



THE SIXTH ELEMENT

VI

UNVEILING THE NATURAL BEAUTY
OF 3D PRINTING

THE SIXTH ELEMENT



UNVEILING THE NATURAL BEAUTY
OF 3D PRINTING



Objet1000™

Objet1000 – the world's largest multi-material 3D printer – capable of 3D printing 1:1 scale parts combining rigid and soft materials, all in a single build.



Objet500 Connex3™

Objet500 Connex3 color, multi-material 3D production system produces complex parts with virtually unlimited combinations of rigid, flexible, transparent and color materials – all in a single print run, requiring no assembly.



**THE SIXTH ELEMENT:
UNVEILING THE NATURAL BEAUTY
OF 3D PRINTING**

November 2014

Materials and techniques

Digital Materials, using triple-jetting technology by Stratasys® Ltd.

Objet®500 Connex3™ color, multi-material 3D Production System and Objet1000™ multi-material 3D Production System.

Core team:

Nick Ervinck

Eyal Gever

Neri Oxman, Architect, Associate Professor of Media, Arts and Science, Mediated Matter Group Director, MIT Media Lab. In collaboration with Christoph Bader; Dominik Kolb (Deskriptiv) and Joe Hicklin (The Mathworks)

Graphic Design:

Studio Razgroup

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INTRODUCTION

THE SIXTH ELEMENT ^{VI} UNVEILING THE NATURAL BEAUTY OF 3D PRINTING

“All matter originates and exists only by virtue of a force which brings the particle of an atom to vibration and holds this most minute solar system of the atom together. We must assume behind this force the existence of a conscious and intelligent mind. This mind is the matrix of all matter.”

- Max Planck: Das Wesen der Materie [The Nature of Matter], speech at Florence, Italy (1944) (from Archiv zur Geschichte der Max-Planck-Gesellschaft, Abt. Va, Rep. 11 Planck, Nr. 1797)

PUSHING THE BOUNDARIES OF MATTER

We live in a world with an abundant array of diversity, evident in the natural environment and in life. “The Sixth Element: Unveiling the Natural Beauty of 3D Printing” by StratasyS engages both the imagination and the senses in its expression of nature and interpretation of organic creation and force.

Through the sense-provoking work of three renowned artists - Nick Ervinck, Eyal Gever and Prof. Neri Oxman - “The Sixth Element” explores the tension between the physical and the metaphysical. This is expressed through extraordinary sculptures that examine the relationship between form, dynamics, movement and performance and that reflect the design nuances made possible with a combination of multi-color, multi-material, rubber, rigid, opaque and transparent 3D printing in all scales.

THE ELEMENTS

“Nature that framed us of four elements, Warring within our breasts for regiment, Doth teach us all to have aspiring minds: Our souls, whose faculties can comprehend The wondrous architecture of the world, And measure every wandering planet’s course, Still climbing after knowledge infinite, And always moving as the restless spheres, Wills us to wear ourselves, and never rest, Until we reach the ripest fruit of all, That perfect bliss and sole felicity, The sweet fruition of an earthly crown.”

- Christopher Marlowe: 1587 Tamburlaine the Great (published 1590), pt.1, act 2, sc.7

The 3D printed sculptures created in this collection were generated out of spirit, from “ex nihilo,” a Latin phrase meaning something “out of nothing.” The series includes 3D printed art inspired by the classical elements of nature, believed by many philosophies to reflect the simplest, essential parts and principles of which anything can consist and upon which the fundamental powers of everything are based. Each sculpture is designed to incorporate a specific element or a combination of elements necessary for sustaining nature.

The five elements in classical thought are Earth, Water, Air, Fire and Life. The sixth element in this series is 3D Printing, used to transform the patterns and forms of the natural elements into sculptures.

3D Printing is the synthesis. It binds the classical elements together and has the ability to transcend traditional ideas, rules and patterns to create meaningful new ideas and interpretations. It is also the key to understanding the nature of creative thought, through the convergence between art, nature and new digital opportunities.

E **ELEMENT: EARTH**
Earth is above all things grounded and stable, trusting to roots and creating a sense of stability in our lives. It is associated with the force from the ground, a source through which we gain our strength, power and roots.

W **ELEMENT: WATER**
Water is associated with emotion, flow, transference, fluidity and birth. It creates polarity, health and sexuality and represents the fluid nature of the body. Our entire existence is based on water, it is critical for the existence of all living matter and organisms.

AW **ELEMENT: AIR/WIND**
Air and Wind are about all the things that we cannot see but can feel. Air is balance and equilibrium associated with creativity, the spark of inspiration, transcendence, cognition, spirit and movement. It is also communication and sound, wisdom and knowledge, light and clear seeing.

F **ELEMENT: FIRE**
Fire implies power, strength, passion and heat. It is also vitality, spontaneity, strength of will, purpose and esteem. It is also associated with destruction, violence, explosion and decay.

L **ELEMENT: LIFE**
Life is about nature, movement, time, growth and love. It also reflects energy, binding and flowing through matter creating what we know as a force of life, sometimes creative and sometimes destructive. Life is also about spiritual growth and the conscious sides of life.

3D **ELEMENT: 3D PRINTING**
3D Printing is an additive manufacturing technology. It is the Axis Mundi, the world center, connecting between the physical and the metaphysical. It signifies the “synthesis” that binds the classical elements together, transforms the organic, unifies particles and has the ability to transcend traditional ideas, rules and patterns to create new meanings and interpretations.

3D Printing has been described as the most influential new medium for creative and innovative professionals. What makes it so unique is its resemblance to the way organisms grow in nature. It harnesses the intelligence and wisdom of nature and defies boundaries to produce a physical shape, expressing originality and imagination.

3D Printing is also the key to understanding the nature of creative thought, through the convergence of art, nature and new digital opportunities that exist for artists and designers – enabling them to produce new forms and shapes that would otherwise be impossible to realize.

EXPRESSING THE RATIONAL AND IRRATIONAL ELEMENTS OF NATURE

3D Printing’s additive process is both highly versatile and uniquely simple, removing the constraints of traditional manufacturing and

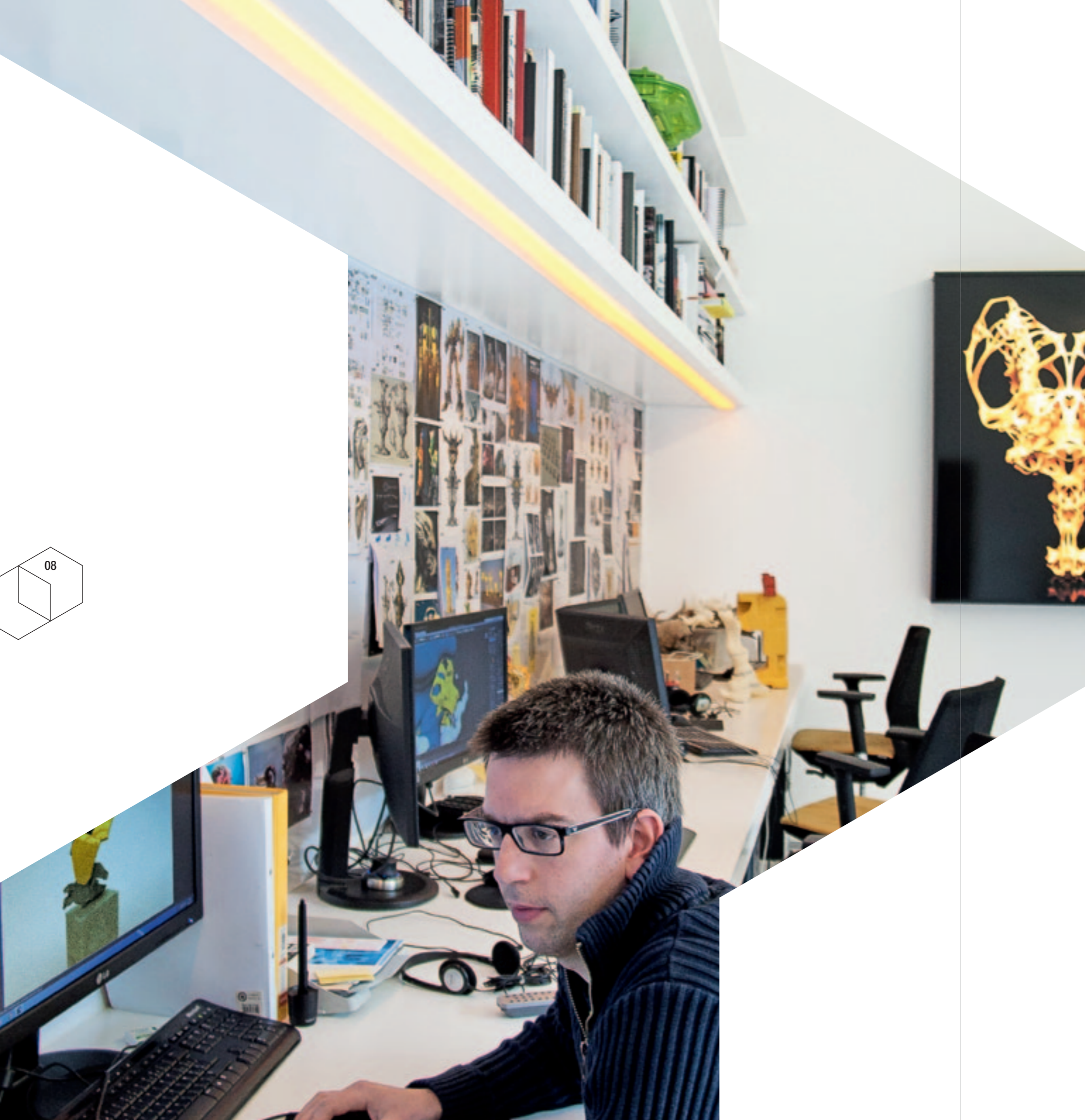
enabling almost all forms of physical expression. It enables artists, designers and engineers to rapidly create whole assemblies, unique artistic geometries and functional prototypes and final parts straight from a 3D design.

The “The Sixth Element” sculptures were created using the Objet500 Connex3 color, multi-material 3D Production System as well as the world’s largest multi-material 3D printer, the Objet1000. Using triple-jetting technology, these 3D printers offer unprecedented control over material properties such as rigidity, opacity and color. The artists were able to control and vary material properties at length scales of only several microns and produce highly complex parts. In some cases, this inspired the artists to think of 3D Printing not only as a fabrication output but as a design tool where the resolution of layers, the use of materials and the coloring strategies can also be hard coded.

The result is a beautiful collection of sculptures reflecting the dynamics and flow that we see in Earth, Water, Air, Fire and Life. “The Sixth Element” demonstrates unprecedented levels of artistic expression, ranging from extremely large in scale standing sculptures to highly precise artworks that feature interesting textures, patterns that deploy density and depth, minute details and complex surfaces and geometries that reflect the rational and irrational elements of nature.

We are proud to be associated with the extraordinary work of Nick Ervinck, Eyal Gever and Prof. Neri Oxman who have created the inspiring artistic pieces you see in this collection.

Enjoy



LIGHT, WIND, WATER, MOVEMENT

DESIGNED BY NICK ERVINCK

Fostering a cross-pollination between the digital and the physical, Belgian artist Nick Ervinck explores the boundaries between various media and explores the aesthetic potential of sculpture, 3D prints, animation, installation, architecture and design. Through his sculptural objects, he examines spatial positioning and points to the phenomenological experience and embodiment of space. These works oscillate between the static and the dynamic and reinvigorate the capacity of the ornament and the void in order to prospect new virtual or utopian territories transformed into reality through the use of 3D printing.

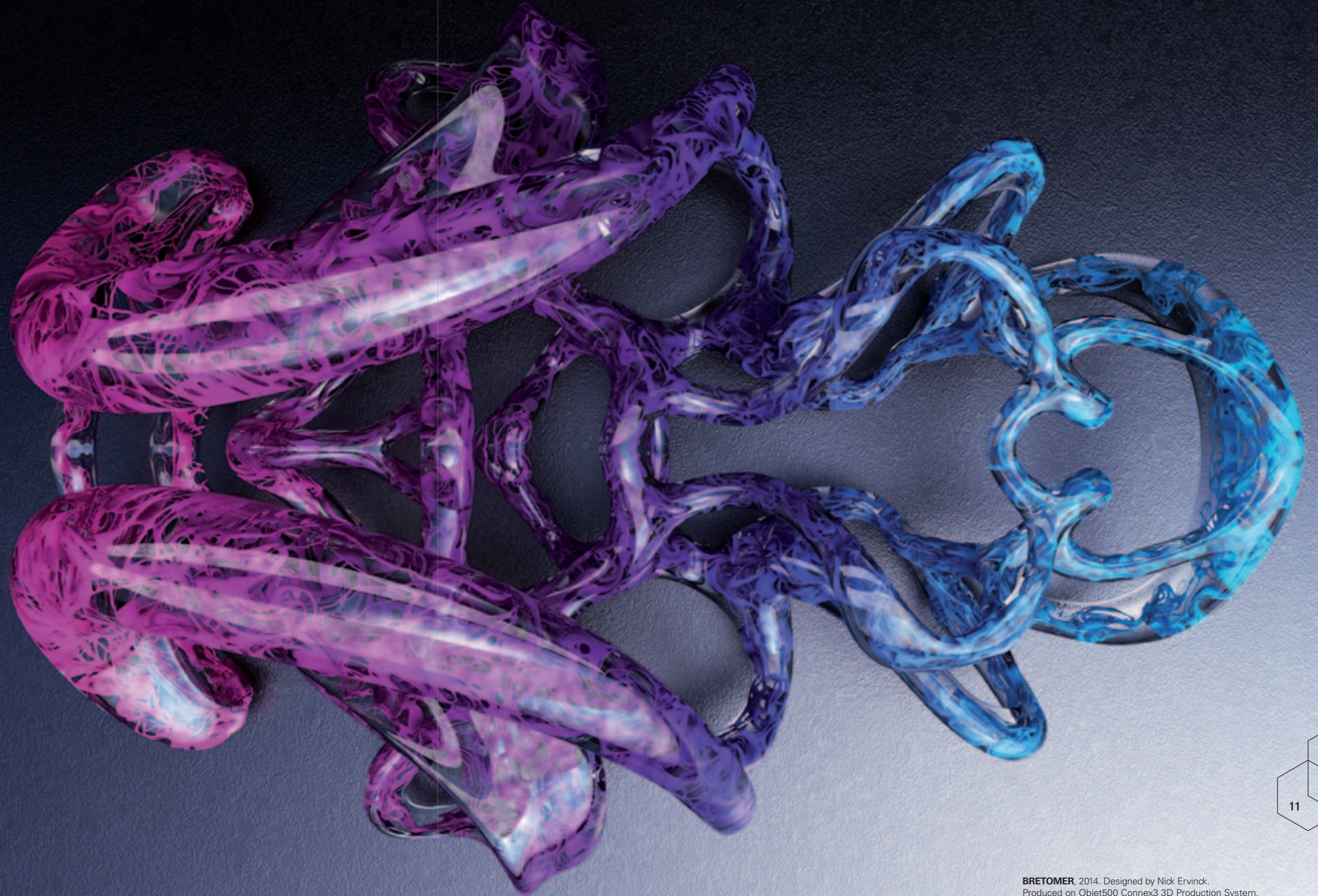
Ervinck's work has been included in numerous group shows, nationally as well as internationally. In 2005, he received the Godecharle prize for sculpture, followed by the Mais prize of the City of Brussels and the Prize for Visual Art of West-Flanders in 2006. In 2008, Ervinck was a laureate of the Rodenbach Fonds Award, and he won the audience award for new media at Foundation Liedts-Meesen. In 2013 he won the CoD+A Award in the liturgical category. Recently, he showed work at MOCA Shanghai, Chamber New York, MARTa Herford, Kunstverein Ahlen, Koraalberg Antwerp, Zebrastraat Ghent, HISK Ghent, Vrijstaat O./Freestate Ostend, Superstories Hasselt, De Brakke Grond Amsterdam, MAMA Rotterdam, Hermitage Amsterdam, Ron Mandos Amsterdam, The Baker Museum Naples Florida, Creativity World Biennale Rio De Janeiro and Oklahoma, Highlight Gallery San Francisco and Telic Arts Exchange Los Angeles/Berlin.

DESIGN IDEOLOGY

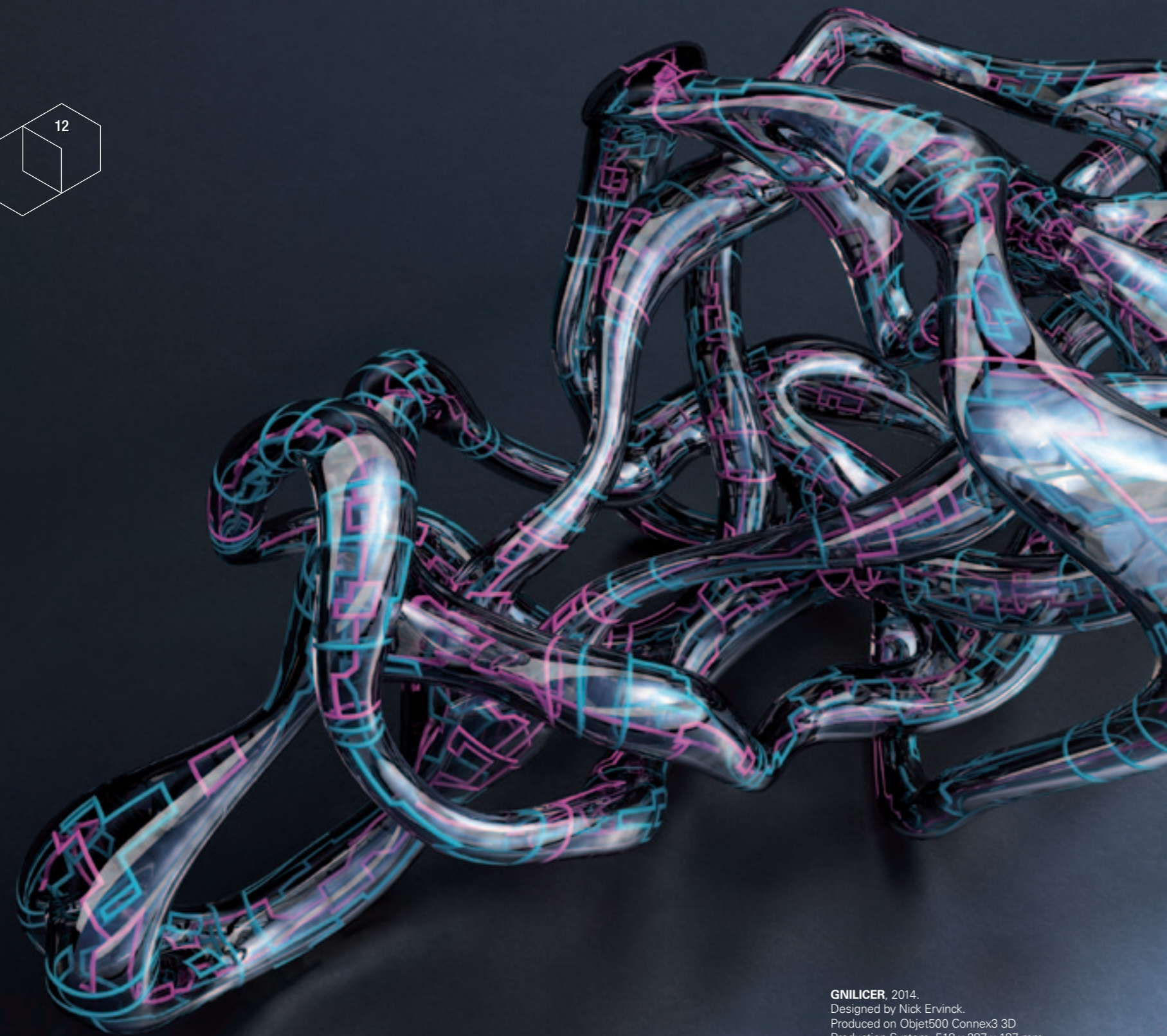
Ervinck's occupation with how art has developed due to new materials and techniques has led him to turn toward architecture, applied sciences and new media, to create forms and designs previously unthinkable. His work seeks to explore the realm of the impossible by constantly pushing the limits of what we call "realistic." Moreover, his designs balance on the edge of functionality, spatial interventions, digital aesthetics and object-oriented eclecticism.

Taking a vanguard position in the field of digital technology, Ervinck applies 3D printing to produce almost any type of intricate geometry or ornament. He uses copy-paste techniques in a 3D software environment, to derive images, shapes and textures from different sources. Ervinck focuses on how the computer can be used in the realization of new, organic and experimental (negative) spaces and sculptures within sculptures, and how the tension between blobs and boxes are articulated during the digital designing process. Organic, geometric, fluid and massive, Ervinck's artworks thus demonstrate the sculpture as a crossover, as a visual hybrid floating between high tech and low tech and referring to both the classic sculpture and the language of futurism, science and high technology.

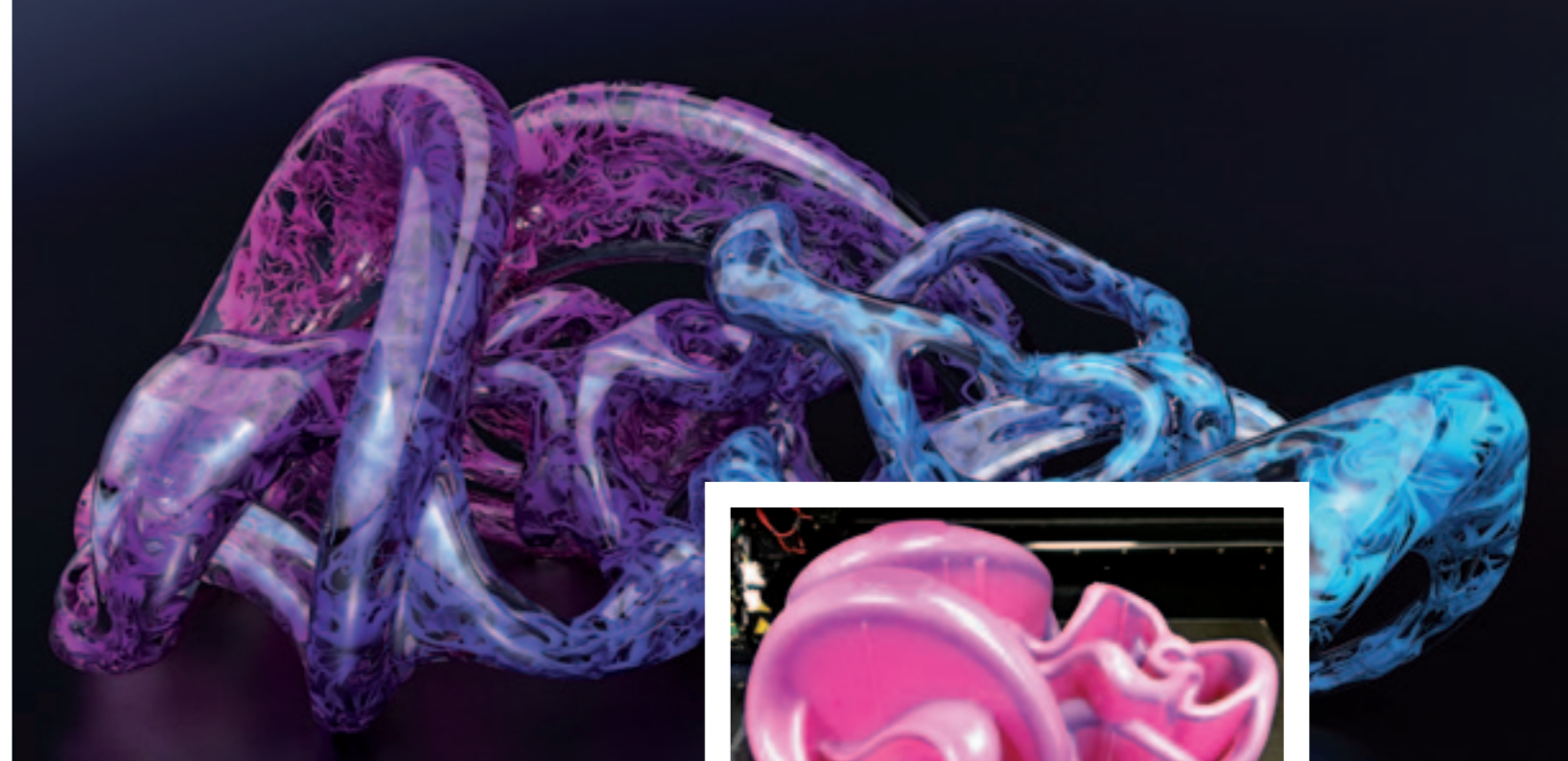
In his sculptures, the incorporation of motion into a stationary sculpture takes precedence and in his recent works with Stratasys, Ervinck focuses on reflection, color and movement to create sculptures that seem to escape the virtual world, yet don't seem to be born from it.



BRETOMER, 2014. Designed by Nick Ervinck.
Produced on Objet500 Connex3 3D Production System.
200 x 353 x 495 mm



GNILICER, 2014.
Designed by Nick Ervinck.
Produced on Objet500 Connex3 3D
Production System. 518 x 287 x 187 mm



BRETOMER, 2014. Designed by Nick Ervinck.
Produced on Objet500 Connex3 3D Production System.
200 x 353 x 495 mm

LIGHT AND WIND: GNILICER AND BRETOMER

"The destruction of the mass" GNILICER and BRETOMER are the continuation of an experiment that Jean Arp, Henry Moore and Georges Vantongerloo started all those years ago when they began their well-intended attack on our perception and definition of mass.

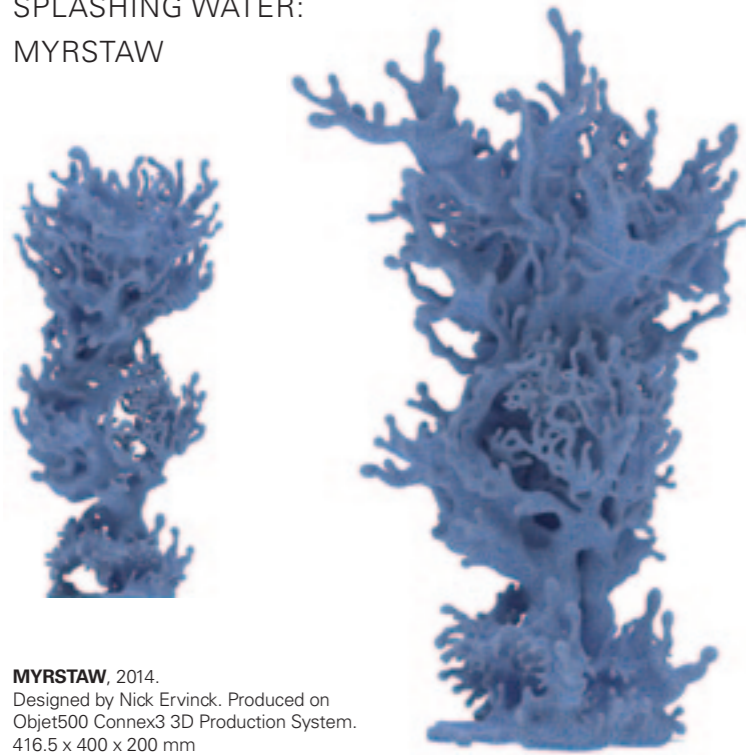
Giving meaning to the negative and giving depth to the hole, Ervinck continues this noble search, tearing down what we know and perceive. He does this by replacing the rigid foundation of blocks and hard materials usually associated with sculpting, with the incertitude of transparency and the seemingly infinite and elusive line. Paradoxically, it is within this incertitude that a new definition grows.

The shape we perceive seems to be very elusive, gives the impression of being unstable, susceptible to change, a visually contingent object. Our mind tries to complete the image we see by suggesting virtual shapes, which seem to correspond with the "outlines" (if there are any). Some of us would recognize older works, like Moore's "Reclining Figure," caught within the essence of these sculptures. Sometimes you could recognize a somewhat threatening alien creature. For some of us, the shapes just keep changing and surprising us. Because of this, the viewer is given a chance at interpretation, which gives us a chance to feel at one with the universe, to come into contact with that elusive universal truth that hides behind this veil we call reality.

GNILICER and BRETOMER are the result of the successful merging of two rather different worlds. This merger of two worlds, made possible by the Objet500 Connex3 color, multi-material 3D Production System. With this 3D printer, Ervinck was able to 3D print GNILICER and BRETOMER the way he envisioned them, an organic, biomorphic shape combined with a very unexpected play of lines. The fluid, organic outer shapes seem to rest upon the detailed and structured inner lines, which function as a floating skeleton propping up the entire sculpture. The colors seem to be caught within, a subtle reference to the noble search alchemists have been conducting for so long - namely trying to capture the essence of colors.

In GNILICER the colored lines remind us of the **light cycles** in the science fiction movie TRON (1982) or of the complex structure computer grids have these days. With BRETOMER we recognize a much more irregular and irrational play of lines, as if not only color, but also the very essence of **smoke** or **wind** is held captive in a foreign body. A power reaching, bending, contorting, trying to find its way through this abstract shape which sometimes has the likes of a strange being, a creature of alien origin.

SPLASHING WATER:
MYRSTAW

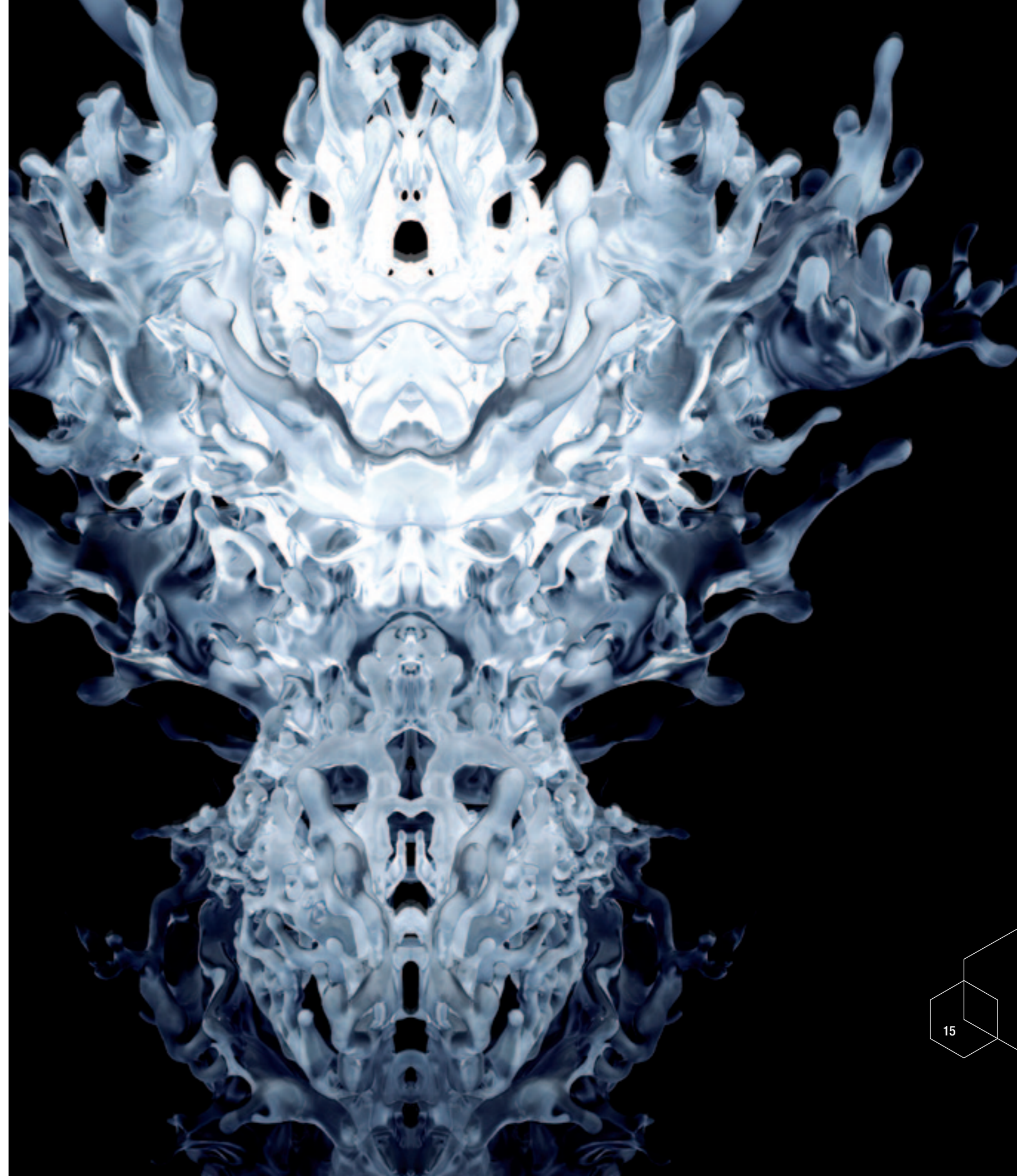


MYRSTAW, 2014.
Designed by Nick Ervinck. Produced on
Objet500 Connex3 3D Production System.
416.5 x 400 x 200 mm

MYRSTAW has something monstrous, a hybrid shape in which one can recognize various elements. In its symmetry it almost has the likeness of an alien creature or even an idol ready to be worshipped. The work isn't clearly defined but points in different directions. The imagery used is clearly inspired by macro photographic images of splashing water, and thus sculpturally interprets the encounter between nature and technology.

Ervinck tries to catch this sublime violence lurking behind a serene surface. How natural erosion processes generate irregular, complex structures (e.g. the erosion of rocks by seawater) has always fascinated the artist, and it was the inspiration for previous works such as NIEBLOY (2010) and IKRAUSIM (2009).

Though inspired by natural dynamics, this sculpture is generated by the power of the virtual. Not liberated from the material by a process of depletion and carving, the virtual form itself rather becomes a generative principle. Although MYRSTAW is designed fully digitally, it is nevertheless tangible because of its manual execution. After all, Ervinck is very interested in how new technologies can revitalize traditional sculpture and explore the limits of the possible.





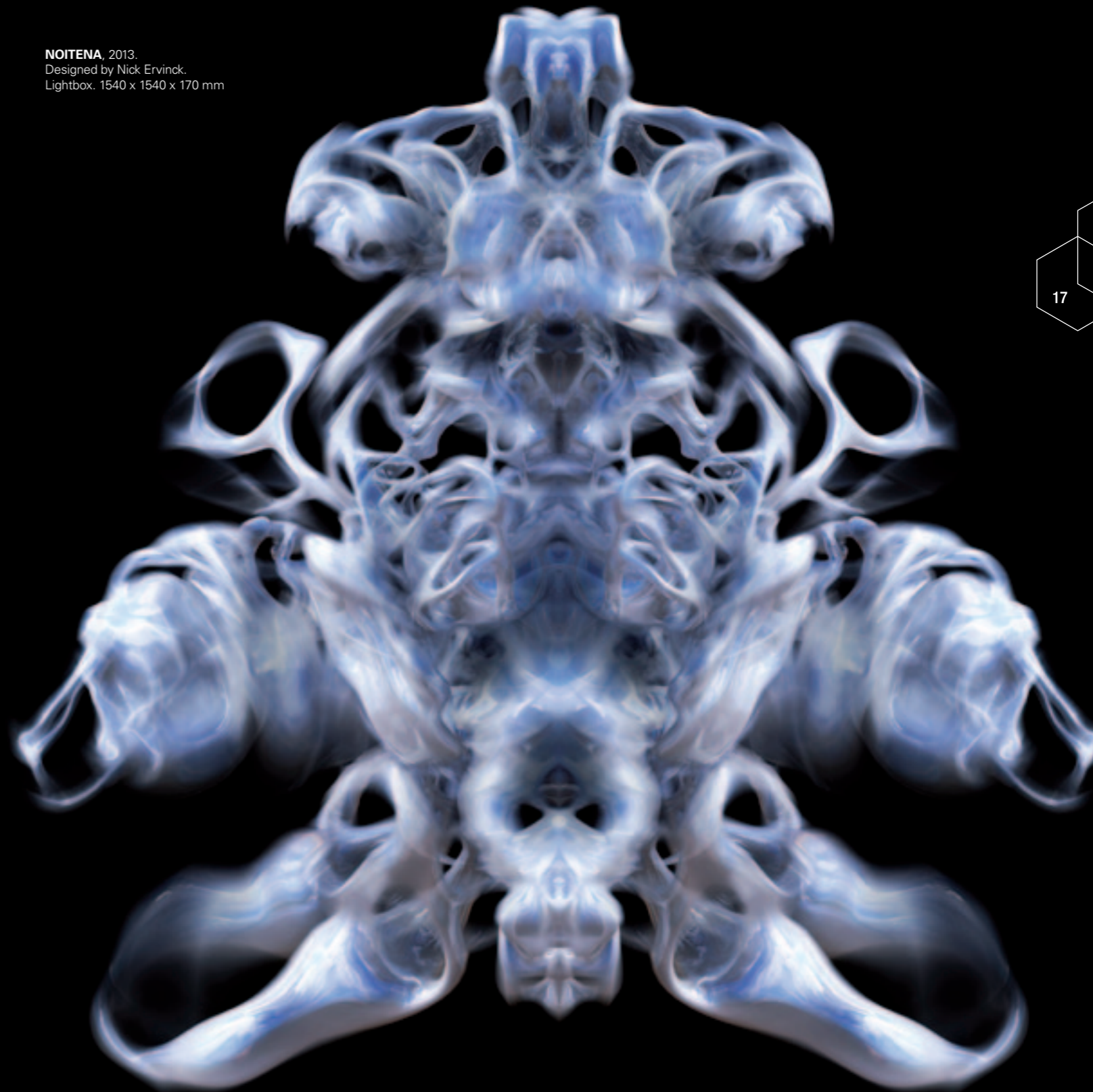
Study for
NOITENA, 2014
Designed by Nick Ervinck

MOVEMENT: NOITENA AND NOITULS

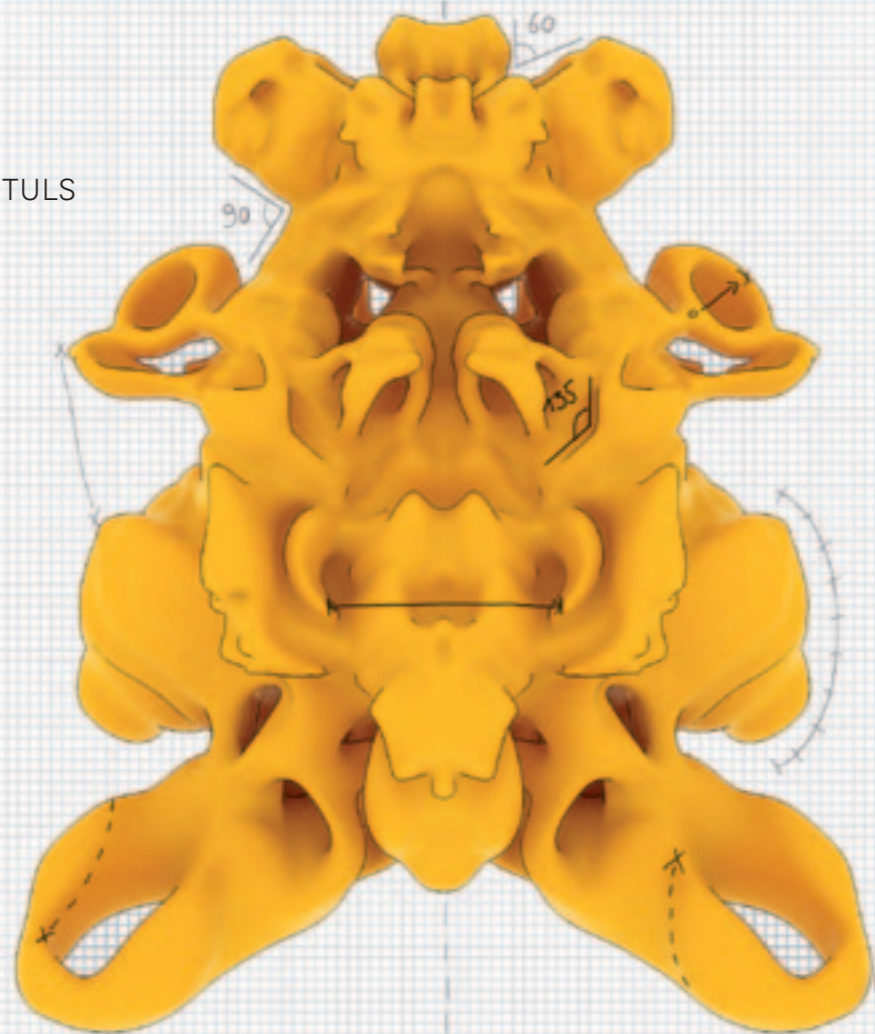
Just like a Rorschach drawing, NOITENA AND NOITULS can be read in different ways and at different angles. They feel spiritual, religious and alien to the touch. Ervinck created with these sculptures, mysterious and poetic works, sculptures that aren't easily fitted into specific categories.

As shadows of the past, these creatures seem to float in an infinite and undefined space. In this way they achieve the status of "nachbilder," or afterimages, optical illusions we see for the short moment after we look directly into the sun. It captures those little illusions we don't understand and therefore seem to forget very easily. That's why we are so haunted by these strange forms, captured in time. With NOITENA and NOITULS Ervinck manages to capture motion on a tangible medium. These sculptures were intertwined through various renderings, each focused on **reflection, color** and **movement**. In this way, he created sculptures that seem to escape from the virtual world, but appear not to be born from it. These sculptures are an homage to Eadweard James Muybridge (1830-1904), one of the first photographers who used his zoopraxiscope to visualize motion in an animation. Inspired by this groundbreaking achievement, many 20th century artists (Duchamp, Boccioni, Bala, etc.) aimed to capture motion, emotion and time in their own artistic medium. Here Ervinck tries to do the same. It is not just an interpretation though: With the help of 3D software, he has renewed the art historical tradition. Just like photographers experimented with new techniques in the beginning of 20th century, Ervinck attempts to push the boundaries with 3D printing in the 21st century.

NOITENA, 2013.
Designed by Nick Ervinck.
Lightbox, 1540 x 1540 x 170 mm



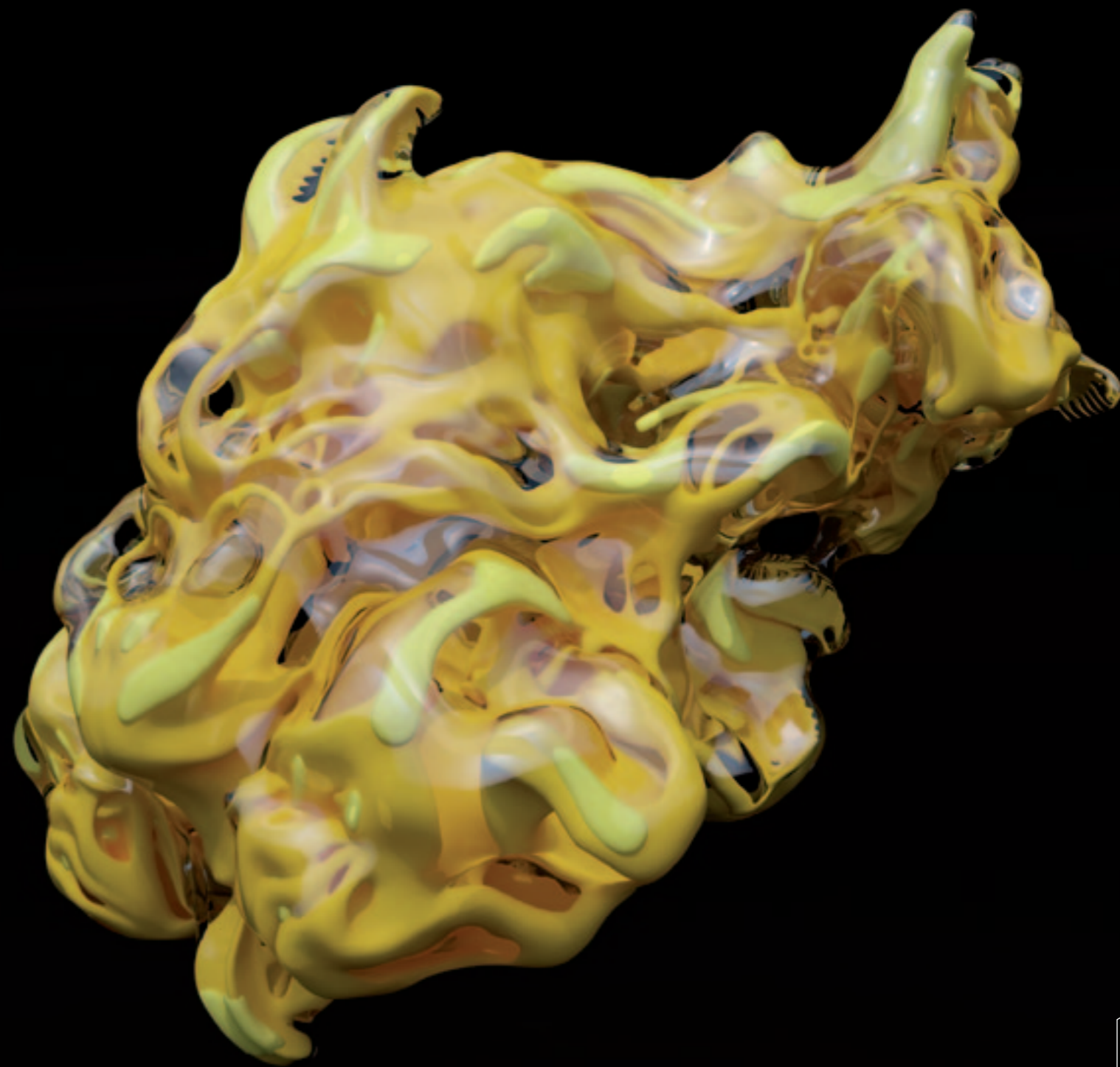
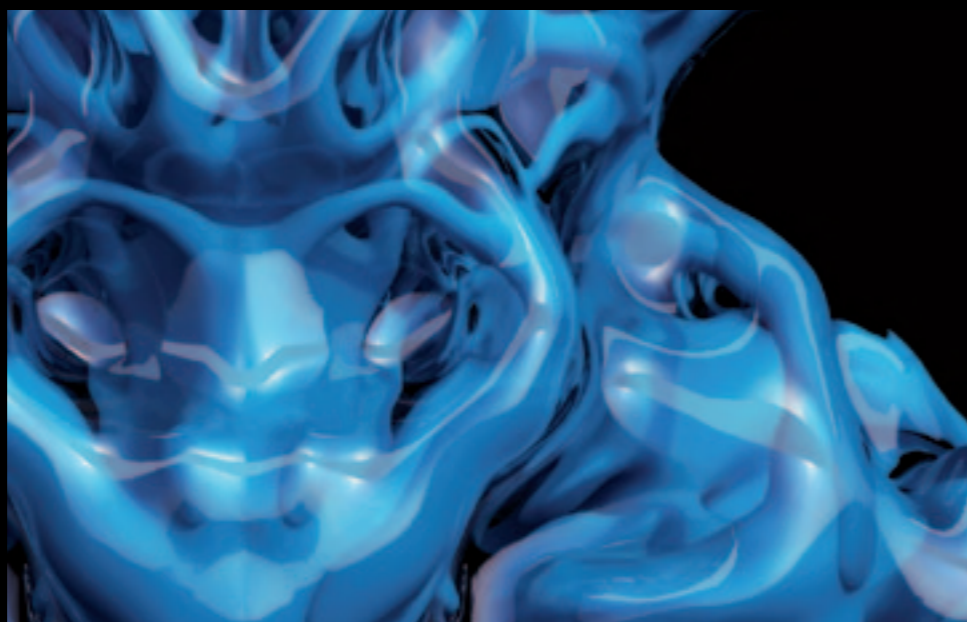
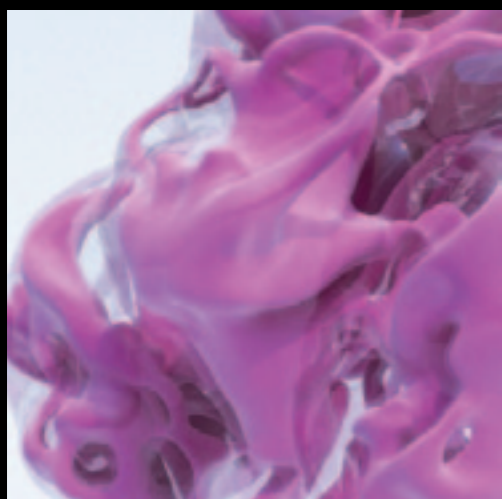
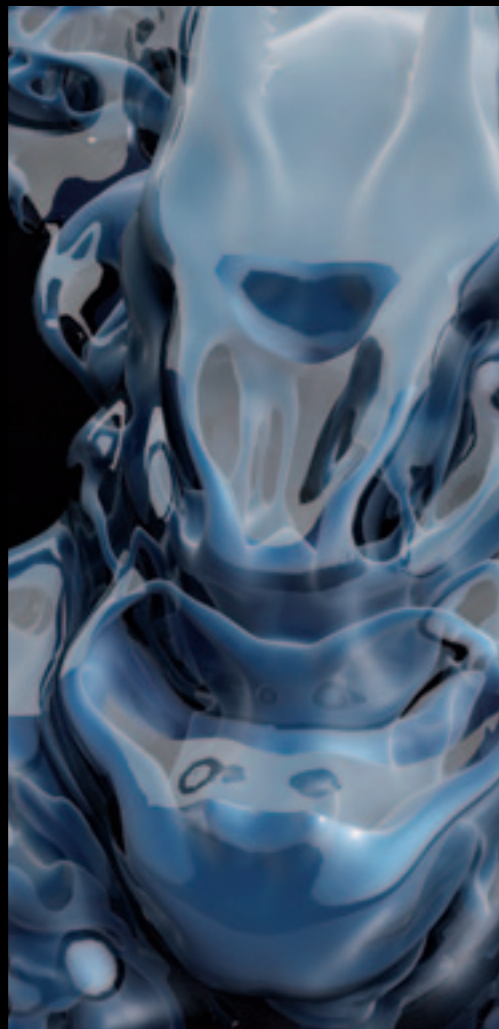
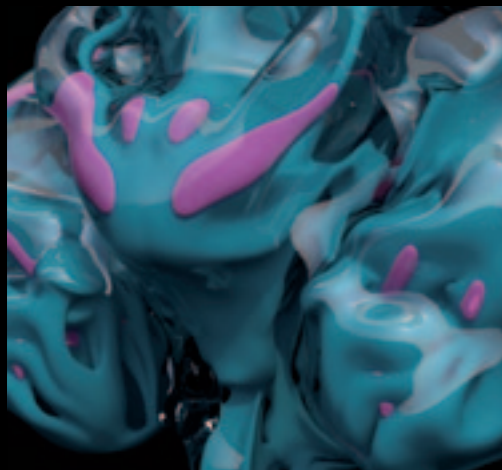
MOVEMENT:
NOITENA AND NOITULS



Study for
NOITENA, 2014
Designed by Nick Ervinck



NOITENA, 2014.
Designed by Nick Ervinck. Produced on Objet500
Connex3 3D Production System. 205 x 300 x 350 mm

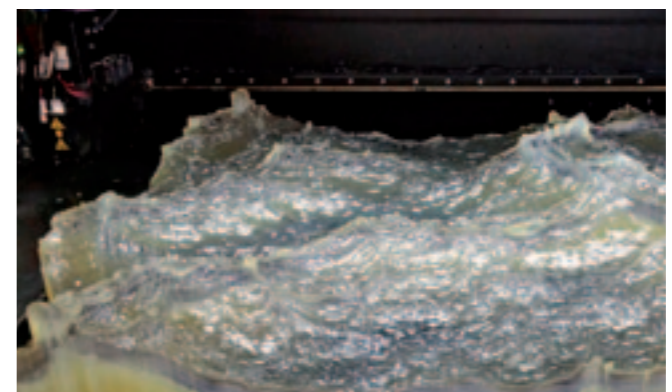


NOITULS, 2014, Designed by Nick Ervinck.
Produced on Objet500 Connex3 3D
Production System.
320 X 245 X 195 mm



SUBLIME MOMENTS

DESIGNED BY EYAL GEVER



PIECE OF OCEAN, 2014.
Designed by Eyal Gever.
Produced on Objet1000
3D Production System.
996 x 796 x 149 mm

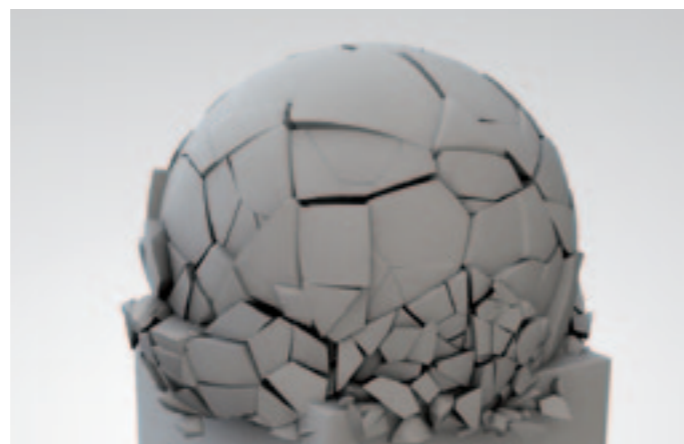
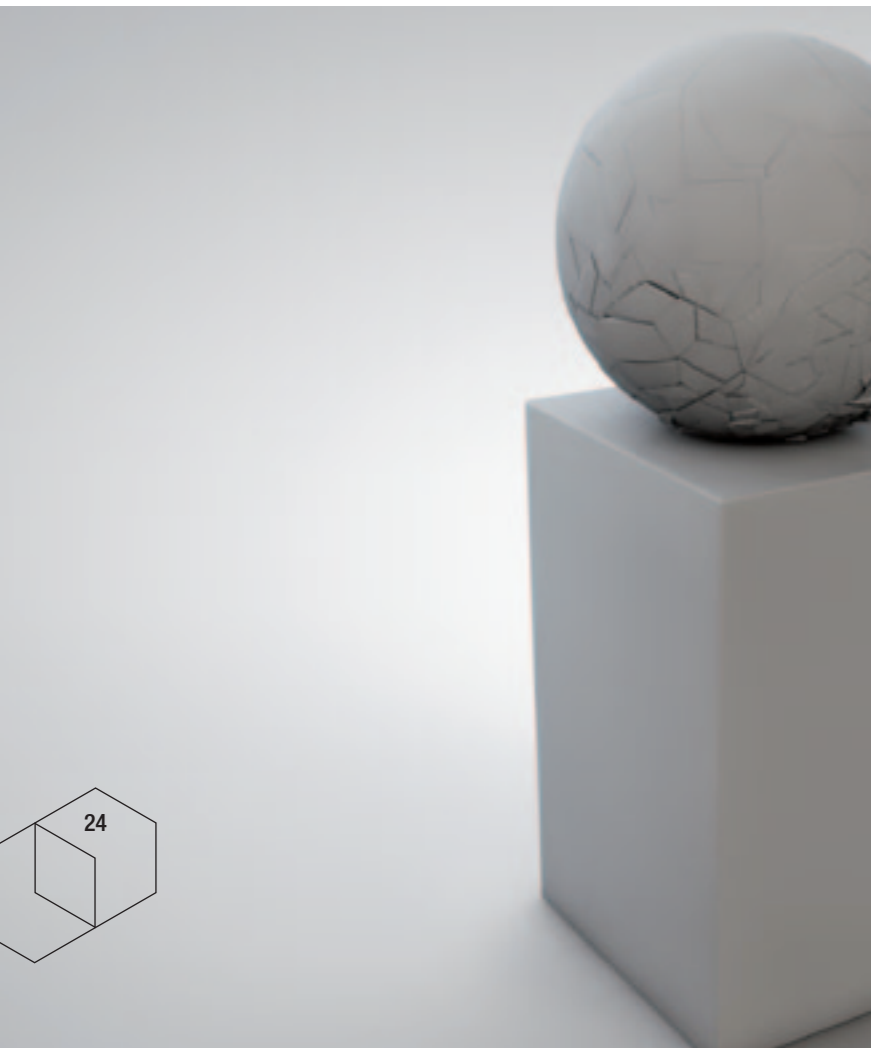
Eyal Gever is a digital artist with more than 18 years of experience in developing 3D technologies. He uses his extensive knowledge of art and technology to develop computer simulations of extreme events, 3D print pinnacle moments from his simulations, and transform them into cutting-edge physical sculptures.

Gever is a visionary in the high-tech industry and has received numerous awards for his innovation in multimedia design and technology. Gever founded and was the CEO of several technology companies including Zapa Digital Arts and Gizmoz, and co-founded Daz3D after the merger of Daz3D and Gizmoz in January 2010.



He has eight patents in Internet multimedia technologies, as well as in 3D computer graphics animation technologies, vision technologies and data transmission and propagation of rich media. He attended Jerusalem's renowned Bezalel Academy of Arts and Design.

A little over a year ago, Gever was approached by the National Aeronautics and Space Administration (NASA) and offered the opportunity to be the first artist to make art in space. The U.S. space agency has been developing a new 3D printer with the ability to print in zero gravity, which a team sent to the International Space Station in October 2014. Gever's art will be printed in space on the International Space Station and publicly revealed around April 2015.



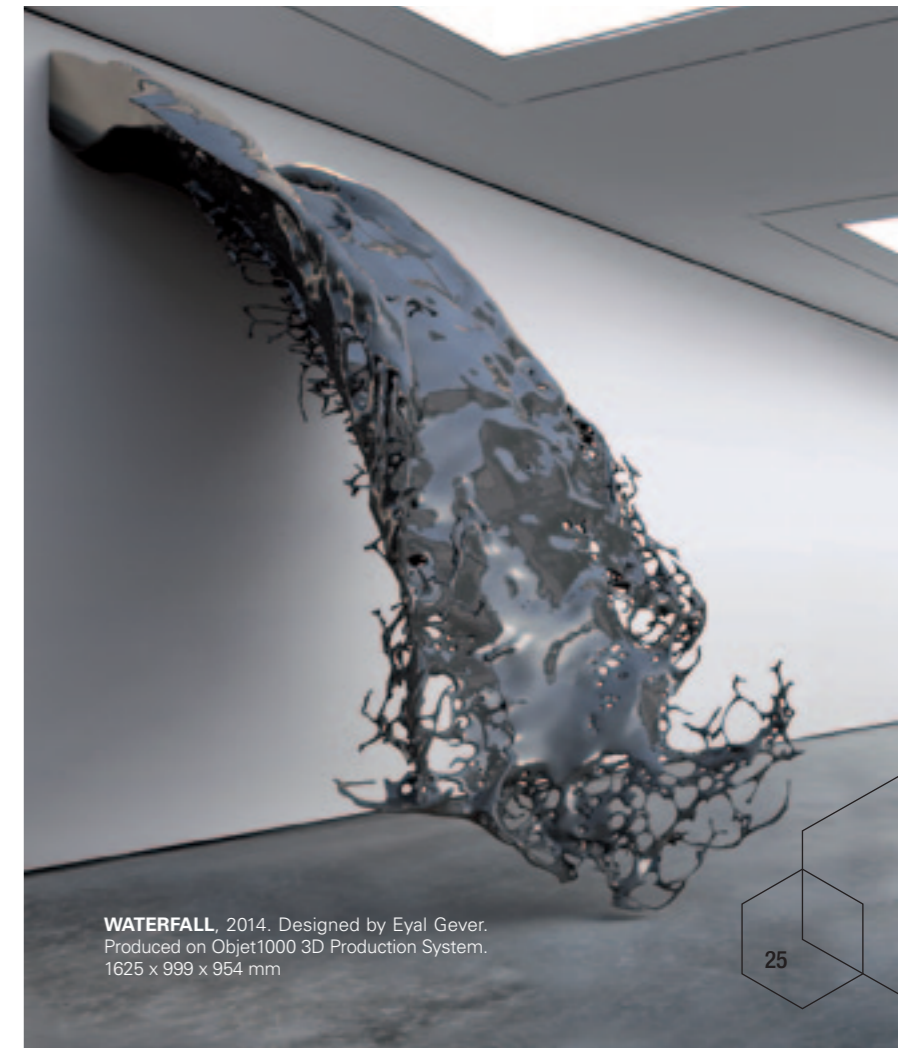
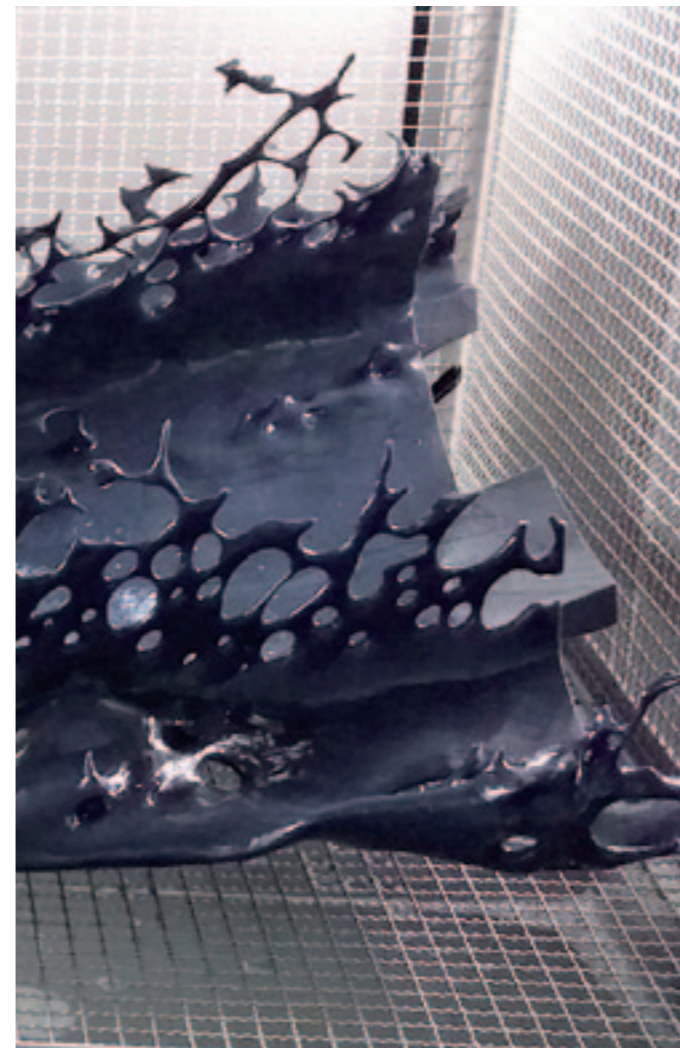
DESIGN IDEOLOGY

Gever creates artworks based on sublime moments. These are moments that fill a person with amazement, awe, terror, astonishment and silence. They are also moments of pure beauty. As Gever's artist statement reads: "To see something we normally cannot see. To examine states where rest and motion exist together. To explore the boundaries of time." Gever's ongoing body of works examines the relationship between the simulated events that he creates and their physical manifestation. These sublime moments are borne out of simulations and translated as art. His body of work exists in three states:

- 3D CGI simulations
- Tangible 3D printed sculptural moments
- 2D digital prints.

Gever is an avid follower of the news, and the main inspirational source for his art works - in search of the sublime - is never forgetting that beauty can come from the strangest of places, in the most horrific events. Gever's art addresses the restructuring of social and political systems, bad news, war reports and devastating images of terror, accidents, violent assaults and the decay of our urban environments. His sculptures also represent natural catastrophes, with their uncontrollable power, unpredictability and potential for cataclysmic extremes.

These everyday events are Gever's source of creativity and his constant reminder of the fragility and beauty of human life. This is Gever's understanding of Edmund Burke's conception of the sublime, which stems from the Greek rhetorician Longinus and



WATERFALL, 2014. Designed by Eyal Gever.
Produced on Objet1000 3D Production System.
1625 x 999 x 954 mm

undergoes philosophical critique by Immanuel Kant. It is his way of transporting this beauty to art. Gever's art is a form of sublimation transforming unwanted impulses into something less harmful.

Challenged by the notion that simulation technologies further blur the line between what's real and what's virtual. Gever is fascinated by how we are using science and technology to gain power over the world and create fictional substitute worlds in which we have complete (manipulated) control. His art, research and development oscillate constantly between these two worlds – the physical and the intangible.

A vital element in Gever's creation process is developing his own proprietary technology toolbox, a kind of 21st century artistic palette,

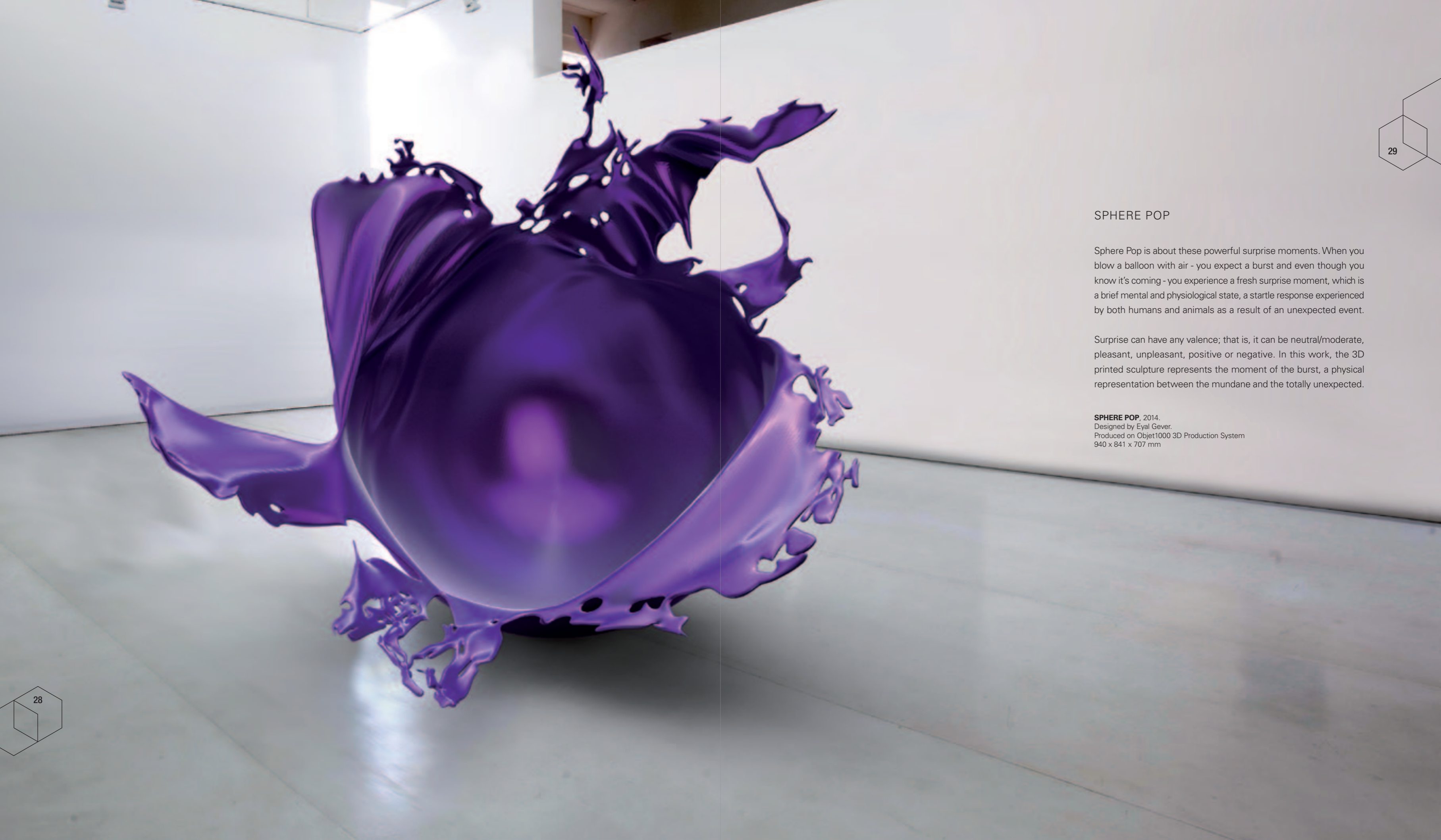
writing code for his simulation and technically pushing the envelope of fabrication, remixing, editing, manipulating and distributing. This enables Gever to create his art and question how the fusion of these two worlds change the way we understand reality.

Advances in visualization technology over the past 20 years have changed the way people look at the world. Simulations take Gever one step further, enabling him to manipulate and experience the impact in real time. Gever's research is influenced by the work of Professor Nick Bostrom, a Swedish philosopher at the University of Oxford, author of "Are You Living in a Computer Simulation?" and director of the "Impacts of Future Technology" program.

WATERFALL

Waterfall examines the relationship between the simulated events that Gever creates and their physical manifestation, incorporating objects of a dense and innovative process to achieve sculptures that seem both real and unreal. This sculpture reflects the moment and the environmental situation that demarcates the boundary between an event and its representation.

Inspired by "Étant donnés" by Marcel Duchamp, Waterfall conveys a 3D printed moment from a very realistic fluid simulation developed using particle-based simulations. The particles were influenced in a multitude of ways by point-based nodes, known as daemons, which can simulate gravity, fluids, water surface flow and collision. They were then 3D printed on the Objet1000 to create a simulated reality with the same intensity.



SPHERE POP

Sphere Pop is about these powerful surprise moments. When you blow a balloon with air - you expect a burst and even though you know it's coming - you experience a fresh surprise moment, which is a brief mental and physiological state, a startle response experienced by both humans and animals as a result of an unexpected event.

Surprise can have any valence; that is, it can be neutral/moderate, pleasant, unpleasant, positive or negative. In this work, the 3D printed sculpture represents the moment of the burst, a physical representation between the mundane and the totally unexpected.

SPHERE POP, 2014.
Designed by Eyal Gever.
Produced on Objet1000 3D Production System
940 x 841 x 707 mm

COLLISION | TRUCK VS TRUCK

Collisions - impact, accident, crash, finite element method. It becomes impossible to distinguish an accident from a violent assault. Maybe the point is precisely the ordinariness of such accidents in contemporary society. Amidst the work and play of everyday life accidents simply happen.

COLLISION | TRUCK VS TRUCK, 2014.
Designed by Eyal Gever. Produced on
Objet1000 3D Production System.
2520L x 566W x 508H mm

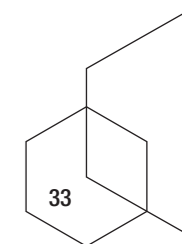
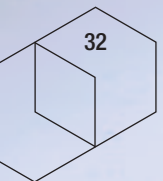
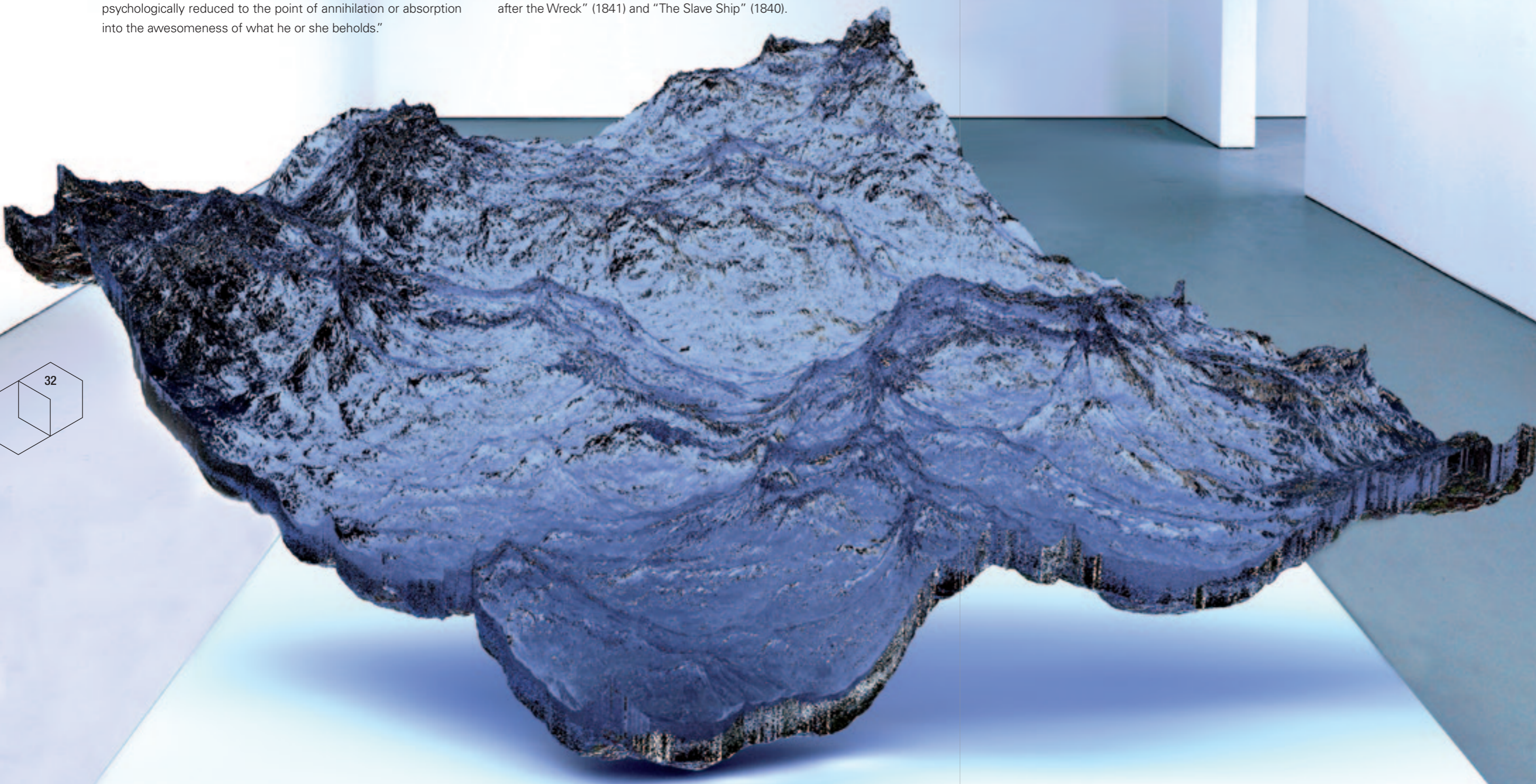
In this work, Gever contemplates collisions of opposites, fear and attraction, seduction and betrayal, from the most tender brutalities to the most devastating sensitivities. He oscillates between these opposites, and to a greater or lesser extent his work is always informed by that.



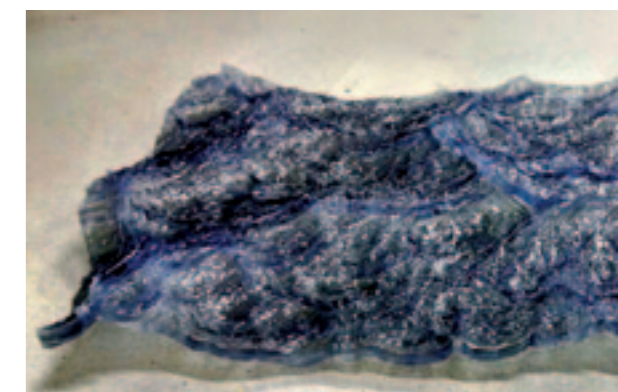
PIECE OF OCEAN

Piece of Ocean is Gever's attempt to behold a physical piece trying to contain some of the awesomeness of a huge 3D stormy ocean simulation. Here Gever is influenced by the English Professor Albert Gelpi who said, "The physical conformation and psychological affect of the sublime landscape dwarfs the physical presence of the beholder so overwhelmingly that he or she feels psychologically reduced to the point of annihilation or absorption into the awesomeness of what he or she beholds."

Gever also admires J. M. W. Turner, described by art critic John Ruskin as the artist who could most "stirringly and truthfully measure the moods of Nature." Suitable vehicles for Turner's imagination were found in shipwrecks, fires, natural catastrophes and natural phenomena such as sunlight, storm, rain and fog. He was fascinated by the violent power of the sea, as seen in "Dawn after the Wreck" (1841) and "The Slave Ship" (1840).



PIECE OF OCEAN, 2014.
Designed by Eyal Gever. Produced on
Objet1000 3D Production System
996 x 796 x 149 mm





WANDERERS

DESIGNED BY NERI OXMAN

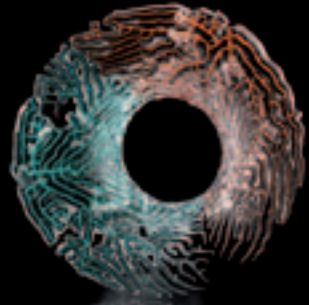
Architect and designer Neri Oxman is the Sony Corporation Career Development Professor and Associate Professor of Media Arts and Sciences at the MIT Media Lab, where she founded and directs the Mediated Matter design research group. Her group conducts research at the intersection of computational design, digital fabrication, materials science and synthetic biology and applies that knowledge to design across scales from the micro scale to the building scale with a focus on additive manufacturing. Her goal is to enhance the relationship between the built and the natural environments by employing design principles inspired by nature and implementing them in the invention of novel digital design technologies. Areas of application include product and architectural design, as well as digital fabrication and construction.

Oxman was named to ICON's list of the top 20 most influential architects to shape our future (2009), and was selected as one of the 100 most creative people by FASTCOMPANY (2009). In 2008, she was named "Revolutionary Mind" by SEED Magazine. Her work has been exhibited at MoMA (NYC) and is part of the museum's permanent collection. In 2012 the Centre Georges Pompidou Museum (Paris, France) acquired some of her works for its permanent collection as did the Museum of Fine Arts in Boston. Other exhibitions include the Smithsonian Institute (Washington, DC), Museum of Science (Boston, MA), FRAC Collection (Orleans, France), and the 2010 Beijing Biennale. Her work has been included

in prestigious private collections and has received numerous awards including a 40 Under 40 Building Design + Construction Award (2012), a Graham Foundation Carter Manny Award (2008), the International Earth Award for Future-Crucial Design (2009), and a METROPOLIS Next Generation Award (2009). Most recently Oxman has won the Vilcek Prize for Design (2014) and the Women in Design Award of Excellence (Boston Society of Architects, 2014). Neri Oxman received her PhD in design computation as a presidential fellow at MIT, where she developed the theory and practice of material ecology. Prior to MIT, she earned her diploma from the Architectural Association (RIBA Part 2) after attending the Faculty of Architecture and Town Planning at the Technion Israel Institute of Technology, and the Department of Medical Sciences at the Hebrew University in Jerusalem.

For her project Wanderers, Oxman collaborated with Christoph Bader and Dominik Kolb (www.deskriptiv.de). Based in Germany, Bader and Kolb operate at the intersection of computer sciences and visual arts. Procedural methods are central to their work and their collaborations. Oxman has also collaborated with Joe Hicklin (The Mathworks) to design volumetric bitmap printing algorithms.

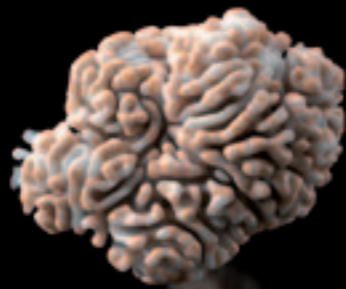
01
Veins



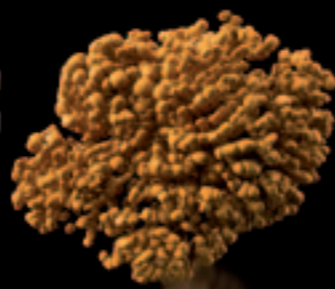
01
Veins Internal structure



02
Cells



02
Cells Internal structure



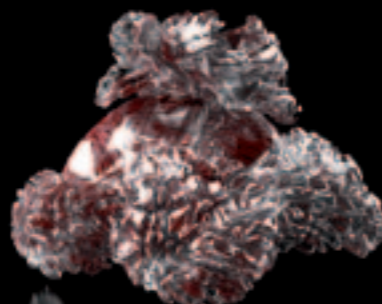
03
Strand



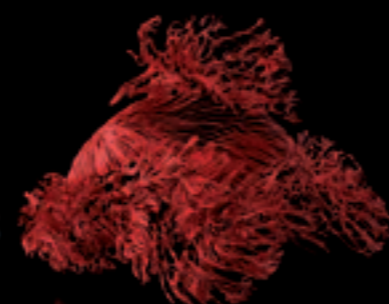
03
Strand Internal structure



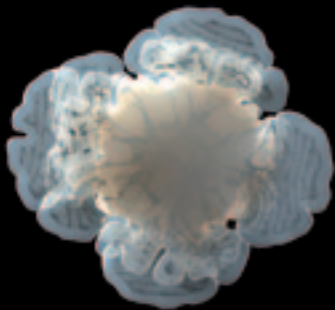
04
Fibers



04
Fibers Internal structure



05
Seeds



05
Seeds Internal structure

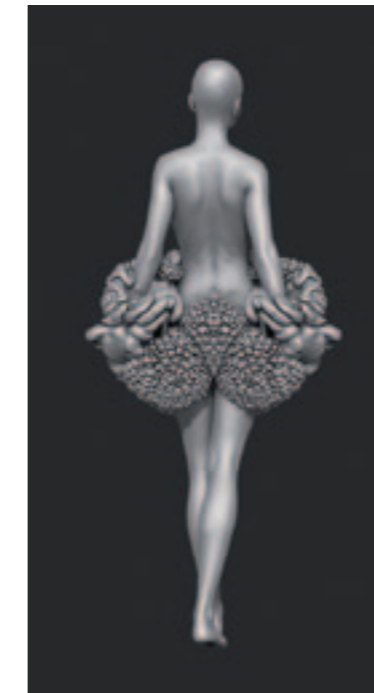
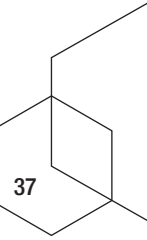
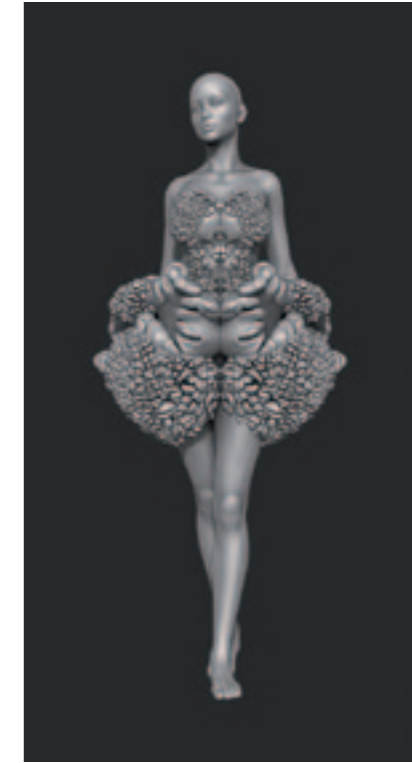


DESIGN IDEOLOGY: AN ASTROBIOLOGICAL EXPLORATION

Traveling to destinations beyond planet Earth involves voyages to hostile landscapes and deadly environments. Crushing gravity, amonious air, prolonged darkness, and temperatures that would boil glass or freeze carbon dioxide, all but eliminate the likelihood of human visitation.

Wanderers explores the possibility of voyaging to the worlds beyond by visiting the worlds within. 3D printed wearable capillaries are infused with synthetically engineered microorganisms to make the hostile habitable and the deadly alive. Each design is a codex of the animate and inanimate with an origin and a destination: the origin being engineered organisms, which multiply to create the wearable within 3D printed skins; and the destination being a unique planet in the solar system. The setting for this exploration is the solar system where, with the exception of planet Earth, no life can exist.

The series represents the classical elements understood by the ancients to sustain life (earth, water, air and fire), and offers their biological counterpart in the form of microorganisms engineered to produce life-sustaining elements. The wearables are designed to interact with a specific environmental characteristic of their



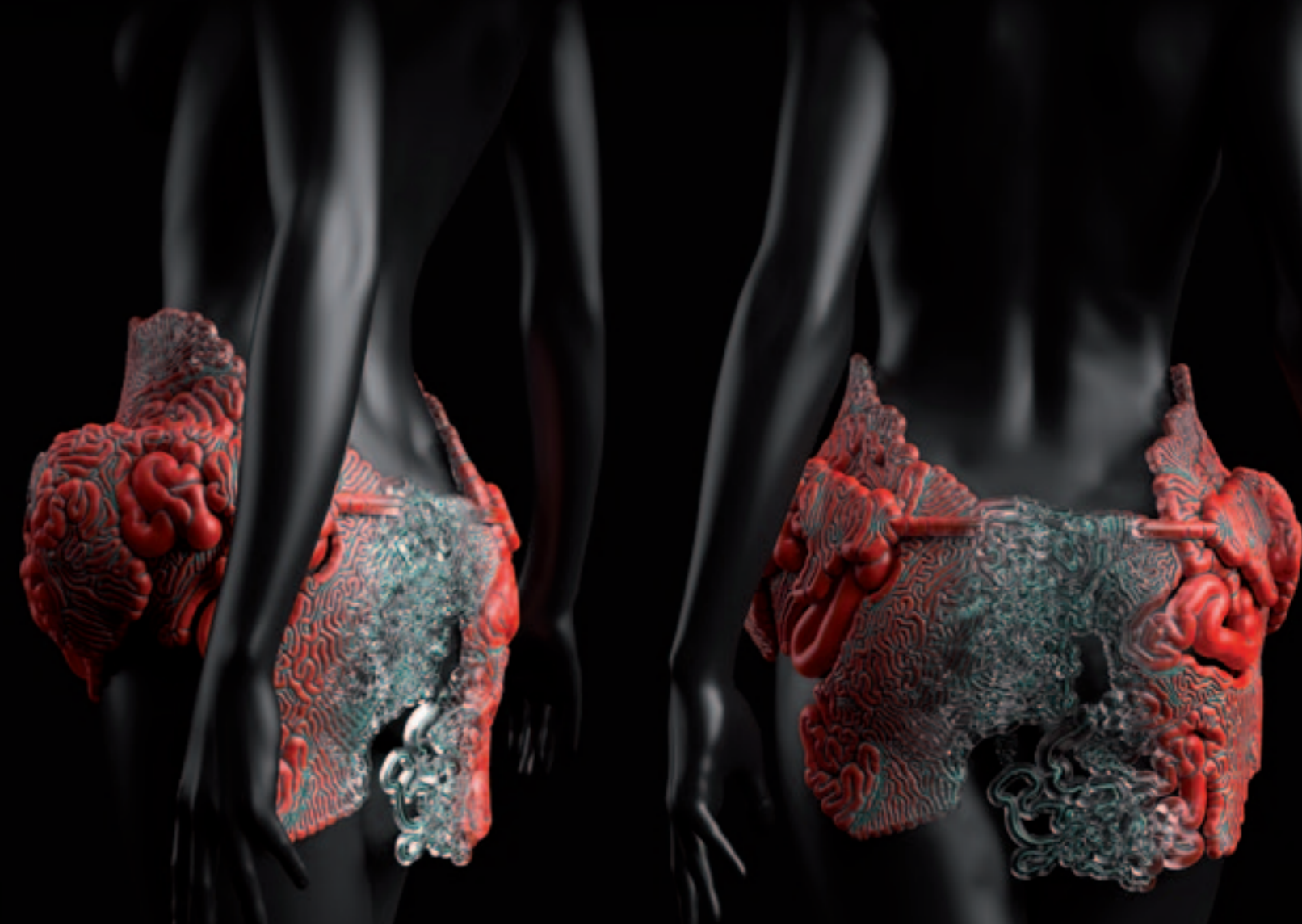
destination and generate sufficient quantities of biomass, water, air and light necessary for sustaining life: Some photosynthesize converting daylight into energy, others bio-mineralize to strengthen and augment human bone, and some fluoresce to light the way in pitch darkness. Each wearable is designed for a specific extreme environment where it transforms elements that are found in the atmosphere to one of the classical elements supporting life: oxygen for breathing, photons for seeing, biomass for eating, biofuels for moving, and calcium for building. Design research at the core of this collection lies at the intersection of multi-material 3D printing and synthetic biology.

Stratasys Digital Materials specifically those available on the Objet500 Connex3 3D Production System offer unprecedented control over material properties such as rigidity, opacity and color. This high level of functional control provides the opportunity to customize the 3D print according to CAT scans or MRI data and design perfect-fit second skins. The materials used for Wanderers are flexible and enable design for movement.

* The word "planet" comes from the Greek term *planets* meaning "wanderer."



MUSHTARI (مشتري):
JUPITER'S WANDERER, 2014
Designed by Prof. Neri Oxman, Mediated Matter Group,
MIT Media Lab in collaboration with Christoph Bader,
Dominik Kolb (Deskriptiv) and Joe Hicklin (The Mathworks).
Produced on Objet500 Connex3 3D Production System.
450 x 450 x 400 mm



MUSHTARI (مشتري):
JUPITER'S WANDERER

Jupiter is the largest planet in the solar system with a mass two and a half times greater than the mass of all other planets combined. Named after the king of the Roman gods, its Arabic name reflects its vastness (Mushtari means huge, giant). A single strand filled with living matter inspired by the form and function of the human gastrointestinal tract, this wearable is designed as a

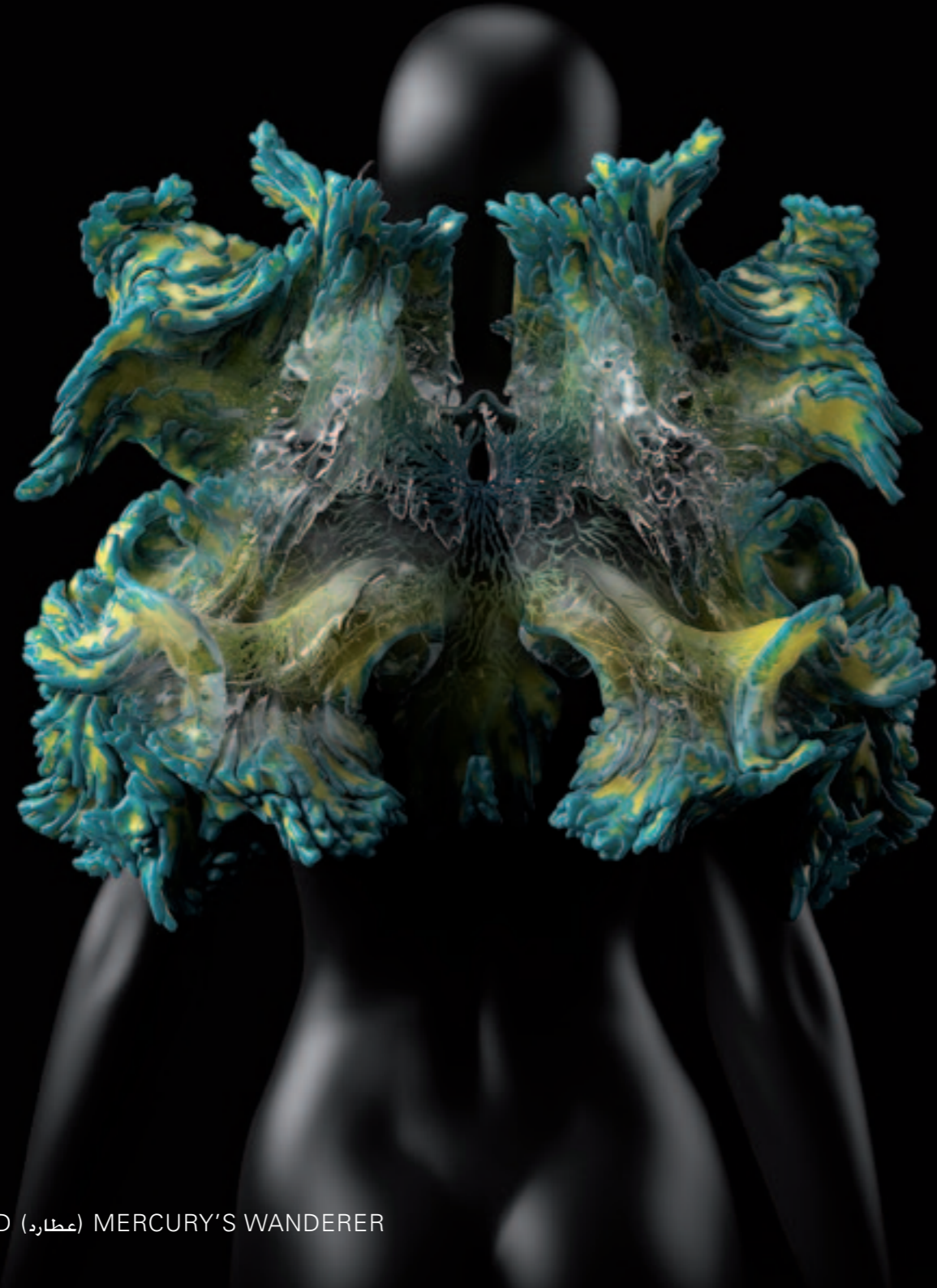
an organ system for consuming and digesting biomass, absorbing nutrients and expelling waste. The peristaltic movement of matter within 3D printed translucent tracts is designed to support the flow of cyanobacteria engineered to convert daylight into consumable sucrose.

ZUHAL (زحل): SATURN'S WANDERER

Saturn is known for its vortex storms forming where there is a steep latitudinal gradient in the speed of winds blowing across the planet's atmosphere. Named after the Roman god of agriculture, its Arabic name reflects the planet and the mythology, representing fertility and growth. The wearable is covered with a dense hairy texture responding to Saturn's vortex winds with intricate structures characterized by high surface area to volume ratio. It is designed as a wearable vortex field, varying in size, density and organization to accommodate for local wind variation. Saturn's moon Titan has been known to possess hydrocarbons in its upper atmosphere, a possible precursor for life. Another moon, Enceladus, has ocean-like composition and has been often regarded as a potential base for microbial life. The hairy fibrous surface of the wearable is designed to contain bacteria that can convert hydrocarbons to edible matter that can be safely consumed by humans.



ZUHAL (زحل): SATURN'S WANDERER, 2014
 Designed by Prof. Neri Oxman, Mediated Matter Group, MIT Media Lab in collaboration with Christoph Bader, Dominik Kolb (Deskriptiv) and Joe Hicklin (The Mathworks). Produced on Objet500 Connex3 3D Production System. 450 x 500 x 400 mm



OTAARED (عطارد) MERCURY'S WANDERER

Named after the Roman deity Mercury (Arabic: Otaared), the messenger to the gods, the planet Mercury lacks any atmosphere, making it susceptible to impacts over its entire surface. The expression "mercurial" is typically used to refer to something or someone erratic, volatile or unstable, derived from Mercury's swift flights from place to place. Otaared is designed as antler-like

extensions of the scapulae to protect the head. The 3D printed structure is computationally grown from the scapulae and the sternum outward generating a branched winged exoskeleton. The printed shell is designed to contain calcifying bacteria grown within a wearable caduceus. The ultimate goal is to grow true bone structures acting as protective exoskeleton.

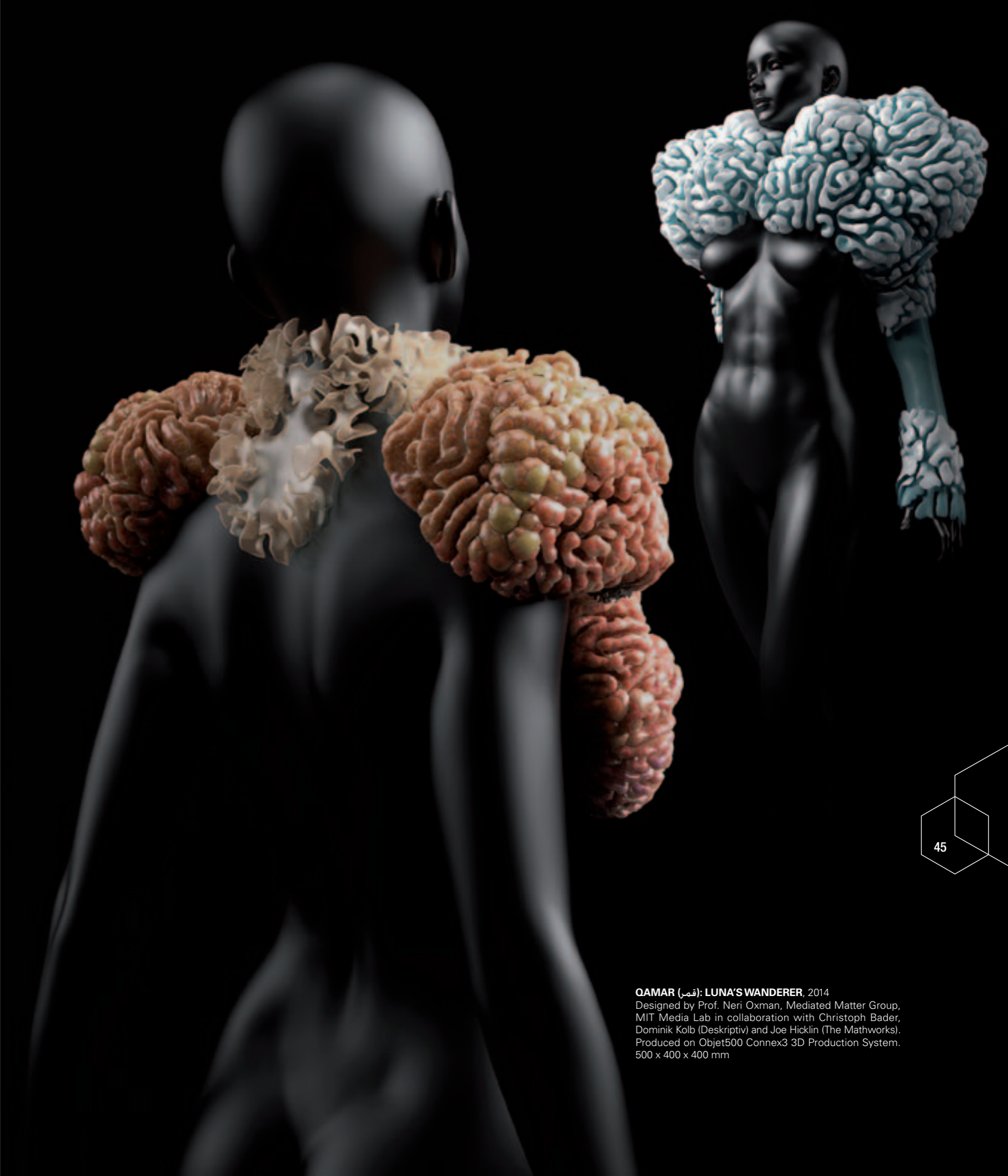


OTAARED (عطارد) MERCURY'S WANDERER , 2014
 Designed by Prof. Neri Oxman, Mediated Matter Group, MIT Media Lab in collaboration with Christoph Bader, Dominik Kolb (Deskriptiv) and Joe Hicklin (The Mathworks).
 Produced on Objet500 Connex3 3D Production System. 500 x 350 x 400 mm



QAMAR (قمر):
LUNA'S WANDERER

Named after the Roman goddess Luna (Arabic: Qamar), the divine embodiment of the moon often characterized by a two-yoke chariot, Luna is the most luminous object in the sky after the sun. Inspired by the moon's surface texture, this design functions as a wearable pneumatic surface for generating and storing oxygen. Unlike a wearable biodome, this texture contains spatial spherical pockets for algae-based air-purification and biofuel collection.



QAMAR (قمر): LUNA'S WANDERER, 2014
Designed by Prof. Neri Oxman, Mediated Matter Group,
MIT Media Lab in collaboration with Christoph Bader,
Dominik Kolb (Deskriptiv) and Joe Hicklin (The Mathworks).
Produced on Objet500 Connex3 3D Production System.
500 x 400 x 400 mm

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