and structural details and qualities of microorganisms that are invisible to the naked eye but visible at a larger scale. The three-dimensional prints proved particularly useful in educational activities to illustrate the characteristics and details of diatoms to biology, physics, engineering, and design students.

The knowledge derived through this interdisciplinary collaboration on the correspondences between morphologies and biological functions was ultimately translated, using a biomimetic approach, into the development of design concepts, projects, and prototypes. Methodological tools such as the hybrid transfer matrix were employed to facilitate collaboration between biologists, designers, physicists, and engineers. This matrix established relationships between the biological characteristics of different diatom species (i*nterlocking, porous structure, colony organization, frustule morphology*) and their corresponding functionalities (*connection, modularity, light focusing, filtering, locomotion, structural optimization, reproduction*), as well as certain design requirements, to identify analogies between diatoms and artifacts upon which to build innovative concepts. In design experiments conducted in various fields of application such as urban furniture, food design, light design, and furniture, the most suitable diatom species to be used as nature models were selected based on the correlations that emerged from the matrix.

One of the early projects developed during the research was Edo, a photovoltaic canopy inspired by the processes through which the diatom *Licmophora flabellata* harnesses energy from the sun for photosynthesis. This pennate diatom aggregates into colonies with a unique fan-shaped form to ensure that all individuals absorb as much sunlight as possible without shading each other. The functional analogy between diatoms and solar panels led to the design of a solar canopy consisting of fan-shaped photovoltaic elements, providing shade during the day, illumination at night, energy for charging portable devices, and information on environmental data of the installation site to raise awareness among people about their potential contribution to reducing air pollution. The image *Back to the future*, comparing Edo with an SEM image of its biomimetic reference produced by De Stefano, was awarded an honorable mention in the Illustration category at *The Best Image of the Year 2009* competition, sponsored by the *Science and the National Science Foundation* magazine.

At the end of the FIRB research project, after developing prototypes of design products inspired by the characteristics of the diatoms investigated in the project, it was decided to extend the

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research findings concerning the new knowledge gained about these precious organisms and their biomimetic potential beyond the academic context. This was done to amplify their impact by involving other artists, designers, architects, graphic designers, musicians, scientists, and communicators from Italy and abroad. To achieve this goal, an exhibition titled *Diatom De-Science*. *Intersection between Design and Science* was organized and held from July 11th to 29th, 2014, at Città della Scienza, the science museum in Naples. The exhibition was curated by Carla Langella, Francesco dell'Aglio, and Giulia Scalera.

The selection of participants for the exhibition was done through a call for submissions, which included a presentation where the new scientific knowledge acquired during the research was filtered through a meta-projectual language and appropriate visual representation for the creative contexts they addressed. The aim was to illustrate the main transferable properties of diatoms to the design field.

The exhibition featured around 50 Italian and international designers, artists, and scientists. The curators of the exhibition closely followed the development of their projects, ensuring their coherence with the interpreted scientific knowledge and facilitating interdisciplinary encounters around individual concepts.

Many of the exhibited products were realized with the support and collaboration of partner companies interested in the innovation potential of diatom research for their own productions. The selection of producers favored companies characterized by high-quality *know-how*, a *Made in Italy* connotation, and a pressing need for innovation. Several products entered the catalogs of the companies and artisans who contributed to their development. The exhibited projects were cataloged based on the biological characteristics and functionalities of the diatoms that inspired the designers: reproduction, colony organization, bioluminescence, porosity and filtering, structural optimization, morphology and texture, interlocking and connections.

The exhibition was conceived as an experience rich in aesthetic and sensory stimuli, allowing visitors to experientially appreciate the multiple qualities of diatoms, understand their environmental value, and grasp their biomimetic potential for the development of new products and technological innovations.

Exhibition Diatom De-Science. Intersections between Design and Science.

Level System, consisting of molds for slip casting ceramics and ceramic vases, designed by the collective Gradosei (Chiara Pellicano, Edoardo Giammarioli, Fabrizio Giuseppe Mistretta Gisone, Daniele Barbiero, Renzo Carriero) in collaboration with Francesco Dell'Aglio and Lithho Ceramic Italy.

In the category of projects inspired by the modes of reproduction, there is the Level System, consisting of molds for slip casting ceramics and ceramic vases, designed by the collective Gradosei (Chiara Pellicano, Edoardo Giammarioli, Fabrizio Mistretta Gisone, Daniele Barbiero, Renzo Carriero) in collaboration with Francesco Dell'Aglio and Lithho Ceramic Italy. The project concept draws inspiration from the asexual reproduction through binary fission of diatoms, which commonly employ this type of reproduction to reduce energy expenditure compared to sexual reproduction. This form of optimization has been translated into a molding model capable of reducing the number of molds to be produced and, consequently, the total cost. The expenditure dedicated to mold production generally constitutes the most significant item in ceramic production and, therefore, the most resistant factor to product innovation. Inspired by the reproductive process of diatoms, a system of different half-molds (resembling valves) has been conceived, characterized by different textures inspired by various diatom species, which can be combined to create multiple combinations. With a limited number of molds, the company has the possibility to offer a wide repertoire of asymmetric vases obtained from different combinatory arrangements, saving on mold production costs. An additional element of innovation and cost reduction was introduced by using 3D printing in mold production, resulting in the ability to create infinite variants with even complex details.

Another project in this category is the *Diatomic Tables system*, designed by Laru, which is inspired by the way diatoms associate in colonies. The tabletops, conceived in various radial and longitudinal shapes resembling centric and pennate diatoms, are made of plexiglass sheets onto which diatom ornamentations derived from microscope images have been digitally printed.

Many artists and designers have been inspired by the photoluminescence observed by biologists and physicists in diatoms using specific microscopes under specific environmental conditions. An example of this is the luminescent jewelry such as

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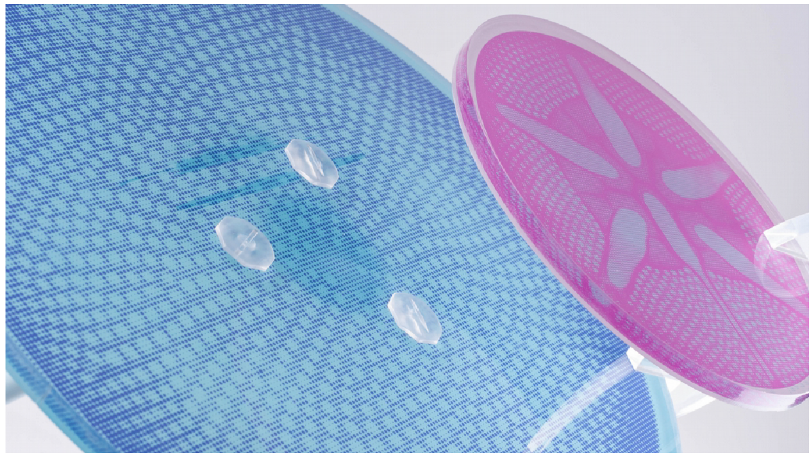

The Diatomic Tables system, designed by Laru.

the *Joyas* del mar collar, designed and created by artist Silvia Beccaria. It is made of photoluminescent PVC rubber, handwoven with nylon, and emits a green light in the dark.

The porosity of diatoms has been observed from various perspectives: as a useful quality in filtering light, water, or air, and as a strategy for lightening and optimizing structures.

Among the projects inspired by the hierarchical porosity of diatoms is the development of new expanded materials. These materials were created in the chemistry laboratory of the Hypucem company, a spin-off of CNR, by designer Enza Migliore during her doctoral research. Using one of the newly developed materials, a ceramic foam based on silicon, the designer created the *Diaphanea* lamp by depositing differentiated layers of foam inside glass spherical diffusers. The hierarchical porosity of the foam filters the light emitted by an LED source, reducing glare and providing differentiated aesthetic and perceptual qualities. Similar to nature, in this project, the designer integrates the objects and their qualities, from the scale of the material to the interaction with light and the environment.

Another project focused on material study is the *DIA_Paper Experiment*, a packaging design for a single fruit created by Mara Rossi. The goal was to propose a solution to safeguard the integrity and freshness of the fruit when carried in a bag for consumption outside the home. The fruit holder was made with an experimentally obtained paper that includes diatomite, a fossil residue of diatoms. This gives the paper the ability to absorb substances that contribute to the fruit's degradation process, keeping it intact for several days.

The shape of the packaging was obtained using an origami folding technique, which provides stiffness to the paper to mechanically protect the fruit during transportation.

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Left: Coscinodiscus Filter, a universal cap designed by Angela Giambattista.

Right: GlòSSA, a nutraceutical candy designed by Serena Fedele.

Among the projects inspired by porosity, another proposal is the *Coscinodiscus Filter*, a universal cap designed by Angela Giambattista to be applied to common PET water bottles for promoting their reuse with drinkable water. The cap contains diatomite, which has the ability to purify water, and is inspired by the selective filtering capacity of diatoms in their natural habitat.

The GlòSSA candy, designed by Serena Fedele, is characterized by a porous microstructure inspired by the hierarchical porosity of diatoms. It contains nutraceutical ingredients that serve as substitutes for dietary supplements. GlòSSA can be consumed in two ways: as a candy that gradually releases its beneficial components during chewing, thanks to the controlled porosity, or as a portable tea pocket that can be dissolved in hot or cold water. The candy is made of a composite material consisting of a matrix of chitosan, xanthan gum, fructose, and malt, with an infusion of petals, pollen, seeds, and fragments of natural roots that possess specific antioxidant, immunostimulant, anti-inflammatory, and detoxifying properties.

Porosity has also been interpreted as a strategy for structural optimization. The *Diatom Helmet,* designed for an exhibition by Paula Studio (Valerio Ciampicacigli and Simone Bartolucci), aims to enhance the performance of a sports helmet by imitating the layered and honeycomb-like structure of diatom cell walls. This design reduces weight, improves breathability, and absorbs impact energy. The helmet consists of three layers made of different 3D-printed materials, joined together by a border rib that structurally integrates the layers, similar to the median girdle of diatoms. The 3D algorithmic modeling was carried out by Antonio Gagliardi from the FabLab Makeinbo in Bologna.

The *Scraps* bracelets designed by B/verse (Giacomo Cesaro, Antonia Auletta) and created through 3D printing offer a vision of contemporary jewelry that is substantial in size yet lightweight and comfortable. They are inspired by the morphological complexity of diatom colonies and their structural optimization.

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The Diatom Helmet, a bicycle helmet designed by Paula Studio (Valerio Ciampicacigli and Simone Bartolucci), features 3D algorithmic modeling, overseen by Antonio Gagliardi from the FabLab Makeinbo in Bologna.

The *Palato* plates, designed by Giulia Scalera and Antonio Iodice, and crafted in porcelain in collaboration with the Anna Maglio laboratory, feature engraved textures inspired by diatom ornamentation. These textures embrace the liquid parts of food, draining them while simultaneously creating ever-changing geometric patterns as a background.

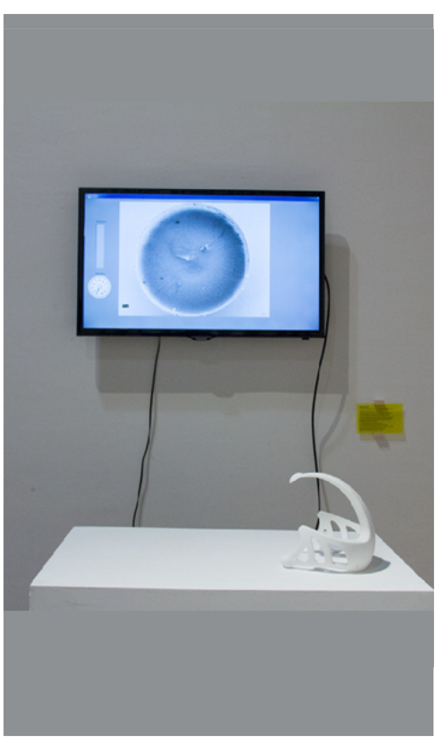
Even the connections found in diatoms, which link the valves or individuals to form colonies, serve as a valuable source of biomimetic inspiration. The APEX glasses, designed by Antonio Iadarola, Nicola Di Costanzo, and Theresa Williams, and 3D-printed, adapt to facial morphologies through movable interlocking mechanisms inspired by diatoms.

The exhibition also included an area dedicated to videos and interactive exhibits. The video created by Marialuisa Firpo, titled *DiaSoundText-Trame Visionore*, connects sounds and colors to the rhythms and harmonies of diatom forms and ornaments. By analyzing various types of diatom textures within their morphological structures, five distinct textures were selected based on their visual signs, frequencies, and repetitions. Each chosen texture was associated with a sound, a rhythm, and a frequency. The author's voice produced individual sounds, which were then mixed into a single track—a harmonic composition—integrated with an animation of vector signs evoking the original forms.

The interactive installation called *Brainzoom*, created by Francesco Sacerdoti and Enrico Esposito, with contributions from Nicola Esposito and Matilde Merciai for the design aspect, allows users to visualize a diatom at various dimensional scales through a *brain interaction* system based on a helmet equipped with sensors capable of reading certain brain waves. By concentrating their mind, users can increase the scale to observe nanometric details of the diatom. The zooming in and out is achieved through a gradual transition of images provided by researcher Principia Dardano from CNR, which are processed using microscopes with varying resolution capabilities. The design of the helmet also pays attention to ergonomics, imitating the attachment methods of diatoms to ensure the correct and quick placement of the sensors and the functional arrangement of voids and frustule ribs to reduce its weight.

The interactive installation titled Semotility, designed and created by Antonio Grillo and Filippo Sessa from FabLab Napoli, allows users to manipulate, move, enlarge, and reduce the 3D models of diatoms using a gesture control system employing *leap motion* technology. These models were developed by designers Antonia Auletta and Giacomo Cesaro based on scanning electron microscope (SEM) data produced by biologists during the FIRB research project for scientific simulations. Even the accompanying sound track of the exhibition is the result of a hybrid design process, as it was composed based on the optical characteristics of diatoms by Edoardo De Tommasi, the coordinator of the optical physics research unit.

The goal of spreading the project's results as widely as possible led to exporting selected fragments of the exhibition to various international showcases.



Bottom left: Interactive installation Brainzoom, created by Francesco Sacerdoti and Enrico Esposito for the aspects related to technology and interaction, with contributions from Nicola Esposito and Matilde Merciai for the design.

On the right: Interactive installation titled Semotility, designed and created by Antonio Grillo and Filippo Sessa from FabLab Napoli, allows users to manipulate, move, enlarge, and reduce the 3D models of diatoms using a gesture control system that employs leap motion technology. These models were developed by designers Antonia Auletta and Giacomo Cesaro based on scanning electron microscope (SEM) data produced by biologists during the FIRB research project for scientific simulations.

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The described experience demonstrates how an interdisciplinary research project funded by the Ministry of Education, University and Research can involve not only the narrow scientific community reached through specialized publications but also a much broader and diverse audience, amplifying the impact of research on society and making it a widely shared body of knowledge.

New hybrid professional profiles

In light of these evolutionary scenarios and the complexity of design issues addressed by biomimetics, the designer must be able to expand their scope of intervention with broader technical and scientific skills, greater flexibility, knowledge of the scientific method, a spirit of experimentation, and the ability to envision possibilities.

Schools and universities must adapt to new educational needs and aim to build new hybrid professional profiles equipped with appropriate tools and skills to manage interdisciplinary processes, anticipate potential futures driven by science, and translate them into possible innovations. To this end, within the Bachelor's Degree Program in Design for Innovation offered by the Department of Architecture and Industrial Design at the University of Campania "Luigi Vanvitelli," a specific course titled "*Bioinnovation Design*" has been developed to provide students with competencies and methodological approaches that allow them to integrate design knowledge with biological scientific knowledge and develop biomimetic artifact projects, from scenario development to prototyping.

The course aims to provide students with critical and methodological tools to outline strategies and forms of product innovation inspired by the biological sciences, referring to the intelligence of biological systems to define new generations of artifacts that are more advanced in terms of sustainability (Vezzoli et al., 2017), optimization, adaptability, and flexibility in response to changing needs, technologies, and contemporary lifestyles. Throughout the course, students learn to consult nature with a scientific approach, going beyond formal imitation and drawing from the most reliable and up-to-date specialized literature in the field. They also learn to explore databases and specific search engines, seeking to appropriate the terminology and methods used by scientists.

Education is the most effective vehicle for fostering the evolution of biomimetics and ensuring the translation of a design trend into new productive methods that improve people's quality of life. The designers trained in these years will be the ones to drive this transition and narrow the gap that still exists between human design and natural design.

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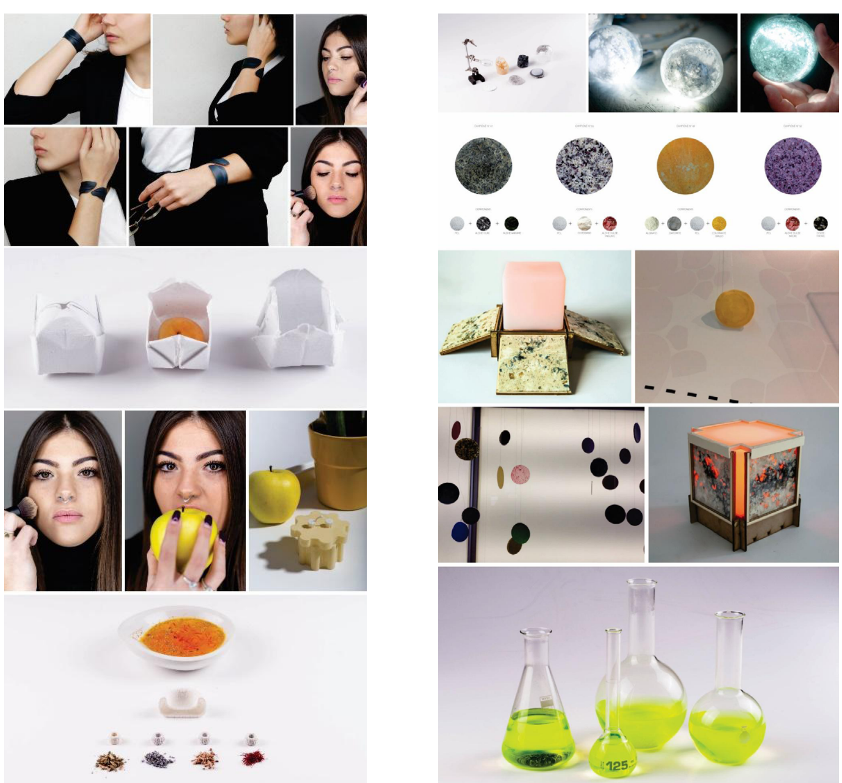
Case [1 & 2] +Design - Waste & Bio-Lighting Design

Case [3 & 4] Design for well-being & Designers in lab



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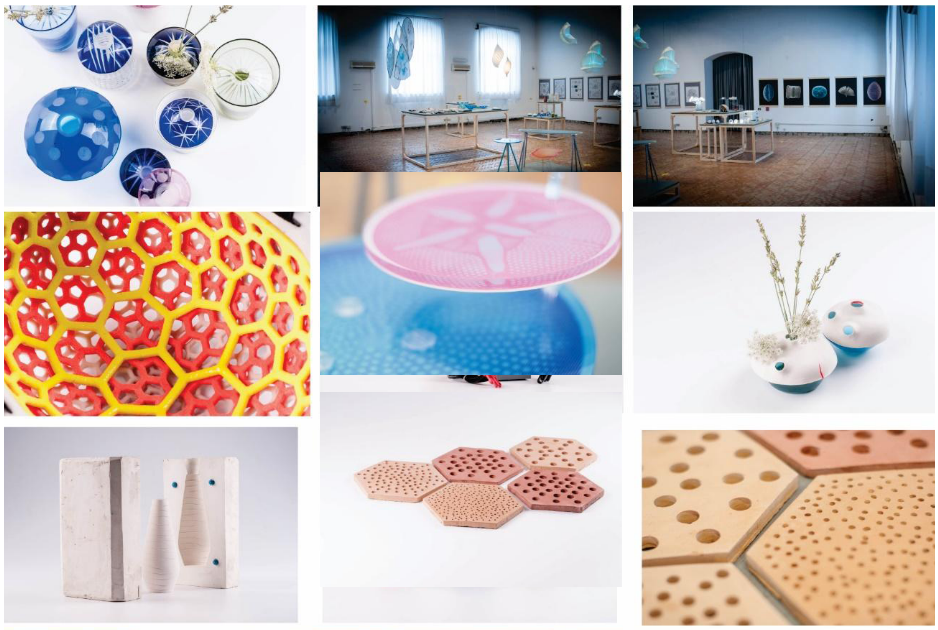
Case [5] Diatom de-science

Coordinators: Carla Langella, Francesco Dell'Aglio, Giulia Scalera



Case [6] Digital biomedical

Coordinators: Carla Langella, Gabriele Pontillo

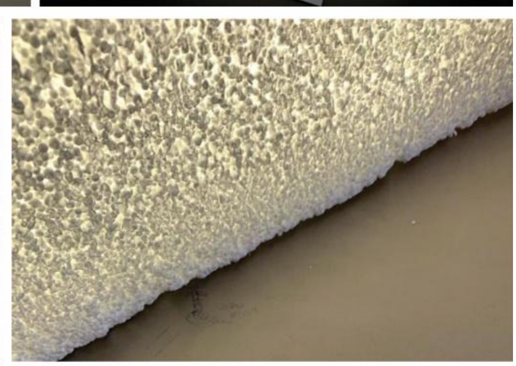
Case [7] Fare Luce

Coordinators: Carla Langella, Francesca Castanò, Maria D’Ambrosio









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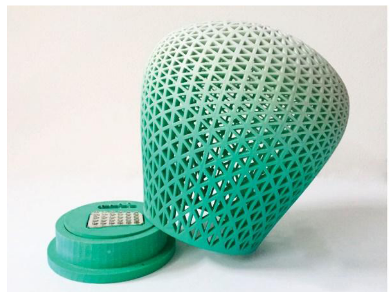
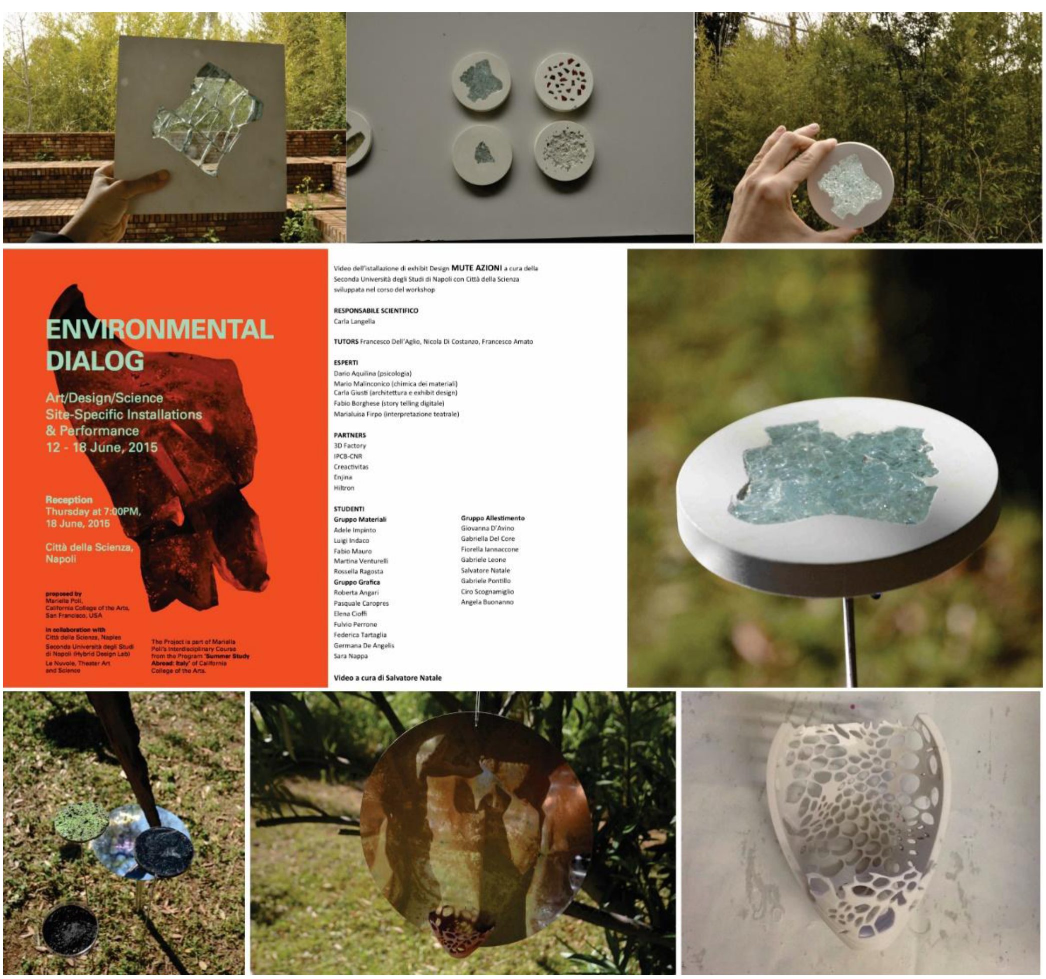
Case [8] Hemp design

Coordinator: Carla Langella



Case [9] Mute Azioni

Coordinators: Mariella Poli, Carla Langella



Case [10] Hybridism 1 & 2

Coordinators: Mariella Poli, Carla Langella, Patrizia Ranzo