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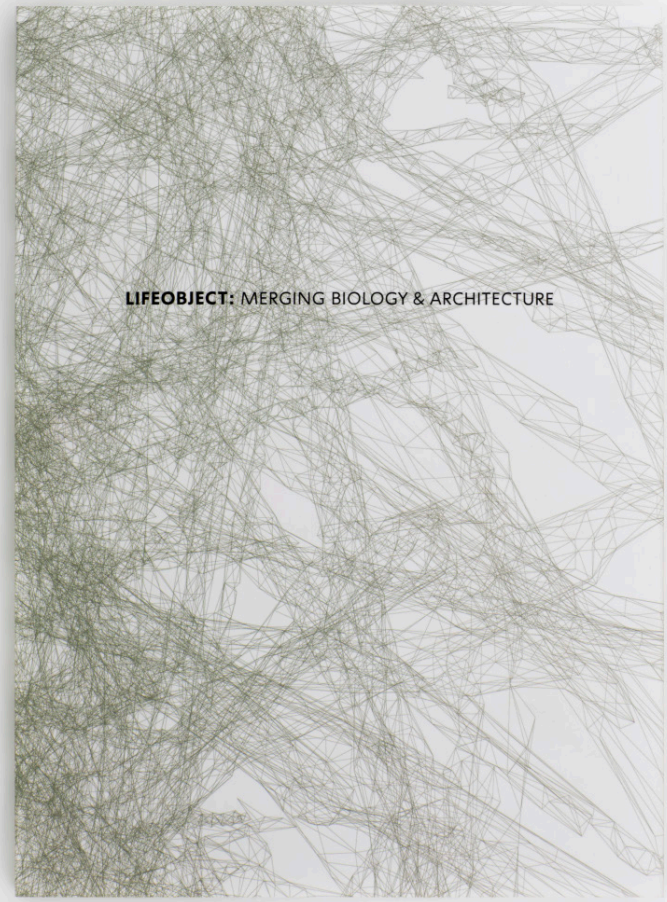

LIFEOBJECT: MERGING ARCHITECTURE & BIOLOGY

Presented at The Israeli Pavillion's Exhibition at The 2016 Venice Biennale For Architecture

The LifeObject book and exhibition examines the influence of biological paradigms on the world of architecture, including the future implications of transposing and merging these two seemingly divergent disciplines. As opposed to biology, which focuses on concepts relating to life and ongoing change, architecture is traditionally perceived as a field of inert entities, focusing on the ability of buildings to survive trans-generationally and serve as sites which preserve the past. The exhibition examines new relationships being formed between man and his environment which invalidate the binary distinction between nature and culture and re-frame the architectural environment as part of a wider ecology.

The platform established by the exhibition is expressed through four sections of informational typologies which are interwoven throughout the book, ranging from case studies to theoretical elaborations. Their dispersal throughout the book suggests a multiplicy of possible relationships between the various topics and fields dealt with in the exhibition.

Curated by Dr. Yael Eylat Van Essen, Arielle Blonder, Noy Lazarovich, and Benaya Bauer

The theoretical section is comprised of five articles that deal with the various aspects underlying the relationship of man to environment.

The core of the book consists of a series of texts that deal with the LifeObject, these texts relate to the structural and material elements of the installation, as well as to the research and design methodologies that frame it. The second part of the exhibition consists of seven studies created by teams of architects and scientists who were invited to propose speculative scientific-architectural scenarios, using biological paradigms, to relate to local and global planning and architectural questions.

Interspersed throughout the book are fragments of a biological- architectural phrase book, which constitutes a conceptual envelope for the exhibition and the book. In its framework, biological concepts receive architectural interpretations stemming from both local and global examples.

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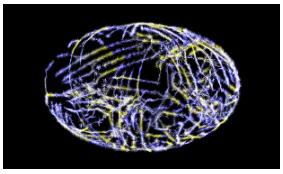
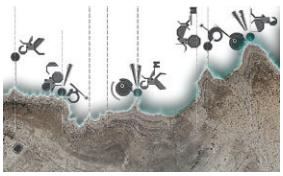
33 **Behave**
ShaGa Shyovitz Architects, Erez Livneh



Behave is a holographic microscope that analyses the breath of spectators, measuring oxygen, carbon dioxide and breath tidal volume. An algorithm programming the behavioral patterns of bacteria uses these biomarkers to simulate the growth, organization and material deposition of a bacterial colony, constructing a virtual biofilm that interacts in real time with sensorial inputs.

39 **Dead Sea Resurrection Project**
Dan Eytan, Ruth Lahav, Boaz Tadmor



The Dead Sea Resurrection Project is a collaborative project between architecture and biology, which links the lake's degeneration to TTTS, Twin to Twin Transfusion Syndrome, where identical twins relying on the same source of nutrients stop receiving balanced blood supply due to an anomaly in the fetal blood vessels. Creating the analogy between TTTS and the lakes' current predicament opens up a host of new approaches to tackling this pressing environmental crisis.

45 **Mergence and Emergence: a Biological Model for Reading Israeli Architectural and Political Space**
Ayelet Zohar

Israeli architectural space consists of two foundational realities – the settlement movement, built upon previously uninhabited natural environments – and a second strategy – based upon the forceful destruction and annexation of Palestinian villages and towns. In order to articulate these two architectural practices, Zohar analogizes these two biological paradigms of mimicry, a visual survival strategy based on resemblance and assimilation, in order to shed light into the survivalism embedded within Israel's early architectural practices.

63 **Out of the Wild: Challenging Israel's Comfort City**
Els Verbakel

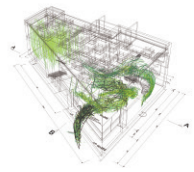
63 **Diffraction Of Urban Crystals, Haifa**
Dr. Arch. Einat Kalisch Rotem &
Madlan Prof. Dan Shechtman

Crystallography and modern urban planning both emerged at the turn of the 20th century. Whereas crystallography advanced into a new era of complexity and possibility, using electric microscopes to unearth previously unseen patterns within crystal formations, urban planning is still struggling to develop new devices capable of identifying the complex patterns within contemporary urban space. this collaborative project seeks to apply the noble prize winning research of professor dan shechtman in crystallography towards the field of urban planning, in order to create new tools capable of recognizing and analyzing spatial behavior patterns through the synthesis of big data.

71 **Live It**
"Commons" | Envisioning the new public space, Uri Shavit, Oded Katz

The degradation of the netanya sandstone cliffs has placed coastal infrastructure, buildings and human lives at risk. The never-ending conflict between natural processes and urban life requires us to redefine a new balance between the natural and the artificial. 'Live It' is a TechnoArt installation that enables viewers to feel, experience, and interact with sustainability and resiliency through a mediated nature-urban encounter. A large image of Netanya's Kurkar cliff's morphology, from a LiDAR (Light Detection and Ranging) scanner covers the pavilion's entire wall. Visitors are invited to use their smartphones to scan a barcode, which will open an immersive 360 degree animated video on their device.

PART II - THE LIFEOBJECT



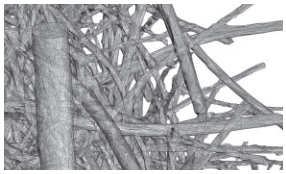
81 **A Matter of resilience**
Arielle Blonder

LifeObject is an architectural installation that transposes the resilient properties of a bird's nest, through scientific analysis, into a spatial form rich with new architectural perspectives. At the core of the installation are free-form volumetric airy surfaces undulating in space that are composed out of over 1.500 slender and light components, inspired by twigs; relying on tension only, they form a light-weight, porous and resilient structure. The LifeObject combines smart, composite and biological materials in the formation of a 'living structure.'

91 **A Biomimetic Application of the Sparrow's Nest in Architecture**
Bnaya Bauer

The LifeObject installation is based upon a biomimetic approach, derived from a complex scan of a bird's nest, made of twigs that are woven together, all elements in the nest are bent in the building stage, thus creating a cohesion system based on tension with no relation to external forces that might shape the structure in future. The second principle demonstrates that while the twig's bending creates a tension induced force that keeps them in place, their spatial adjournment occurs through their integration.

101 **'FRP Twigs': Embedding Fabric Materiality**
Arielle Blonder



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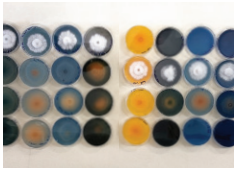
111 **The Breathing cycle and Smart Materials**
Noy Lazarovich

The Breathing Cells are eleven smart units dispersed within the LifeObject that react to the visitor's presence and change their shape, revealing glass spheres containing biological materials that are camouflaged behind a screen of shape memory alloy strips. The breathing cells are an autonomous ecosystem that lives inside the LifeObject. The visitor's presence activates the system, triggering a reaction in the shape memory alloy, which opens to reveals each capsule.

123 **Biological Materials - Cabinets of Curiosities**
Noam Attias



The biological materials featured in the breathing cells are natural organisms whih have the potential to transform building. Applying genetic engineering and biomimetic methods towards existing biological components or organisms can shift their functionality far beyond their original role in the organism or ecosystem, into the fields of advanced materials, applied towards diverse fields, including novel architecture methods.

137 **Urban Angiogenesis/Bio Smart City 3.0**
Knafo Klimor Architects, Ronit Satchi-Fainaro

Bio Smart City 3.0 is a dynamic installation that applies the biological process of angiogenesis - through which new blood vessels form from pre-existing ones - in order to explore new methods of preventing urban over-densification.

143 **Constructing a Niche: Learning From Animal Architects?**
Eva Jablonka

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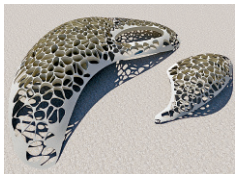
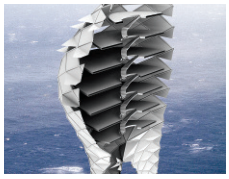
NCArchitects, Guy Austern, Laboratory for Nano-Biotech nology, The Hebrew University of Jerusalem



The nanocellulose desert shelter project explores the architectural potential of nanocellulose, a state-of-the-art material composed of recycled natural fibers, in the design of an educational and cultural center for the bedouin community in Israel's negev desert.

155 **The evolution of Biological Dimensions in Israeli Architecture**
Yasha J. Grobman

163 **The Breathing Building**
Farah Farah, Moti Bodek, David Elad



The breathing building proposes a bio-inspired building ventilation and air conditioning system that mimics the breathing process, where the nasal passage naturally conditions the inhaled environmental air. the proposed project presents a dynamic structure which is the outcomeof a joint collaboration between architects and bioengineers. Anchored in the mediterranean sea off the coast of Ashdod, the

Phrasebook

Rhizome; Variations; Resilience; Hybridity; Ecosystem; Death; Resuscitation; Apoptosis; Paraaite; Genotype, Phenotype; Emergence; Memory; Differentiation; Control; Scar; Symbiosis; Commensalism; Hierarchical Material; Self-Organization; Adaptability; Composite Materials; Fibers; Synthesis; Movement; Feedback; Intelligence; Reflex; Hypertrophy; Mitochondria; Fold; Budding; Isomers; Gangrenous Necrosis; Tumor; Transportation; Immune System; Autoimmune Diseases; Metabolism; Skeleton; Liquid Crystals; Membrane.

VASCULAR SYSTEM
VASODILATOR
ZOKONSTRIKTZIH
HYPERTROPHY
TRANSCRIPTION
BREATHING
METABOLISM
DIFFUSION
CELL WALL
VASCULAR SYSTEM
VASCULAR SYSTEM
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URBAN ANGIOGENESIS/ BIO SMART CITY 3.0

Using Nanomedicine Tools in Cancer Diagnosis and Therapy to Tackle Urban Overcrowding

KNAFO KLIMOR ARCHITECTS
PROF. RONIT SATCHI-FAINARO

Urban Angiogenesis | Rebuilding Damaged Urban Tissue

BIO Smart City 3.0 is a dynamic installation which applies the biological process of angiogenesis - through which new blood vessels form from pre-existing ones - in order to explore new methods of preventing urban over-densification. The installation consists of two towers measuring four and seven feet high, constructed from plexiglass. Red and black liquid flows continually through a series of polyurethane conduits, intertwining within the two towers, demonstrating both healthy and unhealthy levels of habitation, with green fluid demarcating processes of healing. The systems work simultaneously to represent areas of the structure which are either healthy, diseased, or in processes of treatment. The structures allude to the built and unbuilt urban fabric, with the color of the fluid referring to the identification and treatment of diseased areas due to unattended changes in population density.

Global trends of migration towards urban centers are increasing exponentially, overtaxing urban infrastructure to the point where it risks collapsing beyond repair. In order to assess the moment – where overcrowding in a city has reached 'the point of no return', this project examines if tackling urban sickness could be pioneered according to biological principles and methodologies which govern cancer research.

URBAN ECOSYSTEMS

In the age of sustainability, cities are being re-conceived as 'ecosystems', environments marked by a fragile balance between 'biotic' living organisms and the non-living 'a-biotic' factors of their environment. The ability of inhabitants to thrive in nature is dependent upon the carrying capacity of its ecosystem. Earth systems are governed by a dynamic equilibrium. The complexity of nature is derived from the contradiction between these two terms. The urban ecosystem is dependent on the reciprocal relations between living elements and the infrastructure which conditions their quality of life.

These systems can be found in a variety of scales within many aspects of our lives, but a violation of their delicate balance will almost certainly instigate a process of compensation in order to regain stability. Moving beyond the traditional binary which separates the natural from the artificial, towards a more porous integration of the biotic and the a-biotic can imbue our cities with greater resilience and sustainability.

One of the greatest threats to this balance has to do with overpopulation, a point echoed by Malthus[1], who claimed that when population growth outgrows its resources, we reach a 'Point of Crisis'. If we associate this theory with Israel's urban population (92%), it becomes necessary to think of ways of maintaining balance within our urban ecosystem in order to prevent the 'point of collapse'. Perceiving the city as a living organism requires that we look to nature for inspiration, and develop a mechanism that can mimic nature's dynamic means of maintaining balance and resiliency.

BIOLOGY AS A 'MODEL, MEASURE AND MENTOR'[2]

Angiogenesis, the growth of new blood vessels from pre-existing ones, is an important physiological process used for healing and reproduction. Abnormal angiogenesis, either excessive or insufficient, is associated with many diseases, including cancer, diabetes, cardiovascular disease, amongst many others. In these cases, new 'abnormal' blood vessels grow and feed diseased tissues with nutrients and oxygen, provoking the destruction of normal tissues. In the case of cancer, the abnormal vessels allow the tumor mass to grow in size, and facilitate the spreading of cancerous cells into the circulation system, where they lodge in other organs and create tumor metastases.[3]

Interfering with the creation of these new networks of abnormal blood vessels prevents the delivery of oxygen and nutrients, stopping the cancer's growth. While research shows a high prevalence of microscopic cancers in healthy people, the vast majority of these small lesions will never become cancerous and deadly, because they are not able to induce the formation of new blood vessels that nourish them. Therefore, there is an urgent unmet medical need to create smart probes that detect tiny lesions before they

1. Malthus TR., (1798). *An Essay on the Principle of Population*. London: J. Johnson, in St. Paul's Church-yard.

2. Benyus, J.M., (1997). *Biomimicry: innovation inspired by nature*. New York, Quill.

3. Judah Folkman, Tumor Angiogenesis: Therapeutic Implications, N Engl J Med 1971; 285:1182-1186.

become symptomatic, or alternatively, to find a way to regress them in a selective manner back to a dormant or normal state.[4]

The suggested treatment relies on connecting existing methods to nanometer-sized smart carriers that will lead them selectively to target tumors and their surrounding network of blood vessels, and significantly reduce the amount of drugs required as well as the extent of the treatment, ultimately abrogating the side effects associated with standard chemotherapy.[5] It will eventually be possible to treat cancer patients based on a blood test, obfuscating the need to detect the tumors and their precise location. Using non-toxic nanomedicines, it may be possible in the future to treat cancer as a preventive measure before it becomes symptomatic or, in cases where one cannot be cured completely, to make cancer a chronic yet manageable disease. Understanding the interactions between tumor cells and normal cells will revolutionize the way we think about cancer, making it a curable or at least dormant disease leading to major improvement in the quality of life of those who suffer from it.

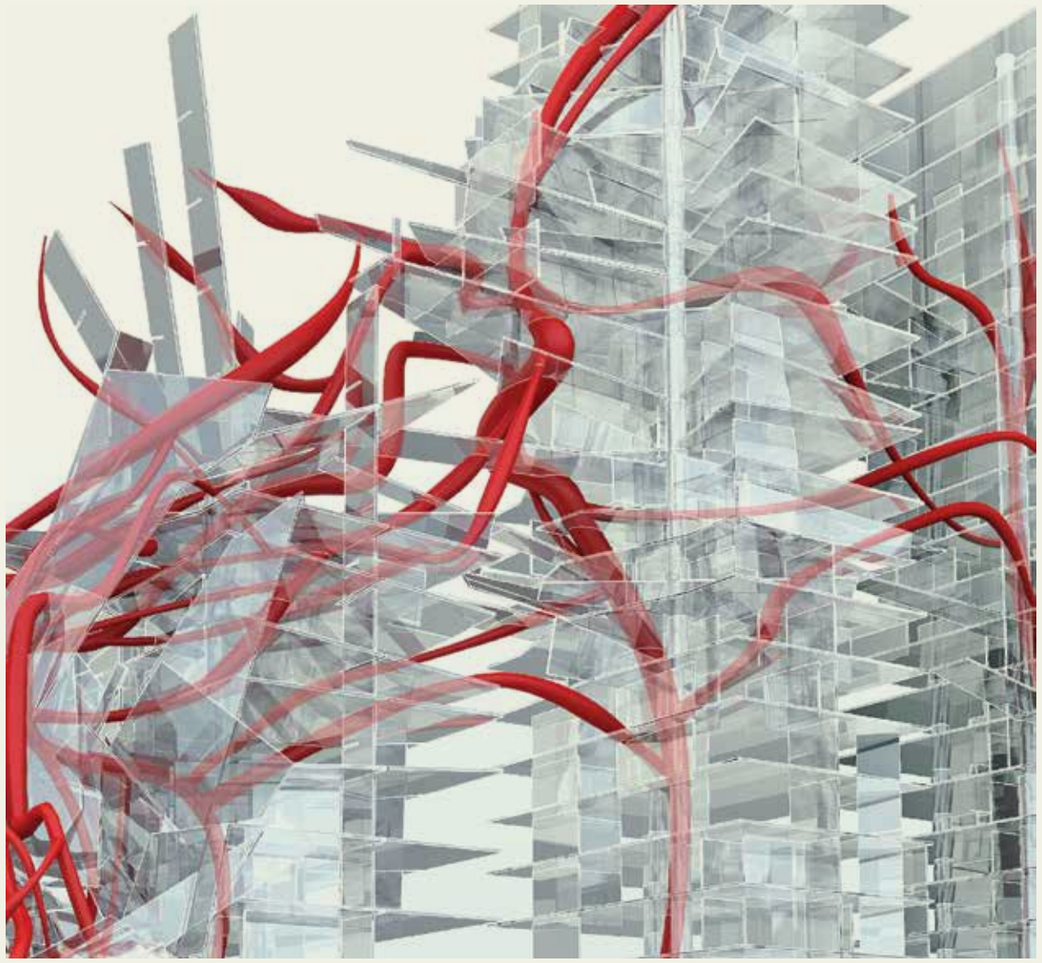
Comparing cancer tumor development with rapid urban growth exhibits similarities in both processes: In both cases if left untreated, infrastructure grows at an uncontrollable pace in order to nourish the new ‘tissue’, both within the biological and urban realms, bringing the system closer to its ‘point of collapse’.

Tel Aviv provides a good example of this. Over the past decade, the city has evolved into a magnet for young creatives, causing a rise in growth and a change in the cities demographic structure. As a result, the local housing market has not been able to keep up with increasing demand. Various urban solutions are evolving in order to provide affordable and appropriate housing solutions, but these solutions frequently lack the necessary support and infrastructure, and frequently bring forth questionable living standards.

Cancer treatment engages smart nano-probes to identify and disrupt the infrastructure created during angiogenesis to treat diseased areas before they reach their pathological stage. This begs the question; can we treat overcrowding through the identification of both healthy or unhealthy infrastructure created as a result of rapid urban growth? These questions have become increasingly urgent in the case of Tel Aviv, where market forces have created a massive change in the structure of the city, with little research or understanding as to how this will affect the city social and ecological services. Tel Aviv is today known as Israel’s startup capital, and is ranked as one of the most innovative cities worldwide. The city is undergoing a digital revolution through the implementation of innovative systems that enhance the well-being of city dwellers. The challenge is to embrace these emerging new solutions by innovatively applying and cross referencing accumulated data, and by

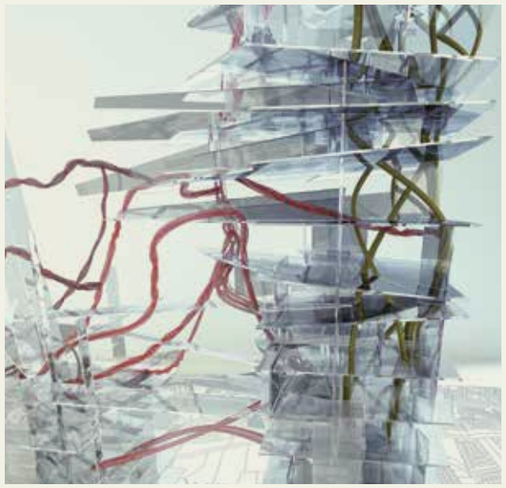
4.Tiram G, Segal E, Krivitsky A, Shreberk-Hassidim R, Ferber S, Ofek P, Udagawa T, Edry L, Shomron N, Roniger M, Kerem B, Shaked Y, Aviel-Ronen S, Barshack I, Calderón M, Haag R and Satchi-Fainaro R, Identification of Dormancy-Associated MicroRNAs for the Design of Osteosarcoma-Targeted Dendritic Polyglycerol Nanopolyplexes, ACS Nano 10(2): 2028-2045 (2016).

5.Satchi-Fainaro R, Puder M, Davies JW, Tran HT, Sampson DA, Greene AK, Corfas G, Folkman J: Targeting angiogenesis with a conjugate of HPMA copolymer and TNP-470. Nat Med 2004, 10(3):255-261.



Excessive Urban Angiogenesis | Reaching the Point of Collaps

Tents Protest in Rothschild Boulevard in Tel Aviv



Urban Angiogenesis | Durability Loss

optimizing tools for the creation of a more balanced urban ecosystem.

The application of bio-processes challenge current planning practices, and raise questions about the ways we can control the different disorders associated with urban densification. Can we monitor existing densification, determine the problematic issues and diagnose them in time to prevent collapse? Or should we expect a 'point of Crisis'? The challenge is to use big data to leverage the benefits of densification, strengthening the advantages while simultaneously averting the 'breaking bad' scenario.

REDEFINING THE CITY - TOWARDS BIO SMART CITY 3.0

Smart City 3.0 is supported by communication systems akin to sensory receptors in the human body. Processes in both the theoretical model and the human body are facilitated by the absorption of stimuli, and the response that follows the absorption of incoming incitements. Information gathered in the city allows us to monitor events and changing urban situations that require our response. Like the human body, where normative and pathological processes exist, the city is in a process of constant dynamic change where various processes of densification are carried out simultaneously as a new 'tissue' forms.
In the body, there are natural mechanisms of control, but at a certain point, the body loses its ability to cure itself and pathological processes overtake and destroy the system. The use of 'big data' for analytical purposes, combined with the proposed nano-technological approach, can be applied to urban zones, sending 'intelligent agents' to identify, detect and treat the affected area without destroying healthy tissues. These tools can prevent the development of destructive pathological phenomena, and strengthen the healing processes through a focused treatment suitably adapted to local problems.

Making the analogy between the biological research and urban planning constitutes a call to learn from physiological and pathological processes in nature and explore how we can harness the wisdom of nature and science for the benefit of planning and architecture. Just as the proposed cancer treatment uses the already accruing process in the body for the benefit of the treatment, Smart City 3.0 should use the evolving and accumulated data and information to provide targeted solutions for local situations. Integrating responsive technology that will react to a variety of issues and events is the key for establishing balanced, stable and resilient cites, all the while introducing a new social and environmental approach to the nature-human ecosystem.

Knafo Klimor Architects was founded by Tagit Klimor and David Knafo in 1980. With over 35 years of practice, the firm's objective in each design project is to embrace wider environmental and social concerns. Both partners are senior lecturers at the Technion, Israel Institution of Technology.

Professor Ronit Satchi-Fainaro is the Chair of the Department of Physiology and Pharmacology at the Sackler Faculty of Medicine, Tel Aviv University. She is the Head of the Cancer Angiogenesis and Nanomedicine Laboratory at Tel Aviv University, and a Visiting Professor at Harvard University.

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Mechanical & Electrical implementation: Yacov Biofcic, ER&D - Engineering, Research & Development.
Cancer Angiogenesis and Nanomedicine Laboratory, Sackler Faculty of Medicine, Tel Aviv University: Prof. Ronit Satchi-Fainaro, in collaboration with Galia Tiram.

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