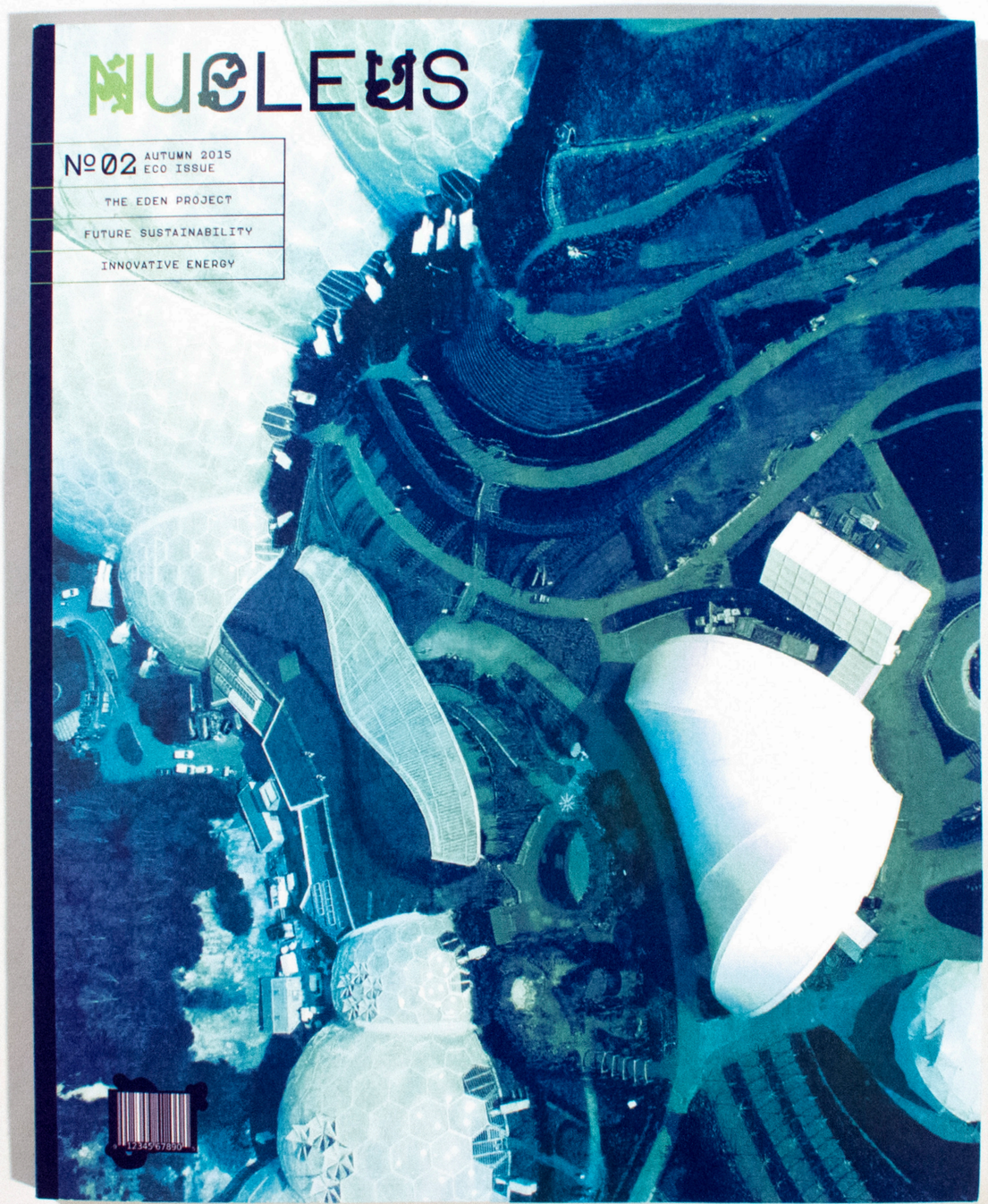
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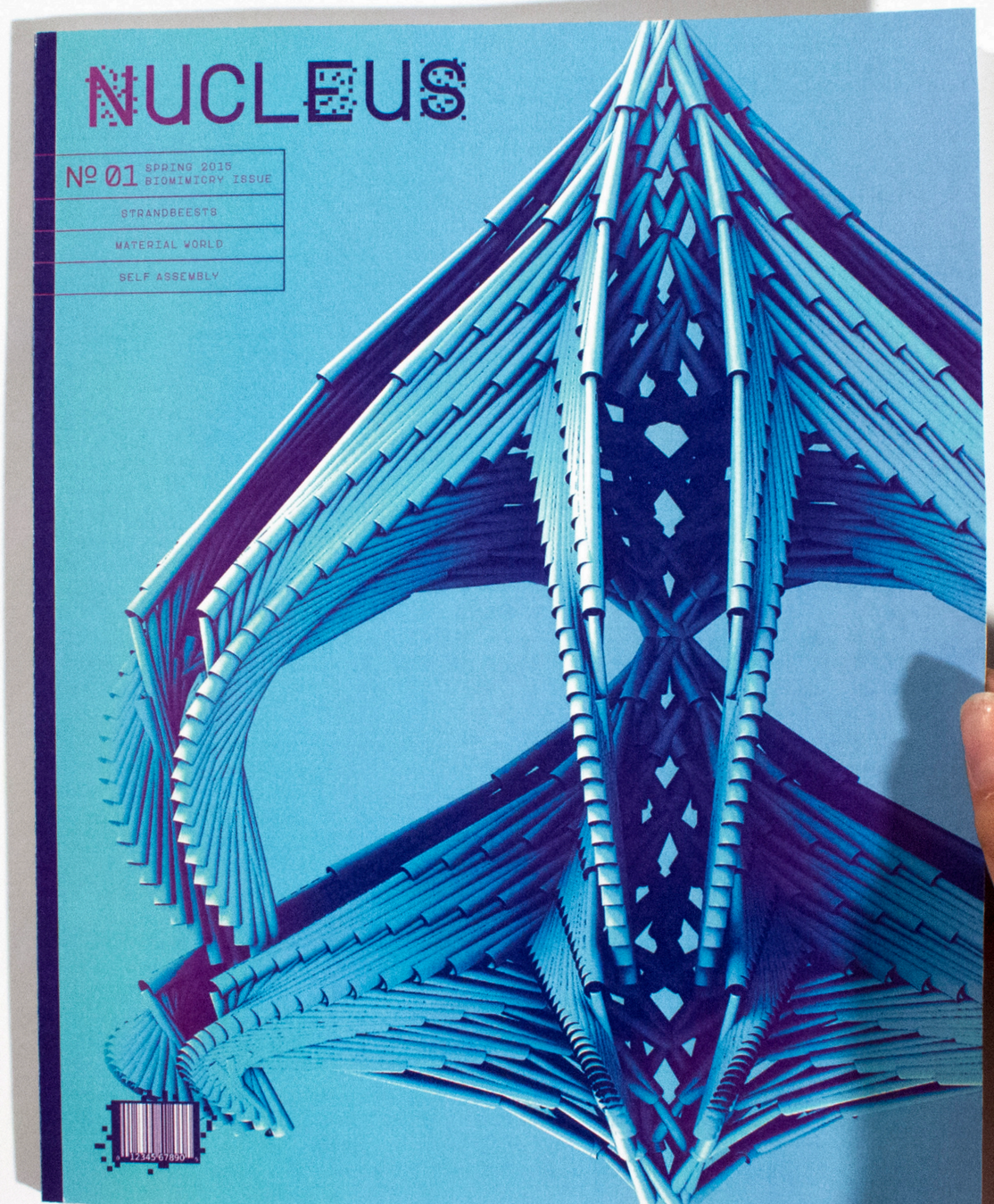
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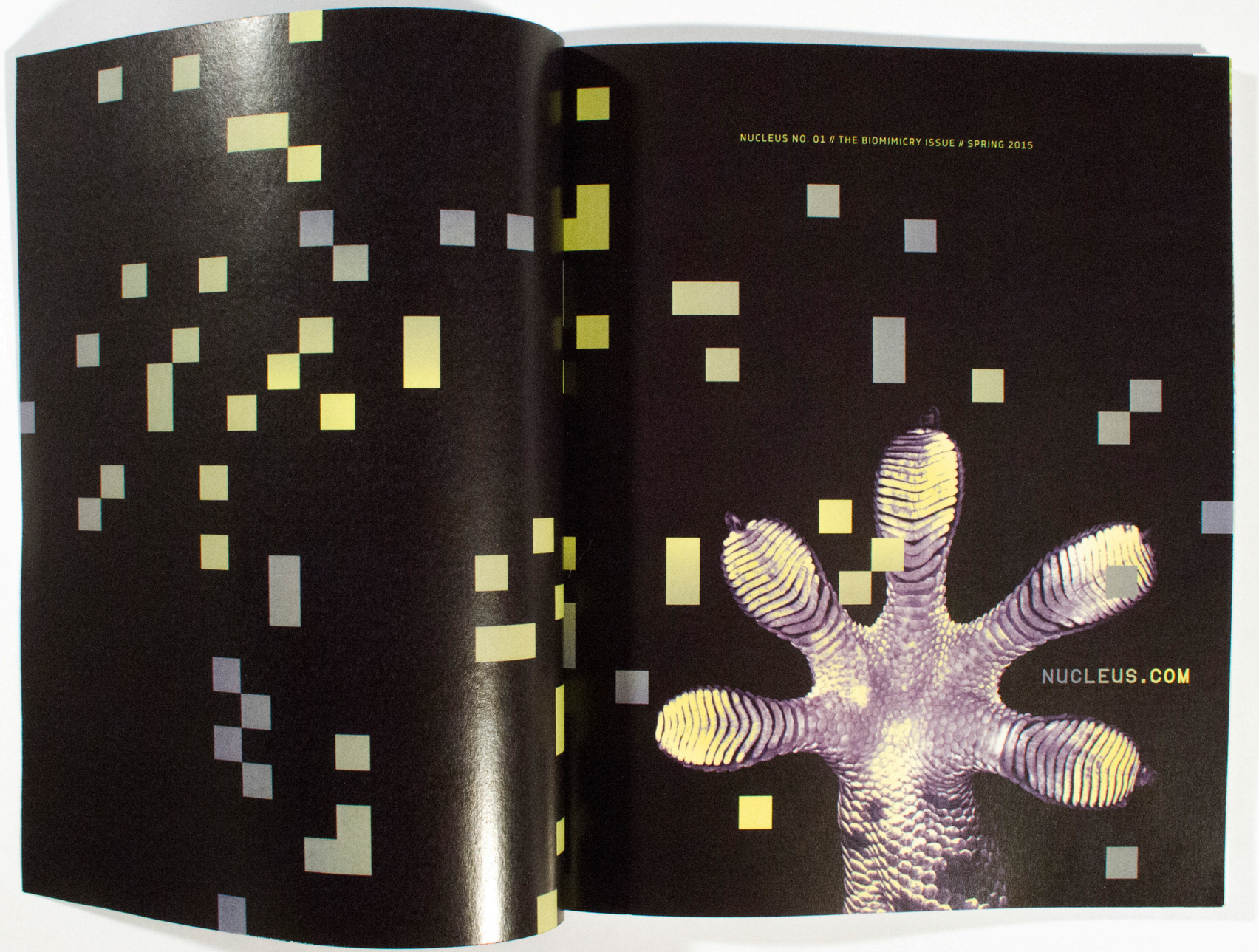
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NUCLEUS

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R Redshaw Columbia University

FROM THE EDITOR

After honing its engineering skills for billions of years, nature has produced some of the world's most innovative technologies and adaptations. From the kingfisher's streamlined beak, designed to soften splashes, to bioluminescent marine life in the deep sea, ecosystems and animals are equipped with a wide variety of specialized machinery. Today scientists and engineers are looking to nature to tackle some of humanity's most complex problems, a process known as biomimicry. The opportunities for innovation seem endless.

Perhaps one of the earliest modern examples of biomimicry, Velcro was developed about 60 years ago after a walk in the woods. Swiss inventor George de Mestral, curious to understand how cockleburs attached themselves to his clothes and dog, examined the plant under a microscope and discovered a jumbled network of tiny hooks across its surface. In nature, these hooks clasp onto loose threads of fabric or animal fur for enhanced seed dispersal. But de Mestral saw potential for something else in nature's design—a strong, yet adjustable, commercial fastener. Today Velcro can be found on a wide variety of items, from sports equipment to car interiors. Frankly, we're not quite sure how we would have made it through kindergarten without it on our shoes.

This is the idea behind the increasingly influential discipline of biomimicry: that we human beings, who have been trying to make things for only the blink of an evolutionary eye, have a lot to learn from the long processes of natural selection, whether it's how to make a wing more aerodynamic or a city more resilient or an electronic display more vibrant. More than a decade ago, an MIT grad named Mark Miles was dabbling in the field of micro-electromechanical and materials processing. As he paged through a science magazine, he was stopped by an article on how butterflies generate color in their wings. The brilliant iridescent blue of the various Morpho species, for example, comes not from pigment, but from "structural color."

We at NUCLEUS are very excited to be bringing you this very special issue focusing on the philosophy of biomimicry. I hope you find it just as fascinating as we do.

LETTERS TO NUCLEUS

Still an Enigma

Kenny Ellis, CA

Thank you for such an incredibly interesting article on fibromyalgia, "An Unnerving Enigma." Unfortunately, one fundamental view about the origin of the disorder was missing. Fibromyalgia is, like tension headaches and some other not so well defined pain disorders, only one symptom of central sensitization syndrome, also known as migraine syndrome. As was not mentioned in the article, patients do not have just pain but also fatigue, memory and mood problems, sleep disturbances, and a variety of symptoms of the dysregulation of the autonomic nervous system. These many different symptoms add to the complexity of life for people living with it, and I'm glad your article explained this aspect even though it missed something else, and overall I'm happy that this was brought to light on some sort of level, as so many people are simply not aware of this disorder as well of the highly varied symptoms .

This symptomatology does not differ at all from that what we see in chronic migraine. The entire spectrum of symptoms does not always manifest at the same time, but over the years—if different epigenetic and stress factors generate more and more widespread neuronal dysfunction—we see one symptom after another rising and fading, typically in a rhythm of three to four months. As a neurologist practicing for over 20 years, I've seen hundreds (if not thousands) of migraine patients also diagnosed with fibromyalgia. After recognizing more than 10 years ago that fibromyalgia is just one variation of the sensorineural dysfunctions seen in migraine syndrome, I have had many more treatment options opened up to offer to patients. Again, thank you for bringing this subject to the forefront of your magazine as a featured focus. Hopefully, treatment options will continue to become more advanced, and more quickly to alleviate the difficulty of living with this condition.

Rx Control

Tory Sails, WA

I read "Prescription for Murder" with great interest, especially as I have seen firsthand what counterfeit medication does to those who believe it will help them. During my first week this year as a visiting ear specialist in Jos, Nigeria, I saw at least six teenagers or young adults with permanent, total deafness of recent onset. I also realized that Each case occurred after they had recently taken antibiotics. The prescribed drugs were not at all associated with hearing loss, and my western colleague and I suspected that cheaper, more toxic medication had been substituted for what they should have been provided with. This counterfeit problem may be and most likely is widespread, as our Nigerian colleagues were surprised to learn that acquired deafness in young people is extremely rare in the US.

As far as the United States is concerned, "Prescription for Murder" paints a frightening picture of the human toll taken by counterfeit drugs. This is something that needs to be stopped, and probably can be minimized by careful enforcement to prevent these horrific tragedies. Congress must keep this in mind as it debates drug importation laws and allocates funds for more rigorous enforcement of these imported materials. Even with increased levels of security and regulation, this problem could still hurt people and bypass even the best efforts to stop them from destroying lives. Some counterfeits are so well designed they escape notice by even the most astute health professionals.

Power to Flowers

Sam Kelly, KS

I have a few gripes with the article on flower sourcing,"Flower Power." If buying flowers grown on U.S. farms from neighborhood florists "seems increasingly quaint," it is no more quaint than buying an ink and paper magazine in order to read an article about flowers. If our intent is to race to the bottom, then I guess we should mindlessly buy the industrially produced grocery store flower arrangements and ignore the "quaint" neighborhood florists who buy flowers locally and support their community. I would suggest an article that focuses on the responsible "green" alternatives of the floral industry instead of wringing our hands and doing nothing about this issue.

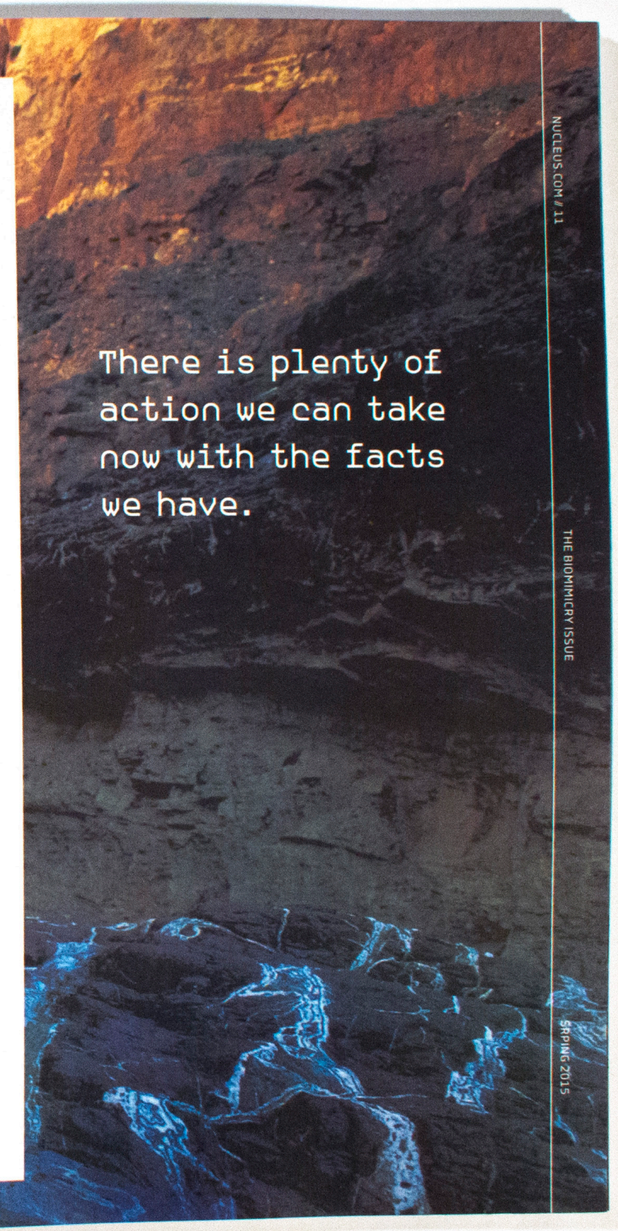
Writer John McQuaid rightly notes in "Flower Power" that heavy water consumption by the cut-flower industry has created water shortages in Colombia. However, this is not the only industry that must use water in order to be successful. I would like to add that, in fact, any export of fresh produce is to a large extent an export of water. Thus it is a problem not only for flower exporting regions but also for the production of fruits and vegetables in dry climates such as Southern California or Israel. Not only because of flowers, but also because of produce production. Both areas have lost species because of the depletion of the water supply as well as agricultural expansion.

Action for Bees

Sarah Turning, RI

the great cover article of last month by aptly identifies three different causes of widespread bee die-offs: pesticides, parasites, and monoculture. Although the exact toll of each on the bees may not be fully understood, we must not get so mired in the unknown that we fail to acknowledge the known and take action. There is plenty we can do now with the facts we have. We have started down the right path by uncovering certain causes of bee death, but what good is the detective work if nothing comes of it? So often, action is taken too late in the game for anything useful to come about. I am convinced that action will uncover even more complexities and answers to what is killing off these creatures which we need to survive.

There is very strong science on the poisoning of bees by several types of pesticides, neonicotinoids and other new pesticides that chemical companies are rushing to be sold on the market. The latest, sulfoxaflor, sailed through Environmental Protection Agency approvals. EPA is rubberstamping these pesticides without looking at the science and without requiring labeling that would protect bees. Does nothing about this seem backwards? This massive commonsense gap is why my organization has joined with beekeepers nationwide in a lawsuit against EPA. Fixing this is one clear solution in my mind, and as such I am taking action to correct it.



STRAND BEESTS

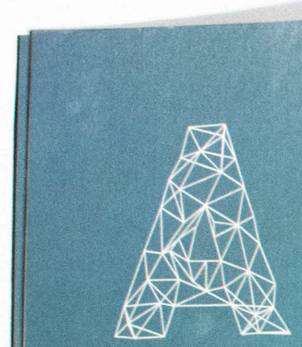
A DEEPER LOOK AT THEO JANSEN'S INCREDIBLE CREATIONS

WRITTEN BY LAWRENCE WESCHLER
PHOTOGRAPHY BY LOEK VAN DER KLIS

ABOVE a strandbeest on the beach
NEXT more strandbeests parade down the beach
Loek van der Klis

ON A BLUSTERY OCTOBER afternoon, on a gently raised hill above Ypenburg, the Netherlands, roughly halfway between The Hague and Delft, the 66-year-old once-aspiring physicist Theo Jansen and several assistants busily prepared to launch an odd sort of species invasion. In a few weeks, Jansen's strandbeests—the huge self-propelled beach-striding contraptions that Jansen has spent the better part of the past quarter-century conceiving, evolving and constructing from out of ever more ambitious concatenations of lightweight yellow PVC tubing and spiny white sails—would be strutting their improbably lifelike stuff up and down Miami Beach at Art Basel, to the drop-jawed amazement of all.

But for the moment, Jansen had to carefully, with near-veterinary skill, slice and fold six of the wide-slung beests into two 40-foot-long shipping containers, so that they would survive the rigors of their Atlantic passage. After they land in Miami Beach and then in Salem in the fall of 2015, the beests will spend the following year or two alighting at the Chicago Cultural Center and possibly in New York after that, among other places. Everywhere they go, visitors will be subjected to Jansen's soaring contention that what they are witnessing is in fact nothing less than a new form of life—and indeed life in the very midst of going viral, and not just in the cultural sense.



Adept at both drawing and math, Jansen put in seven years at Delft University of Technology on the physics track. But then he realized that he was never going to be happy "working as a robot for Philips electronics," and thereafter he gave himself over completely to the more "hippieish" pursuits of music-making and painting that had been calling out to him all the while. Late in the 1970s, he and a group of friends managed to commandeer an abandoned school off a Delft canal (one that Werner Herzog had just abandoned after shooting "Nosferatu" there) as their studio and living space, and he has been living there on and off ever since.

By the mid-1980s, Jansen was also contributing a column every two weeks to the Dutch national newspaper De Volkskrant, or The People's Newspaper, where he began hazarding all sorts of variously inspired (and sometimes cockamamie) schemes. For example, a new feature for passenger-jet flight, with the nose of the plane chopped clean off and the space immediately behind it converted into an observation deck, approachable through an airlock and entirely open to the elements (Jansen remains convinced and could almost convince you that the various air pressures would even out); and, another time, an arrangement of six mechanical plug-in timers, piggybacked in a way, one upon the next, that the outermost one could be counted on to sound off once every 23 million years (you never knew when these might come in handy).

And then one day, several years into this journalistic dalliance—on Feb. 24th, 1990, to be precise—Jansen took note, and quite early note at that, of the fact that the seas seemed to be rising, of the high tides registering co higher up the beaches with each passing season, a development, he pointed out, that ought to be of considerable concern and attention to his fellow Netherlanders, citizens, after all, of the Low Countries, territories much of which famously lie beneath sea level. But not to worry, for here, too, Jansen had a plan. After all, he suggested, wasn't the problem simply one of finding a way of transferring sand grains from the bottom of the beach up to the top, in the form of giant, continuously maintained protective dunes. If that was all there was to it, why not just invent a race of wind-powered beach creatures—strandbeests, as he dubbed them—veritable herds of them, that could merrily perform the task in perpetuity. In fact, he informed his readers, he already had two prototypes firmly in mind, and he was planning to take the coming summer to build the things, so they could be then placed onto the coast in time for the first autumn storms. "Perhaps," he concluded by way of blithe surmise, "the Dutch coast will look quite different in a year's time."

"I suppose I was a little overoptimistic back then," Jansen admitted to me one afternoon as we sat in the cluttered study of his Delft homestead. "I fancied myself becoming a hero by saving the entire country, like that proverbial boy with his—do you also have this expression in English?—his digit in the dam wall."

As the years passed on, Jansen was growing less and less interested in the seemingly ever more distant goal of sand-shifting and dike-plugging and more and more captivated by the sheer marvel of the immediate evolutionary process playing out before him. There were countless dead ends and haphazard detours. "As how wouldn't there be," he once asked me, "random mistakes and mutations being the very engine of evolution?" The calibrations and recalibrations took years, across generation after generation of new beest types and fresh experiments at the shore. "People will talk about how beautiful my beests are as they parade down the beach," he said. "But you have to understand: I was never interested in beauty as such in them. I was interested in survival, so everything was based on a consideration of function, how to make the things function better. The fascinating thing, though, was that—here again, as with nature—the better the functioning, often, the more beautiful the result."

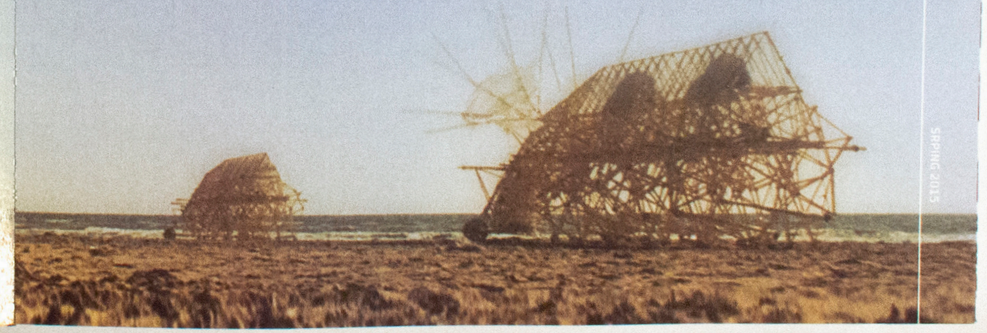
I WAS INTERESTED IN SURVIVAL, SO EVERYTHING WAS BASED ON A CONSIDERATION OF FUNCTION.

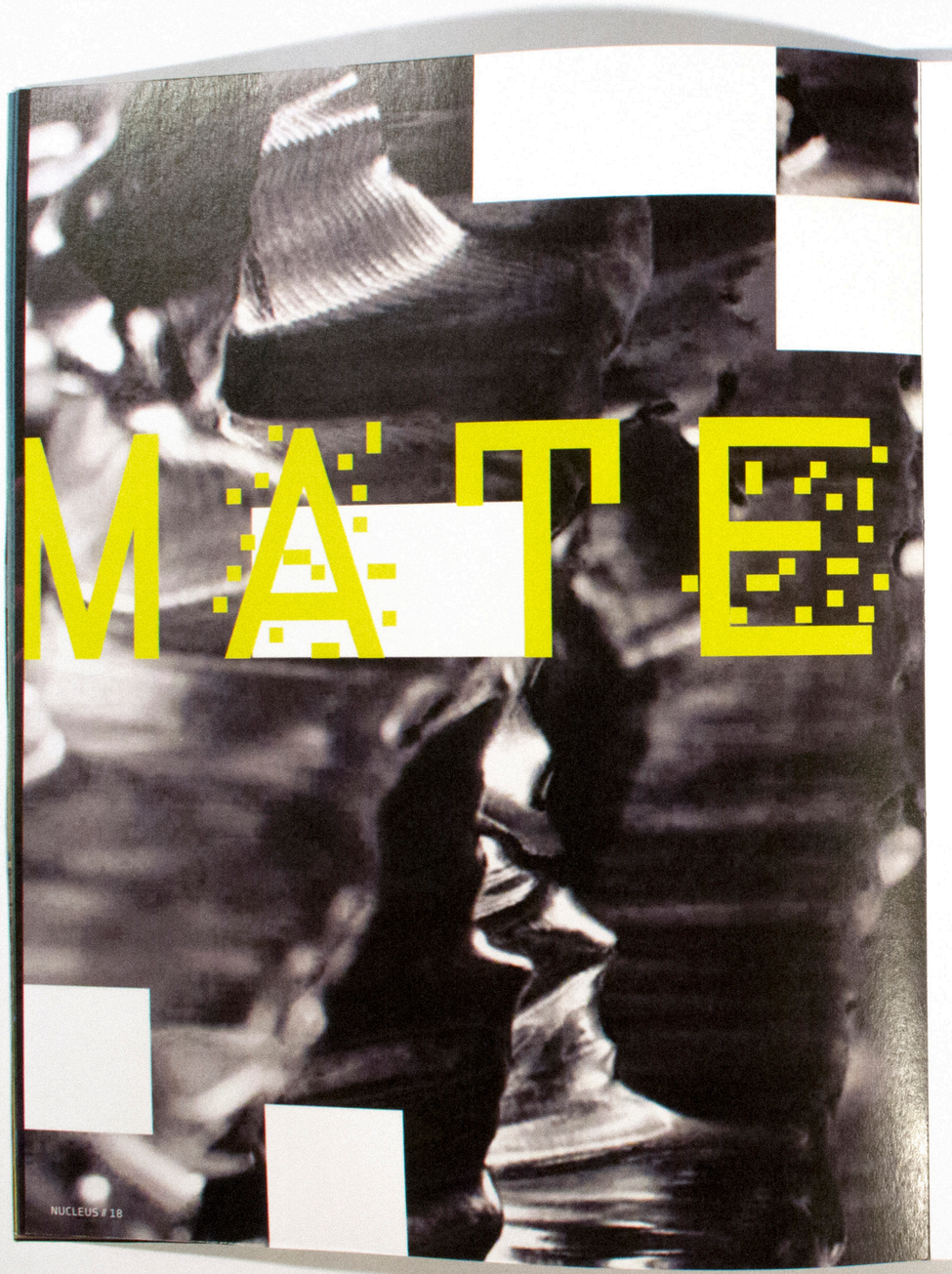
The thing of it is, as I increasingly came to feel whenever Jansen would take one of his creatures out for a stroll, they really do appear to be alive. Purposeful, resolute, canny. They don't fall into the uncanny valley that famously afflicts so many other robotic assaults on the absolutely lifelike, perhaps because they are not trying to seem anything other than what they are: They are self-evidently PVC machines, and yet, in their steady animation, they almost seem to evince a soul. Watching the strandbeests breasting forward in full stride, we can't help ourselves: Our hearts become lodged in our mouths.

But does that say something about them or about us? One time, as one beest, winded, slowly wound down to a stop, I asked Jansen that other version of the question that had been haunting me all along. "Oh," he responded, without a moment's hesitation. "It is obviously them: They are very much alive." Thus, one day, Jansen was telling me that his strandbeests were already propagating themselves exponentially all over the world—not only because he had posted his famous ratios as open code for anyone else to use, but also because his beests had begun appearing in ads and videos. In one ad, in which Jansen served as a paid spokesman for BMW, he was heard to proclaim, in true Renaissance fashion, that "the walls between art and engineering exist only in our minds." Likewise, perhaps, you were given to grumble, those between art and commerce—although Jansen's continuing development of the strandbeests was now being supported to no small extent by these sorts of commercial endorsements. The point for Jansen, though, was that every individual who saw these images had in a certain sense taken their memetic material into their own life, and the beests thus began partaking of life in the form of lived ideas.

AS WITH NATURE: THE BETTER THE FUNCTION, OFTEN, THE MORE BEAUTIFUL THE RESULT.

Turning from there to the question of how you define "life," an associate editor at *Scientific American*, Ferris Jabr, writing on this paper's opinion pages not long ago, used Jansen's own case as an occasion to contend that "strandbeests are no more or less alive than animals, fungi and plants." In fact, nothing, he went on to insist, is truly alive. (Nor is anything else entirely nonliving.) "Some things we regard as inanimate are capable of some of the processes we want to make exclusive to life. And some things we say are alive get along just fine without some of those processes." In particular, Jabr pointed to how viruses, non-self-sustaining bits "of DNA or RNA encased in a protein," while capable of incredibly efficient reproduction and evolution, can only do so by introjecting themselves into a living cell and "hijacking" its capacities. "We have insisted that all matter naturally segregates into two categories—life and nonlife—[but] have searched in vain for the dividing line." The reason being that it's not there. Life, he goes on to suggest, is a concept, a useful concept (it's in our heads, and perhaps can't help but be), "but it doesn't reflect the reality of the universe outside the mind."





MATERIAL WORLD

A conversation between Andrew H. Dent & Neri Oxman

The very nature of matter as we know it is being re-engineered as new sciences of design erode our orthodoxies. Nowhere is this any more apparent than in the work of Neri Oxman, whose research initiative MATERIALECOLOGY and projects for the MIT Computation Group is transcending genres, fads and boundaries. Hers is a unique blend of architecture, computer science, material engineering and art that has her simultaneously commissioned to create medical devices for Boston's Museum of Science and pieces for MOMA's 2008 exhibition Design and the Elastic Mind. Here a dynamic and hybridized vision of matter cuts through the inertia of convention.

A former medical student at Hebrew University and the Technion Institute of Technology, Oxman then made a final stop at the renowned Architectural Association in London before joining MIT as a presidential research fellow and PHD candidate in Design Computation in 2006. By using software to create new composite materials Oxman has been able to replicate the processes of nature, creating materials that are able to adapt to light, load, skin pressure, curvature and other ecological elements. Oxman spoke to us about her vision for the future of design and material construction and the projects she's developing that might just help us get there a little bit quicker.

LEFT E.X.Y.Z.S.S.T by Neri Oxman, 2008
Mikey Siegel

I am also positive that within a decade we will witness significant transformations not only in design, but also in the construction industry. Buildings will be printed "file to fitness" on-site. Granted, the complexity of implementing new technologies in societies structured around old ones are a major problem. But in the long run, transformative technologies will redefine the ways we think and make. Novel technologies start out as art forms, using the sciences creatively to reverse engineer the ancient skills of craft forms, still struggling to be born. So we are working against technical difficulties but also cultural barriers. With regard to Rapid FAB, Recent initiatives in such technologies combined with innovative work into composite materials are now enabling designers and engineers alike to rethink the functions and potential features of products and buildings as affordances directly and selectively promoted through their making. Assemblies of stiff parts tightly held together using joins and bearings slowly wither as we make room for the biological paradigm in which the product becomes a generic medium of response, amplification, growth and repair. The future is that close: printing building tissue as continuous strands of stiff and elastic matter operating seismic dampers will become simply a matter of hitting the power switch.

There has been much interest in "bio-materials"- those that can be grown or manipulated using biological processes. Are we yet at a stage where this can be done reliably and functionally, or is it still at a development stage? How do you see this area progressing?

Biomaterials make up an interdisciplinary science merging elements of biology, chemistry, material science, tissue engineering and medicine. Many exciting applications of such materials include the production of bone plates, artificial tendons and ligaments, blood vessel prostheses, coronary valves, and joint replacements. Such materials are comprised of living tissue or a device that augments natural functions. As such, these materials must be compatible with the human body; they are predominantly used for medical applications. But the processes by which they are engineered and developed can shed much light on the design process of products and building parts that respond to their natural environment. In my view, the development of biomaterials in the medical industry is overwhelmingly inspiring to us designers. I believe it is just a matter of time until we implement such methods in the built environment, and we are not the first. Many generations before us have used the stuff of life in the design of artifacts: ancient kayaks have incorporated bone parts to increase stiffness, cellular plant tissues are known to have been used in the design of swords etc. The combination of these age-old crafts with rapid technologies will then bring us into a new age of a Rapid Craft.

In my work I seek to shift the discourse of design production from form-centric approach to an environmental centric approach where form is motivated, represented and defined by its structural and environmental performance. Unique form, much like nature, is triggered by natural forces and by material behavior. This line of thought promotes a new kind of aesthetics, and indeed a new ethics—a new way of thinking about design.

X, Y, Z, S, S, T (pronounced: EXIST: On the Nature of Coming into Being) attempts to explore the notion of reconstructing material behavior. The piece investigates how environmental conditions can inform material organization. Tissue engineering in construction not only encourages greater attention to material formation, it may facilitate the emergence of a new materialism in architecture and design. An object-oriented finite element application determines the material's behavior according to parameters such as stress, strain, heat flow, stored energy and deformation due to applied loads and temperature differences. The resulting model is six dimensional and includes 2-D information (X, Y), out of plane deformation (Y), elastic stress (S), strain (S) and temperature flux (T). The tissue is then reconstructed using a CNC mill and metal steel and wood composites.

Is biomimicry the only way in which we can really achieve true sustainability? Are there areas where you feel that human-developed processes trump those of nature?

Biomimicry is not a method; it is a philosophy, an intellectual disposition, and a mentality with which to perceive the natural world around us. It is the study of age-old design solutions to problems in the natural world as potentially relevant to contemporary design and engineering.

The use of renewable energy sources is a good example of sustainable methods that take more time to infiltrate the market, but are very efficient in the long run. I think we have a huge responsibility as designers not only to express problems in a meaningful way but in addition to act upon them with creativity.

"Cartesian Wax"—a prototype for an environmentally responsive skin—is an exploration into building envelope design. The work promotes integration between the structural and environmental elements of the skin. The structural elements provide for an optimized distribution of load, while the environmental elements allow for the infiltration of light and heat to and from within the skin.

Ironically, the more knowledge I gather, the more I indulge in trial & error.

Integrated solutions may prove to be more sustainable as they are in the natural and biological world. Less redundant and more custom-fit to their environment, space and structure can now be shaped and manufactured using state of the art fabrication techniques and technologies. It is a well known fact that in nature shape is cheaper than material. And in design, this was never the case. Material is traditionally assigned to a shape by way of post-rationalizing its geometry. That is where we need to question the value of craft, and material attributes as design drivers in addition to their applications post the generation of form.

Materials are clearly a major influence in what you develop. To what extent do you let the material inform the process? Is knowledge of the properties of the material essential in your initial investigation or do you simply work through a type of trial and error in the material choice?

Funny you should ask in those terms. Ironically, the more knowledge I gather, the more I indulge in trial and error as a form of experimentation. A good knowledge base only helps specify the design space sine qua non its constraints. So problem-solving a design problem is as important as designing the set of constraints affecting it.

Material properties are an essential part of my work. In most cases I attempt not only to understand the properties I'm working with but also to recreate them. As a designer, I distinguish between engineering properties (quantitative; those without which the building will not stand up) and architectural properties (qualitative; those that impact the spatial and sensual experiences within a space).

Do you have favorite materials or at least favorite attributes in materials?

Any material that offers an integral way to change it fascinates me be it heated plastic, re-engineered plant tissue, augmented muscle or organic skin. Wright when asked about his favorite building, answered, "The next one". I might answer in kind saying, "the next engineered material."

OPPOSITE Neri Oxman working on Catesian Wax
BEHIND Fibonacci's Mashrabiya
ABOVE Neri Oxman with Penumbra **LEFT** Ray Counting
B. Obman, Mikey Siegel

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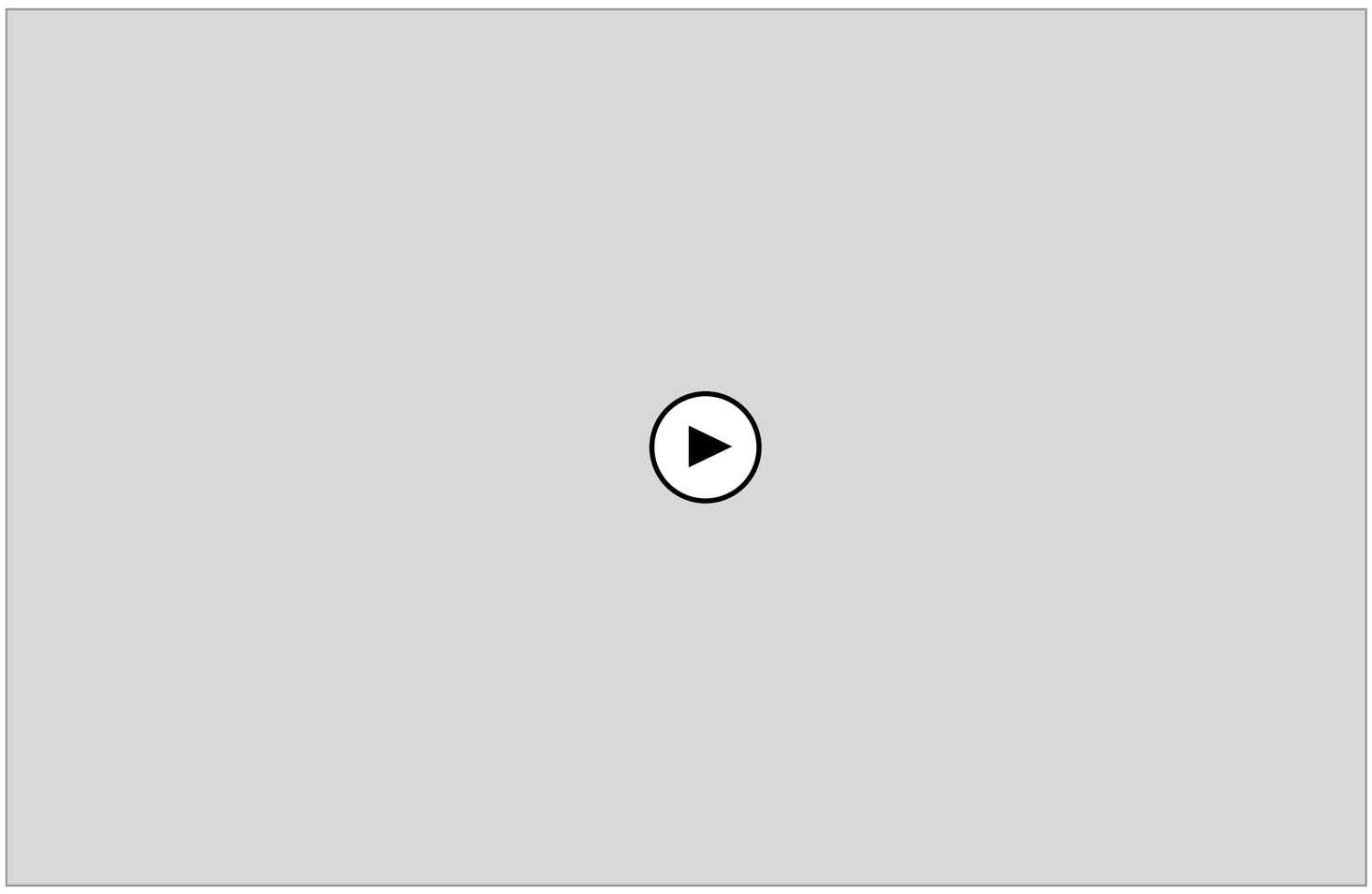

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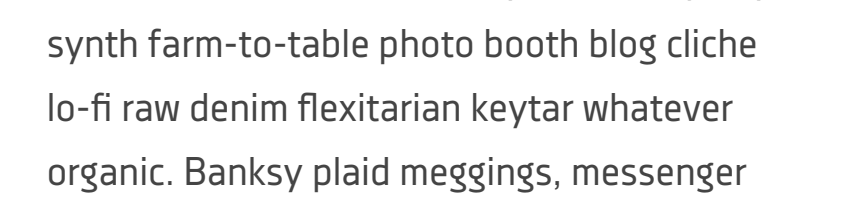

Portland iPhone Kickstarter sustainable Tumblr brunch, forage heirloom ennui.Authentic Bushwick try-hard, art party synth farm-to-table photo booth blog cliche lo-fi raw denim flexitarian keytar whatever organic. Banksy plaid meggings, messenger bag listicle quinoa mumblecore. Locavore migas pork belly bicycle rights, bitters paleo craft beer tousled actually selfies Helvetica artisan 3 wolf moon. Listicle salvia disrupt stumptown Vice chillwave.

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