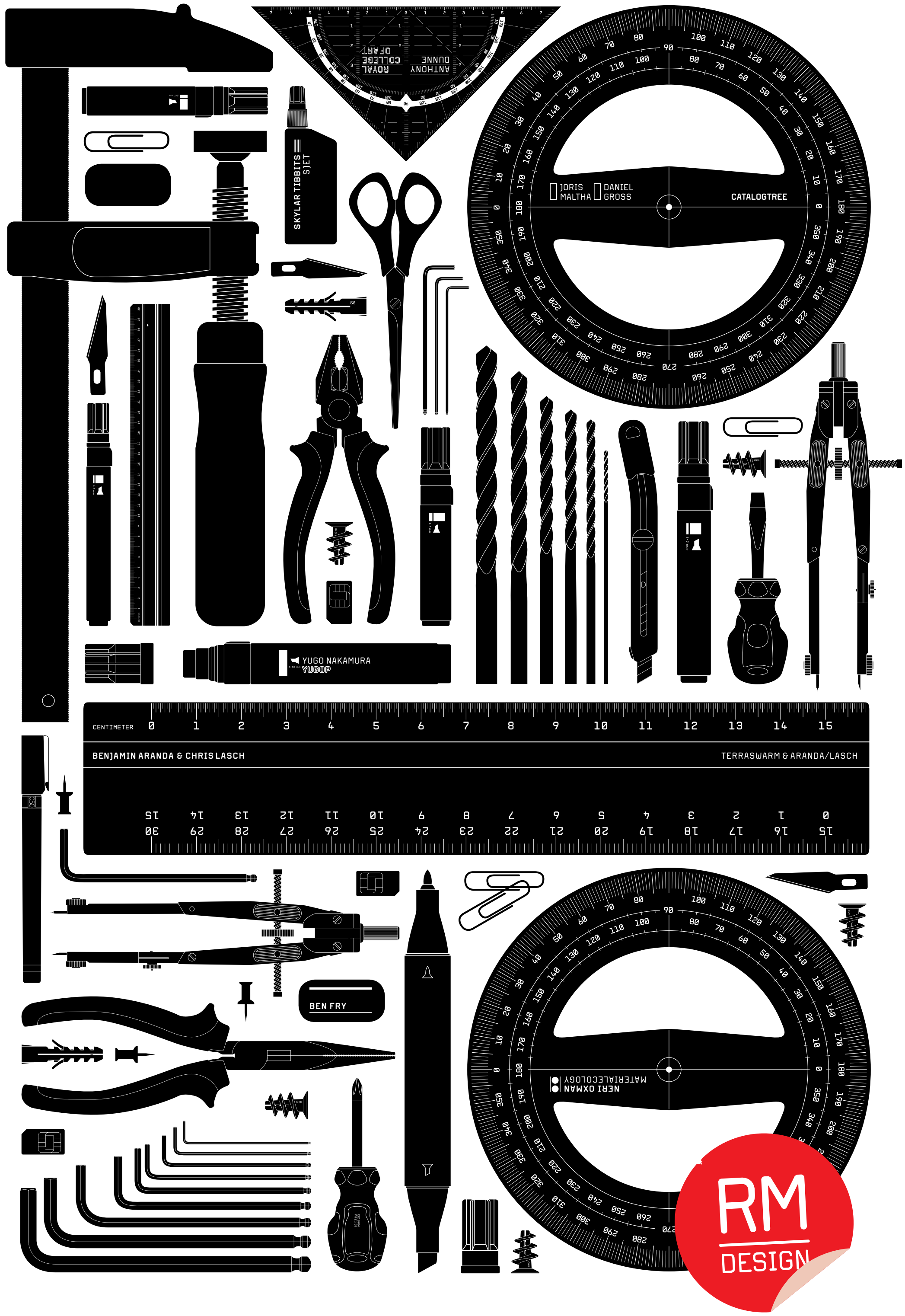
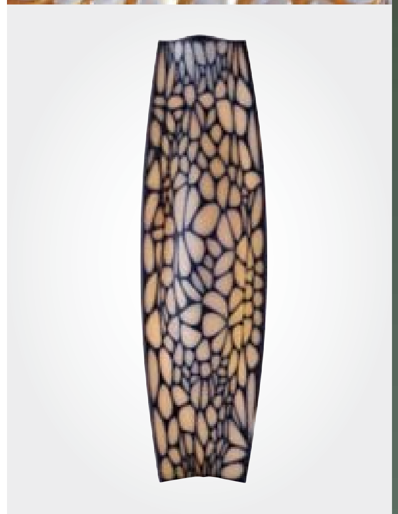


REVOLUTIONARY MINDS Design, like science, is pushed forward by innovative young thinkers who challenge the status quo. When ideas from science meet innovative visual thinking, tools and techniques from both disciplines combine to accomplish what bench research cannot. Here, in our fifth installment of the Revolutionary Minds series, *Seed* profiles seven of the most exciting individuals, studios, and groups that are operating at the intersection of science, design, and architecture—and creating provocative, experimental work in the process. The language of design is a populist one; it can translate abstract ideas into concrete objects we can hold, touch, or occupy. In the world that these visionaries are creating, science and design rely on each other. And both are the better for it. BY EMILY ANTHES

DESIGN

NERI OXMAN

MATERIAL ECOLOGY



"Cartesian Wax" (top) is a material that acts as a living organism, responding to local environmental demands. "Monocoque"(bottom) is a load-bearing building skin that features vein-like elements.

FORGET DESIGN AS AN ART FORM: Neri Oxman wants to turn it into a life science. Oxman, who refers to her work as "material ecology," explores the limits of architectural materials and the relationship between these materials and their environments. A building, she says, can be designed simply by adhering to certain dimensional or spatial requirements. Or it can be utterly redefined by considering how the structure will interact with light, wind, and the behavior of those who inhabit it.

In Oxman's effort to redefine buildings this way, she focuses in particular on the creation of new materials that borrow from nature in the way in which they interact with the world. "The natural world, particularly the biological world, is displacing the machine as a general model of design ideas," Oxman says.

Oxman calls form "the result of material organizing itself according to environmental pressures, toward a specific function." Nature, she says, is our ancestor in design: "There is a lot to be said about the form of a tree or the way in which our skins respond to heat." For instance, she has long been interested in creating buildings that are seamless, continuous tissues—more like the human body than the beams and columns typical of architectural structures. Living tissues have to negotiate many functions, and by drawing upon them for inspiration, Oxman hopes to create not just a structure but also an entire environment.

One of her current projects, "Cartesian Wax," is an attempt to do just this, using a combination of rigid and flexible resin to create a building "skin" that evokes living matter. The material has no joints and responds locally to changing light, wind load, temperature, and more. "The contemplation that a building can breathe and sweat is an investment in bridging the classical gaps between engineering, design, and the natural sciences," Oxman says. "The built environment may be conceived of as a living thing." What's more, buildings are also a record of the processes that were used to create them. In this way, Oxman says, materials can even be said to have a kind of memory, another tie-in to living systems. "Materials think," she says.

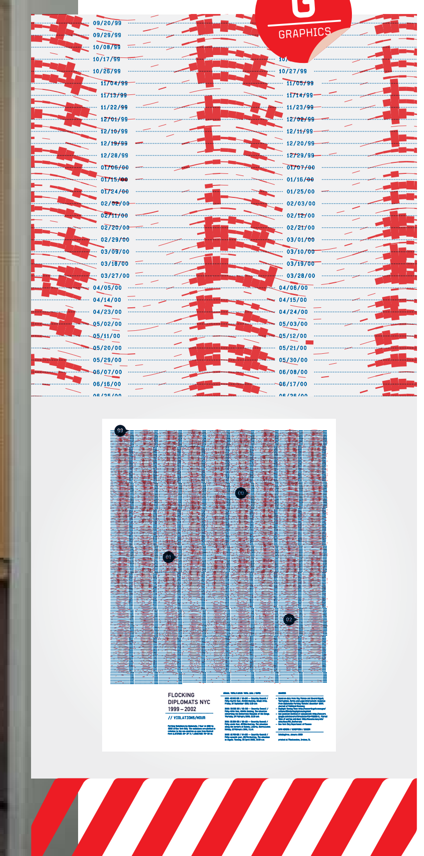
Oxman, who is currently based at MIT working toward her PhD in Design and Computation, chooses to call herself not an architect but a "fabricator." She hopes to lead the way in a wider integration of design, fabrication, and the life sciences and is already using scientific technologies and techniques in her creation of forms. "Now is the time for scientists to learn from designers," Oxman says, "rather than only the other way around."

PHOTOGRAPH BY NOAH KALINA

JORIS MALTHA & DANIEL GROSS

CATALOGTREE

G GRAPHICS



Gross and Maltha created "Flocking Diplomats" (above) to reveal the trends hidden inside a study of parking tickets earned by foreign ambassadors in New York. Their work frequently illustrates the behavior of people going about their daily routines.

TECHNICALLY, JORIS MALTHA AND DANIEL GROSS are designers, but their work creating visualizations of detailed data sets has more than a passing resemblance to science. The pair actively compile, combine, and analyze data about the complicated behaviors of human networks and crowds in order to illuminate trends that might otherwise remain unseen. "It's the business of every graphic designer to make something visible that somebody else is not able to see," Gross says. "We aim to make these invisible things visible."

A current project called "Flocking Diplomats" examines the behavior of foreign ambassadors in the US whose diplomatic immunity covers fines for traffic violations and other infractions. When Maltha and Gross discovered that a researcher had been collecting data on parking tickets earned by ambassadors in New York City, they wrote to him, requesting the numbers. Maltha and Gross tasked themselves with visualizing the more than two decades' worth of data in a way that revealed the phenomena hidden within.

The pair, who work under the name Catalogtree, took their usual systematic approach. In order to create a final product from reams of raw data, they devised a set of rules describing how the data should behave. "We think of it as a game that needs to be developed," Maltha says. "The visual outcome is generated by those rules." That means Maltha and Gross don't know ahead of time what the final product will look like. "It looks like someone else is designing for you," Maltha says. "The system generates from itself something that is really quite beautiful in the end."

In the case of "Flocking Diplomats," the outcome is a stunning poster that reveals different trends at different scales. Up close, what becomes apparent is the huge bump in parking tickets earned by diplomats using their cars around lunchtime on weekdays—as many as 60 per day. Back up, though, and more macro trends become obvious, such as the drastic drop in parking violations committed by diplomats in the days and weeks following the attacks of September 11, 2001.

Maltha and Gross have applied their rules-based approach to illuminate trends taking place anywhere from the real estate market to the basketball court. They are intrigued by the notion that people's daily lives are part of a vast, unseen experiment and that they are documenting the results. They hope their work will be compelling enough to inspire researchers to further investigate the phenomena they illuminate in their designs, Gross says. "That would make us really proud."

PHOTOGRAPH BY THIJS WOLZAK

YUGO NAKAMURA

YUGOP

I INTERACTIVE

IT'S IMPOSSIBLE TO TRULY experience the animations created by web designer Yugo Nakamura without participating in them. His thoroughly modern designs are more than technological projects; they are laboratories for investigating the interaction of the human and inhuman. "I'd like my work to be a filter," Nakamura says, "that lets the interesting parts of the new media environments—the computers and the people who are involved—become more alive."

Nakamura is particularly interested in complexity, and many of his works use small, interconnected parts to produce complex systems. Take, for example, an animation called "Entropy." In it, elliptical shapes join onto each other, creating a growing chain. Each ellipse serves as a hinge around which the entire chain can rotate. As it lengthens, it starts to spin and twist, growing into what looks almost like a living organism. "This is one of the examples of how a complex system emerges from a chain of simple connections," Nakamura says.

But the system gets more complex with the addition of a human user. In "Entropy," as in much of Nakamura's work, the user can change the course of the animation, in both predictable and unpredictable ways, with a click of the mouse. He cites the complexity of human behavior as a source of the intrigue: "A simple thing like moving the mouse is never completely logical, nor completely random for a human being. A person only moves like a person. I have always been interested in expressing this—to extract the essence of human behavior and bring together the logical and illogical."

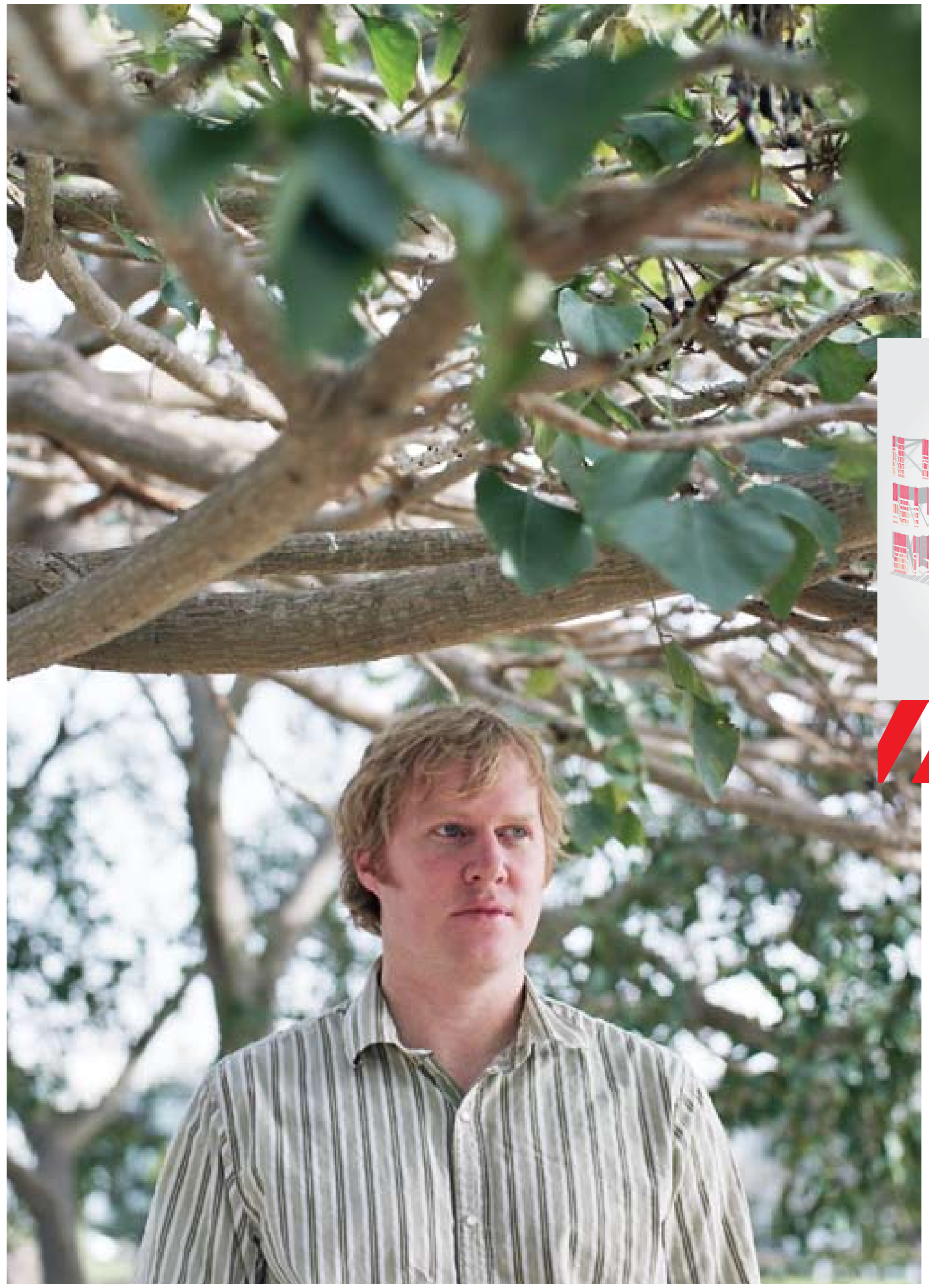
Nakamura's work explores the intersection of the technological and the human in other ways, too. This duality is front and center in pieces like "ClayGrid," in which Nakamura combines the handmade art of claymation with digital programming to transcend the limitations of both. The resulting animation shows clay balls endlessly dividing and recombining, creating an ever-changing grid of dots.

Nakamura has also found huge commercial success, designing websites for companies ranging from UNIQLO to Honda, as well as for The Museum of Modern Art. But even these designs are less passing advertisements than lasting works of art. Nakamura, who studied landscape design, believes that the same craftsmanship that goes into designing real environments should go into designing virtual ones. In the ephemeral world of the web, Nakamura's goal stands out. "Making something good enough to withstand the test of time is important," he says.

PHOTOGRAPH BY THONG VAN

"Entropy" illustrates Nakamura's interest in complexity. In the animation, small, simple parts form a chain to create a moving image that is ultimately highly complex.

Ben Fry's "Isometric Blocks" displays data from the Broad Institute's HapMap project. The interactive graphic allows researchers and the public to examine the information from various perspectives and examine relevant nuances.



BEN FRY

I INFORMATION

BEN FRY DOESN'T EXTRACT DNA, sequence genes, or synthesize new molecules. So he might seem an odd choice for a postdoctoral fellowship at the Broad Institute, one of the world's leading genomics research centers. But Fry, a designer, had long been attracted to the problem of creating visual representations of large data sets. At the Broad, he had access to one of the most complex sets of them all: the human genome.

"The genome is 3 billion letters—what does that look like? This was a perfect example of a massive data set that we know very little about and affects us at a lot of different levels," Fry says. He became fascinated, he says, with "trying to figure out a way to represent genetic data so we can figure out what's in it and what we can actually learn from it."

Fry created a visual display for the HapMap, a project spearheaded by the Broad that seeks to catalogue human genome variation across several of the world's populations. The resulting images present data in multiple dimensions, providing an illustration of the characteristics of different population groups and comparisons between the groups. The interactive graphic allows users to navigate among multiple visualizations, choosing to look at the data in the form they find most useful or interesting.

Though he says he constantly underestimated just how large and complicated genomic data sets were, Fry found a way to create visualizations that clearly present the information. In fact, his work has helped researchers find genes and mutations of interest and allowed them to arrive at a more accurate count of the total number of genes in the human genome. It is exactly this ability of design to clarify complicated data that makes it so useful to researchers.

Lately, Fry has become fascinated by all the data being collected by internet search engines and what they reveal about people's stream of consciousness and the way they interact with the internet. He considers creating visualizations of search engine data, but hesitates because he worries about violating the privacy of internet users.

Fry, who is no longer at the Broad but continues to collaborate with its researchers, says he hopes that his visualizations help scientists see their work in a different way. Design, he says, plays a critical role in how science is done: "You can only advance a scientific field as quickly as you can communicate it." The role of design in the process, Fry says, must grow.

PHOTOGRAPH BY YE RIN MOK

A

ARCHITECTURE

BENJAMIN ARANDA & CHRIS LASCH

TERRASWARM & ARANDA/LASCH

AN ECLECTIC COLLECTION OF WORLDLY things inspires architects Benjamin Aranda and Chris Lasch: Native American baskets, flocks of pigeons, nanomaterials. But what intrigues the pair about all these items is the information contained in their structures. Aranda and Lasch are building their practice on the idea that complex natural patterns can inspire novel ways of creating architectural forms. "We're looking at complexity in order to find opportunities," Aranda says. "You can build a process that allows you to discover and tap into certain rules in nature."

Aranda and Lasch published a book, *Tooling*, about these rules and their use in creating architecture. In *Tooling*, the pair outlines seven naturally occurring geometries—flocking, weaving, and packing, for instance—then unravels the logic behind the patterns and works them into algorithms that can be used to design structures. Though Aranda and Lasch break complexity down into formulas, they use the algorithms to arrive at results that are anything but formulaic. In one recent installation they broke weaving down into its binary logic, forging an art form called computational basket weaving. "There are surprises all along the way," Aranda says. "We're operating using our intuition. But we're using these generative processes to create something we otherwise couldn't imagine. That's something we share with scientists—there's an ethic of discovery."

Lately, the pair has been working with molecular structure, developing algorithms based on crystal shapes to generate designs. So far Aranda and Lasch have applied this logic primarily to creating furniture. They designed and built a Louis XV-style armchair based on the structure of a crystal lattice and a walnut dining table made of thousands of individual wooden tetrahedrons. Both designs draw inspiration from the notion of quasicrystals, or crystals that have so-called "forbidden symmetries." Though the table is merely the result of stacking nearly identical wooden blocks, the final product is intriguingly nonuniform and asymmetrical. "It's about this architectural holy grail of having the efficiency of modularity but the variety of irregularity," Lasch says.

These pieces are a testing ground for principles that Aranda and Lasch eventually hope to use to create larger installations and buildings. And it's not just about the final product, Aranda and Lasch say—it's also about developing a new process for building and new ideas themselves. "There are architects who really take on the world's problems," Aranda says. "We produce problems. And then we work to solve them."

"Quasi table" (top), commissioned by the Johnson Trading Gallery), is inspired by the impossible symmetries of quasicrystals. "Baskets" (bottom, Endless Knot, Aranda/Lasch and Terrol Dew Johnson 2006) are built using the binary logic that underlies weaving.

PHOTOGRAPH BY NOAH KALINA

DESIGN

SKYLAR TIBBITS

SJET

C COMPUTATION

Tibbits used networking logic to generate objects and was surprised to discover that the end result resembled a flower, which he named "Chrysanthemum." His unconventional approach to creating space and structure can reveal unexpected mathematical connections.

SKYLAR TIBBITS TAKES GENERATIVE architecture to an extreme. He begins his designs without any particular end result in mind. He is interested first in mathematical logic, developing algorithms based on principles like fractals, recursion, or tessellation. He uses these to generate three-dimensional shapes, and the end results hardly look like buildings—one resembles a roller coaster, another looks like a pair of wings, a third like shards of glass. But their strange geometries reflect Tibbits's exuberance for the unexpected architectural forms that common mathematical principles can generate. "It's never initially about developing space," says Tibbits. "You're developing relationships or organizations or scientific rules, and out of that comes space."

In one of his earliest investigations, "Cracking," Tibbits created forms by breaking complex shapes down into triangles and then using formulas for fractal growth to turn these triangles into new architectural structures. One of the resulting designs resembles a fractured, spiraling high-rise. Though Tibbits does turn some of his designs into small-scale built works, most of his designs are not intended to be structures that humans can occupy. Instead, he envisions his work as experiments in new ways of creating space. "We have these notions of what a house or what a building has to be," Tibbits says. "When you look at smaller-scale pieces you can break those notions."

Most recently Tibbits has become interested in artificial intelligence—using the mathematics of networks, swarm logic, and clustering to generate abstract shapes and patterns. In one new piece, based on the logic behind networking, Tibbits started with a set of points and generated a series of closed curves based on algorithms describing the proximity relationships between the points. He was surprised to discover that the result was a three-dimensional object that looked strikingly like a flower, and he titled the piece "Chrysanthemum." Tibbits finds these surprises particularly exciting. "You're developing forms," Tibbits says, "but out of that comes these connections you may not have recognized before."

The projects themselves provide fodder for future work, and each design suggests a new tangent for Tibbits to follow. "It's the endless search for more," he says. "I'm always looking for the next technique: How can we push the boundaries a little bit further, how can we push our notion of what space is?" He hopes his designs will also prompt others to create work that stretches our usual conventions about space and structure. "What you just produced," he says, "how does it inspire more?"

PHOTOGRAPH BY NOAH KALINA

ANTHONY DUNNE

DESIGN INTERACTIONS PROGRAM, ROYAL COLLEGE OF ART

P PRODUCTS

DESIGNING A COMMERCIAL PRODUCT frequently happens after engineers have taken scientific ideas and turned them into real technologies. At the Design Interactions program at the UK's Royal College of Art, students and faculty members design differently. They spend their days playing with scientific ideas, actively imagining the products that might result from advances in fields ranging from biotechnology to nanotechnology. In doing so, they create objects and ideas that aren't final products but launching points for further investigation, research, and discussion.

Anthony Dunne, the head of the program, says that designers are expected to take "a passive approach" to technology they encounter. "But we shouldn't have to just wait until scientific ideas become technology. We can engage with science in a more speculative way," he says.

Take the work of recent graduate Susana Soares. She was inspired by research that shows bees have a sensitive sense of smell. Soares worked with glass blowers to create containers that harness bees' natural olfactory talent for medical diagnosis. Soares imagines a patient blowing into one of the glass chambers and watching for certain behaviors in the bees that might suggest the presence of disease. Afterward, the bees can be released. "It's a sustainable way of using the biological systems around you," Soares said. The aesthetic suggests that we can create a scientific future that is far less sterile than we might imagine.

Sometimes the results of these design explorations are more unsettling. Dunne and his colleague Fiona Raby created "Evidence Dolls," which allow women to collect and store DNA of their potential partners. The dolls, which can be personalized to represent different people, are like modern-day voodoo dolls: genetic material storage devices with drawers for hair, fingernail clippings, and more. Dunne and Raby do not intend for the dolls to actually be mass-produced; they envision the dolls as a conversation-starter on the implications of scientific advances. "Biotechnology could have a massive impact on how we relate to each other as people," Dunne says.

The program hosts public exhibitions and events and at its core is a mission to involve working scientists in students' projects and critiques: Many of these relationships continue beyond the program. "Traditionally, design only makes a decision in the way a product will look," Soares says. "I work with scientists and engineers and researchers so I can bring design to the beginning, so the end product of research is the decision of several disciplines."

PHOTOGRAPH BY FRANÇOIS COQUEREL

In "Sniffing Others," Susana Soares imagines a future in which people literally sniff out their mates, something we may already do unconsciously. This "necklace" encourages potential suitors to smell the wearer's neck.

REVOLUTIONARY MINDS VIDEOS ONLINE