ELECTRONIC POPABLES

THIS NEW PAPERCRAFT GETS TRICKED OUT WITH SOUND, LEDS, AND TOUCH SENSITIVITY.

Pop-up books have always been magical—pull a tab, lift a lever, spin a disc, and you make a story leap up from the page. But in *Electronic Popables,* Jie Qi takes their whimsy to the next level, embedding electronics that make the pages do more than just pop: They light up, play music, twinkle in a mesmerizing pattern, rhythmically pulse, and subtly move in response to the heat of your touch. It's double the magic—and double the ingenuity.

"With mechanical systems, you can see how one thing leads to another," Jie says of her traditional paper-engineering predecessors. "Pull this lever, and its other end goes up. But adding circuits provides more surprise because electricity is silent, instantaneous, and even wireless. And with programming, you can incorporate intelligence and automation, which open up a new world."

Jie has always liked working with paper. And after a bout as a premed major, she decided to put her science chops to artistic use: "Medicine is creative in a problem-solving sense, but in personal expression, not so much. You want that out of the operating room!" So Jie joined MIT's Media Lab and got back to crafting. Turns out that with cheap conductive materials, Arduinos, and a sense of electronics' expressive capabilities, paper may just get an unexpected reboot.

HOW JIE TINKERS

Making Paper Pop

Jie's *Electronic Popables* project does the unexpected: It transforms hardcore electronics into a storytelling medium. "I started thinking, 'How can we think about circuits as not just an engineering tool but also a craft supply?'" Jie says. The answer was to find friendly materials that are fun to use—and to make art that's equally fun to interact with.

EARLIER EXPLORATIONS: JIE BUILT PAPER FLOWERS THAT LIT UP AND BLOOMED.

"When I was little, my mom brought home an origami dog. I was really intrigued, so she got me an origami book, and I looked at the diagrams. They helped me learn the physical properties of paper and fall in love with the infinite possibilities of a material that's so simple—and plentiful and cheap!

"I make some circuits out of conductive paint and fabric, but I most often use copper tape from The Home Depot that's used to keep away snails. Because it's copper tape instead of wire, you can choose a place and stick it down in a line, and if it doesn't work, you can pull it up to redo it. It's like playing connect the dots, but your lines conduct electricity and the electronics glow and move when you connect them with the lines. For me, the point isn't just that I can make an LED turn on, but that the LED can help tell a story. For instance, I made a circuit to represent a neuron, and when you blow on a tiny microphone, the lights come on and 'blow your mind.'

THE PROGRAMMING BEHIND JIE'S ELECTRONIC BOOK? ARDUINOS DEVELOPED FOR PAPER BY LEAH BUECHLEY AND TUNG SHEN CHEW.

"Each page of the book shows a different circuit element. The jellyfish page uses a DIY potentiometer made of pencil graphite, so when you move the dial, the fish float and dim. The Venus flytrap page was most challenging—when you stick your finger in a leaf, it closes around your finger. So it needed muscle wire for moving the leaves, which requires high power. Then it needed a sensor to detect light touches. And all of this had to fit on a thin pop-up stem and leaf. Then there was the code. To me that was the hardest—I was learning to program, and I had to make my sensor read capacitance.

"At first I assumed that a mechanical switch would be easy to translate into an electrical one. I started by looking at the buttons and slide switches all around us and replicating those real-world examples with paper. Then I had an epiphany: When building paper switches, there's nothing keeping you from making the switch completely different—you can make it look any way you want. So I sketched some flower designs and figured out how to turn the leaves and stem into switches, then used those drawings to make the book's first page. When the book was done, I bound it so I could access its electronics from the back to fix bugs.

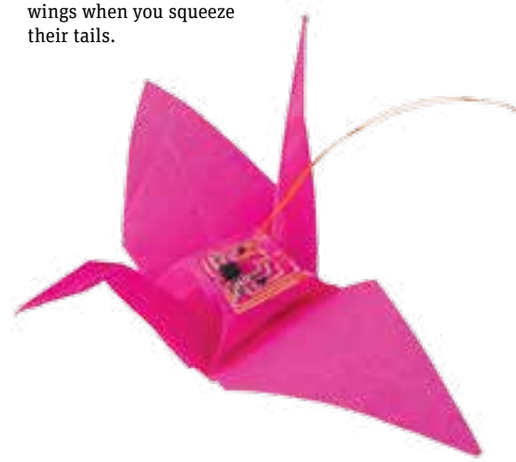
TINKERER DETAILS

Favorite tool I got my first X-ACTO knife in sixth grade, and I still have it. It lets me create 3-D structures with the freedom and fluidity of drawing with a pencil. But I have to be careful—since it's metal, it sometimes shorts my circuits!

Tinkering strength I'm happiest when I can go on and on uninterrupted and tweak something until I love it, focusing long enough for an idea to appear and then grow into a full-fledged thing.

Advice to new tinkerers It helps to draw or build a working model to make the idea real. Also, don't be afraid of breaking things, which is especially important when learning electronics. It also helps to find a friend to get excited with you!

Inspiration I'm interested in embedding electronics into traditional crafts, like these origami cranes that flap their wings when you squeeze their tails.



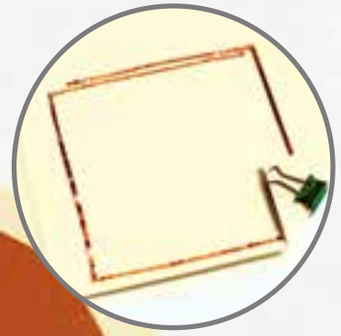
HOW YOU CAN TINKER

Play with Paper Circuits

Borrow a page from Jie's book and experiment with your own paper circuits—you can get started with the friendly light-up greeting cards you see right here. We like these cards because they allow you to express your ideas through construction, and because they demystify electronics so that everyone can play. The truly hard part is deciding who'll be the lucky recipient.

COLLECT COMPONENTS Before you build, gather a few electronic components: a coin-cell battery, copper tape (available in the gardening section at home-supply stores), and surface-mount LEDs, which you can find online. Then scour your house for small binder clips, clear tape, cardstock in a color you like, scissors or a craft knife, and tweezers. (Surface-mount LEDs are teeny-tiny, so handle them with tweezers and secure them with tape.)

POWERING UP Start by folding your paper to create a basic greeting-card shape. Then make a place for your coin-cell battery by creasing a dog-ear fold at the bottom right-hand corner of the page. Before you come up with a design, bear in mind that it should be arranged in a loop, so that electricity can flow from the battery to the LED and back to the battery again. It should also include two lines of copper tape: one that touches the LED's negative leg and one that touches the LED's positive leg. These lines of tape extend toward the dog-eared corner, with one crossing the fold. That way, when you place the battery in the corner and fold it up, the battery will press against both copper strips and complete your circuit. A binder clip will help hold the battery in place!



MAKE IT EVEN BRIGHTER Putting together a card with multiple LEDs isn't much more complicated—just position all your lights so that their positive legs are on the same strip of that awesome copper tape, and their negative legs are on another. Bear in mind that LEDs get dimmer the more you add, as they use the same power supply.

SEE IT IN LIGHTS Now that you understand how to power your circuit, design a card with its own special light-up action—maybe it's a yellow-eyed hoot owl, or candles on a birthday cake. . . . It's up to you! Sketch on the front of your card, then open it up and tape an LED on the inside where you want it to shine through the paper. Now for the crucial bit: On the inside of the card, lay down a copper-tape track on both sides of the LED so that the LED bridges a gap between the two tracks, and run the copper tape all the way to the dog-eared corner. For any places where copper tape needs to turn at an angle, fold the ends diagonally into corners and secure them with clear tape on the paper. Slide the battery into position so that, when the corner is folded up, the battery's positive side will press against the copper tape that touches the LED's positive leg and its negative side will press against the copper tape that touches the LED's negative leg.

PAPER POSSIBILITIES

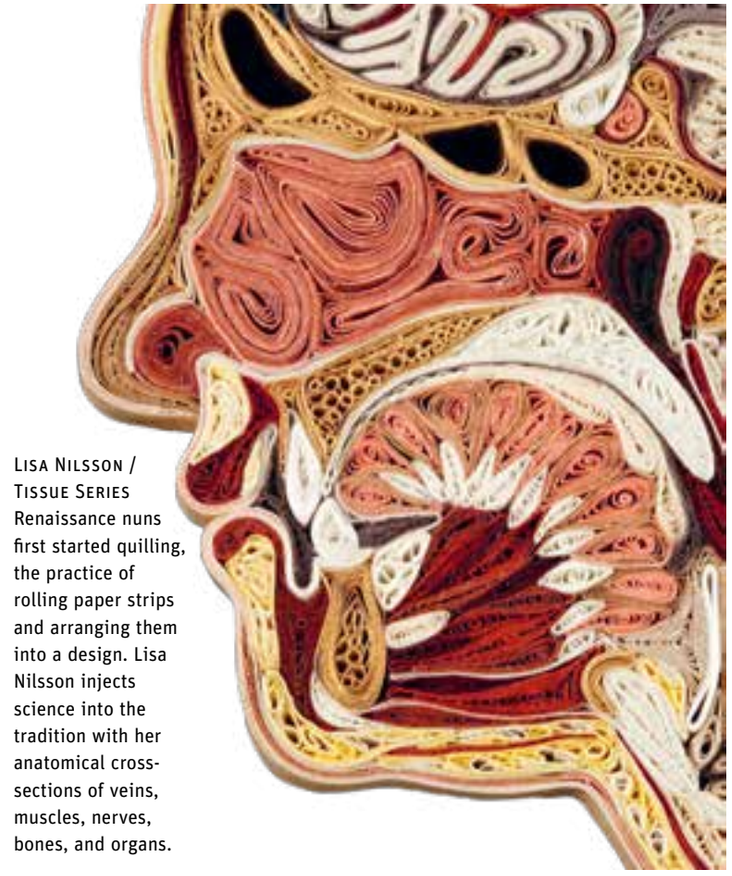
Origami may be an ancient craft, but today's paper artists use cutting-edge methods to explore biology, architecture, mapping, and, of course, whimsy.

Matthew Shlian & Michael Cina / Aleatoric Series
Matthew Shlian uses paper to explore cellular development, collaborating with scientists to mimic organic functions. Here, he's teamed up with graphic artist Michael Cina to combine their two mediums: tessellated papercraft and painterly abstraction.

Akira Yoshizawa / Paper Peacock
The grandfather of modern-day origami, Japanese master Akira Yoshizawa pioneered the technique of "wet folding": slightly dampening the paper before creasing it for a realistic, sculpted effect.

Su Blackwell / Snow White in the Woods
British book artist Su Blackwell has a background in textiles, and her detailed, handmade papercraft evidences a familiarity with stitching and embroidery. To make her pieces, she reads the selected book once or twice, then begins to carve elements from its pages and add three-dimensional details, like the trees, houses, and Snow White figure here. She often creates natural settings or reenvisions scenes from children's stories.

David Canavese / Millennium Falcon
Believe it or not, this ½-inch- (1.25-cm-) long replica of the fabled *Star Wars* ship is made entirely of folded and cut paper. David's other sci-fi replicas include TARDIS from *Doctor Who* and *Stars Wars'* Rebel blockade runner and the *Imperial*-class Star Destroyer.



Lisa Nilsson / Tissue Series
Renaissance nuns first started quilling, the practice of rolling paper strips and arranging them into a design. Lisa Nilsson injects science into the tradition with her anatomical cross-sections of veins, muscles, nerves, bones, and organs.

Karen O'Leary / Modern Maps
An architect working in North Carolina, Karen O'Leary creates maps of major cities, trimming away land and leaving a web-like network of streets and rivers—all without the use of a lasercutter. Her work inverts our notions of positive and negative space, making familiar places seem new.

WONDROUS WEARABLES

SCI-FI FILMS HAVE ALWAYS PREDICTED THAT SOMEDAY WE'D WEAR ILLUMINATED CLOTHES. BUT WHO DREAMED THEY'D LOOK SO LOVELY?

When you think of electronic wearables, sleek and futuristic feats of textile engineering likely spring to mind—garments that light up with bold, blinding lights or magically move on their own. Garments that sense temperature changes or create sounds, and that are often made of synthetic fabrics and sewn-in battery packs, motors, and even an accelerometer or two. These costume-like pieces are flashy and smart but lack the comfort and familiarity of, say, your favorite sweater.

That may be why Grace Kim's illuminated handmade creations feel so special and surprising. Elegant, subtle, and made of oh-so-touchable natural fibers, Grace's wearables combine hard-won electronics ingenuity with old-school crafting techniques and inspiration. Case in point: Her *Sessile Handbag*—a pale, felted tote bedecked with barnacle-like circles of gathered muslin (called yo-yos by generations of crafters). LEDs are nestled inside these barnacles and sewn with conductive thread to a LilyPad Arduino, a textile-specific microprocessor coded to make the LEDs twinkle in a random, organic pattern.

It took Grace a while to hit upon a crafty approach. At NYU's Interactive Telecommunications Program, she grew frustrated with designing pieces that were bogged down with wires and heavy components. "I marched into my advisor's office and blurted, 'I don't like technology!'" Grace says. "The thing I cared about most was aesthetics. I wanted the electronics to help the aesthetics instead of taking them over."

From there, Grace got inspired by Scandinavian patterns from the '60s and turned to knitting, felting, and embroidery as more fashion-friendly tactics. "The more traditional crafts you know, the more tools you have at your disposal when you're trying to make something new," she says. Because even the future could stand a good lesson from the past.

HOW GRACE TINKERS

Crafting with Lights

To create her wondrous handbag, Grace holed up in her apartment and tirelessly knitted, felted, and prototyped her way to an eye-pleasing accessory. But as with so many other tinkerers before her, the story really starts in her childhood, when she learned the value of dogged determination and basic crafting know-how.

When I was eight, I decided to make a doll, but I didn't really know how to sew. For the head, I cut two fabric circles, did a running stitch around them, and started stuffing it with Kleenex. I thought my mom was going to be mad that I was wasting tissues, but instead she drew a figure on newspaper and had me cut it out of fabric. Then she made me sew it the *right* way, so I had to learn a backstitch. She even taught me how to do the hair, which was really cool. Then I started sewing all these *Anne of Green Gables* clothes for the doll, and that was superfun.

Before I made the *Sessile Handbag,* I first tried knitting a capelet that lights up, as I wanted to make something that was small enough to be intricate without needing a ton of power. I was really attached to using a coin-cell battery, as I didn't want a bunch of hardware sticking out, so I could light only two LEDs at once. At first I tried putting LEDs in floral embroidery patterns, but it seemed cheesy—I wanted the LEDs to look natural and subtle, like a bead catching the light. Then I found a pattern in a Scandinavian book, *The Stitches of Creative Embroidery,* and it reminded me of wood grain. It had these circular elements with two lines passing by them, and I immediately thought of power and ground. So I wondered if it could represent the flow of electricity.

When I started making the bag, I needed something to protect the LEDs. I'd been sewing yo-yo quilts, and I decided to try housing LEDs in the yo-yos and scattering them all over the bag. When I put the LED inside the first one and it started fading, it dawned on me that it looked like a lifeform breathing inside a barnacle. But I liked that, when the bag was turned off, the LEDs were concealed—it made it clean and minimalist.

GRACE'S GO-TO TOOLS: MAUCH CHUNKY YARN, KNITTING NEEDLES, AND LOTS OF CONDUCTIVE THREAD TO MAKE THE MAGIC HAPPEN.

The bag looks neat now, but making it was chaos—fabric was all over the floor, I was covered in pieces of thread, and I kept stepping on needles. And the bag looked completely insane. I had alligator clips attached to each LED and I was trying to hook them all up to a LilyPad in the center, then flipping it over to see if it worked. Some of the conductive threads had to cross each other on their way to the LilyPad, so I put a few on one layer of felt and some on the layer underneath so they wouldn't touch and short out. For the fade, I assigned each of the LilyPad's digital pins a light level using the values of a sine wave from the Arduino community. The order in which the LEDs fade in and out is determined by the Fibonacci sequence, giving it a natural look.

TINKERER DETAILS

First tinkering moment I wanted to sew a tote bag when I was a kid, and my mom grabbed a paper bag, turned it inside out, and said, "See where the glue lines are?" She taught me to figure it out myself, rather than buying a pattern.

"Real" job Interaction designer. I make wireframes and system diagrams.

Getting unstuck Honestly, I freak out a little! But I've done this enough that I recognize the stages, so I can realize that I'm just at a certain point and it may suck for a while. And when you solve it, you feel really happy—it's empowering.

HOW YOU CAN TINKER

Fashion Soft Circuits

Grace's soft circuits are beautiful and inspiring, and we like how she combines old, tried-and-true crafting skills with new technologies. You can tinker with these techniques to create items that you would want to wear out and about—and these simple light-up pieces are a good place to start!

FIRST THINGS FIRST To make the crafts you see here, you'll need to source conductive thread and conductive fabric (the kind used here is called zelt), both of which are available online. (It's pricey, but if you buy both copper and silver fabric, it'll be easy to keep track of what's power and ground.) Other electronics to scope out include LEDs, coin-cell batteries, and battery holders. You'll also need felt (cut into pieces large enough to fit around your wrist with a little overlap, and extra for decoration), needles, pliers, and magnetic snap closures.

A BEGINNER'S BRACELET Cut two narrow strips of conductive fabric that, when put end to end, will run the length of your felt, with an LED-size gap between them. Sew the pieces to the felt with conductive thread. Use pliers to twist the legs of an LED into little eyehooks, and place it between the conductive-fabric strips. To stitch the light to the conductive fabric, repeatedly pull the conductive thread through the LED's eyehooks, down through the silver fabric, and then up again until it's secure. Sew the battery holder to the conductive fabric with its positive end oriented toward the LED's positive leg, and attach snap closures to both ends of the fabric strip. Now for the fun: What felt scraps can you sew around your LED to make it special? To light it up, slide a battery into the holder and snap it around your wrist.

. . . OR SAMPLE A SAMPLER Another of Grace's crafts is a classic embroidery sampler—only this one lights up! To make your own, sew two strips of conductive fabric down either side of a piece of felt, then use conductive thread to practice your favorite stitches. Leave a place for a battery pack, LEDs, and other components in every row, lining them up so that the positive legs are on one side of the sampler and the negative ones are on its opposite side.

TRY A BRIGHTER BRACELET OPTION What's better than a bracelet with one LED? One with two, obviously! Tinker with your materials to see what designs you can light up, experimenting with more complicated soft circuits that feature different types of conductive fabric (silver for negative, copper for positive); smaller LEDs that draw less current; and multiple layers of felt with the electronics sandwiched between them. Just remember that your LEDs' positive and negative legs must be connected to the positive and negative terminals of your battery pack, respectively. Also, your snap closures must be in contact with the conductive fabric in order to be functioning parts of the circuit and light up when you clip the bracelet on.

HI-TECH STYLE

Technology is all about trends, and it's merging with another realm ruled by fad: fashion. These days, designers and geeks are teaming up to make apparel that's nothing short of wearable wizardry.

Janet Hansen / El-Wire Apparel
The unofficial light-up apparel designer to the stars, Janet uses thin strands of battery-powered electroluminescent (EL) wire to outline costumes' seams and construction details with vivid, brightly colored lines of light. The results are show-stopping.

Hannah Perner-Wilson / Textile Switches
Hannah's sensor switches have ushered in a whole new way to develop electronic textiles. Many wearables artists have used her fabric push buttons, beaded tilt sensors, pom-pom sensors, and bend sensors as parts of their playfully illuminated, almost sentient clothing.

Leah Buechley / LilyPad Arduino
A former professor at MIT's Media Lab, Leah developed the popular LilyPad Arduino (shown here in embroidery by Becky Stern). A microcontroller mounted to a lightweight, flexible board, the LilyPad can be programmed to control lights, sensors, and other fashion-forward components that users attach with conductive thread.

Hussein Chalayan / Transformer Dress
Turkish designer Hussein Chalayan works at the intersection of high fashion and technology, incorporating muscle wire (an alloy that morphs when heated and returns to its original shape once cool) to create shapeshifting garments that magically drape, fold, and pop up all on their own.

Mary Huang / LED Dress
Designer Mary Huang's jersey and crocheted dress features a dozen battery-powered LEDs that light up the garment's torso. When the dress isn't worn, it can be used as a lamp, expanding its usability and cutting down on its time hanging in a closet. Huang wanted to make a piece that was truly day-to-night: In sunny hours, the LEDs are hidden from sight. But when it's dark, the garment transforms into an ethereal, spectral light show for the body.

Naim Josefi & Souzan Youssouf / Melonia Shoe
If 3-D printing is the future, what better vehicle to transport you there than these 3-D-printed shoes? Sketched by designer Naim Josefi and then modeled in Rhino software by Souzan Youssouf, the footwear introduces a brand-new production process to apparel manufacturing.

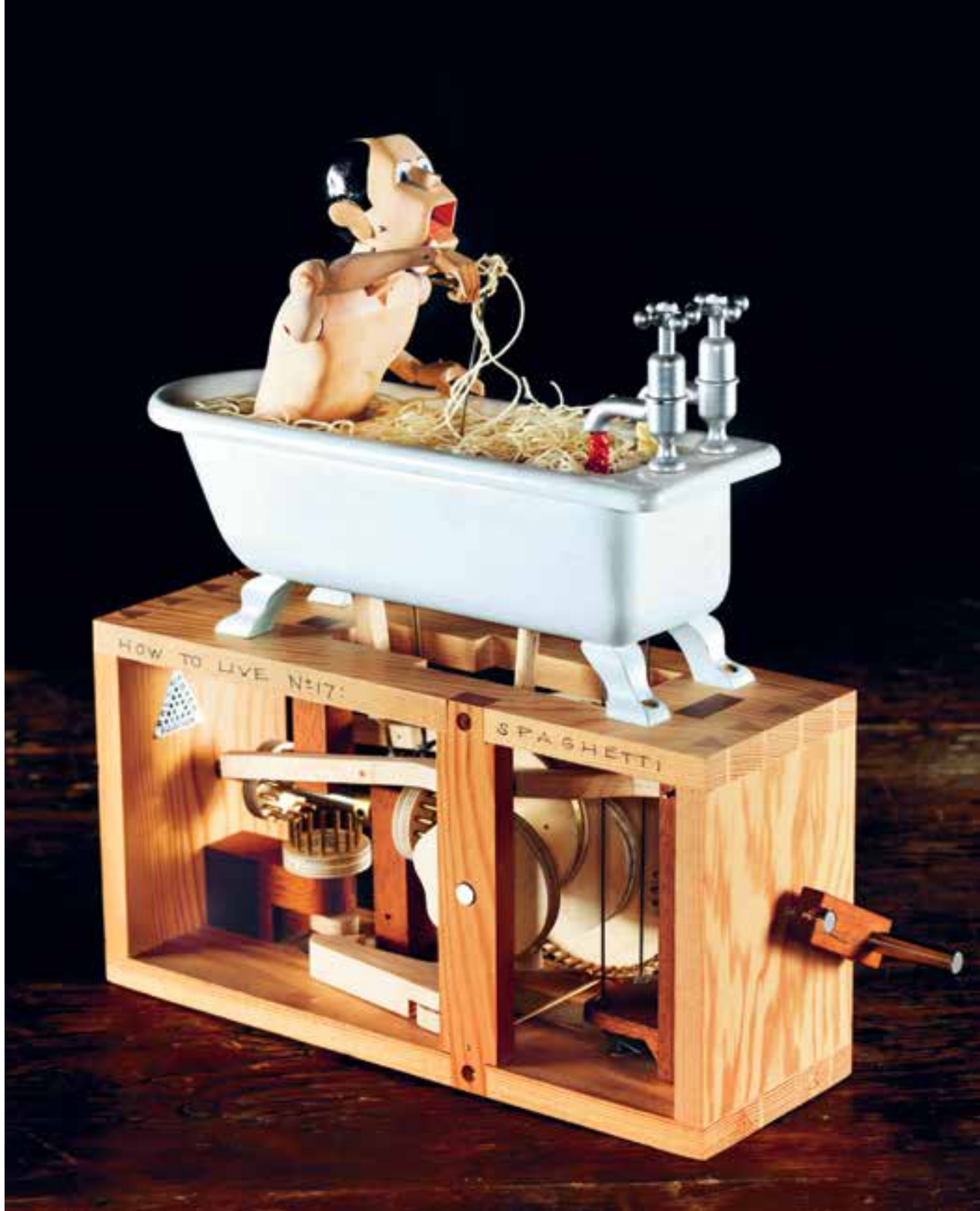
ABSURDIST AUTOMATA

WITH A SIMPLE TURN OF THE CRANK, THIS FELLOW EATS HIS FILL OF SPAGHETTI—AND GIVES YOU A TASTE OF MECHANICAL COMEDY, TOO.

Somewhere in the village of Stithians, Cornwall, holed up in a rustic, ivy-covered cowshed in his backyard, Paul Spooner is likely to be hard at work. He might be cutting boards with an antique sewing machine that he modified into a saw, or drawing new designs in one of his many sketchbooks. Or maybe he's wielding an old surgical scalpel, whittling tiny and charming figurines from salvaged wood. Only one thing is sure: When Paul works, it looks a lot like play.

And that playfulness certainly makes it into his finished pieces. Called automata, these small, toy-like machines ask viewers to rotate a hand crank, then watch as this gesture is translated by a series of levers, cams, and gears into a tongue-in-cheek joke about *la condition humaine*. In *How to Live #17,* Paul's initial premise was that we all must learn life's lessons—even the most rudimentary, like how to eat spaghetti, a notoriously messy noodle best consumed in proximity to soap and water. It's an apt choice in setting for such a lesson, but it's also a riot. "Once I made a list of things that were funny," Paul recounts. "And bathtubs came up quite frequently, as did corkscrews and Welsh lessons." As for the spaghetti, there was a practical concern behind making it the machine's main course, as the springy noodles cleverly conceal the mechanics that lift the man's hand to his mouth. "Often what appears to be humorous actually has a good deal of logic behind it," he says.

We love Paul's work because he takes it seriously without taking himself seriously, and because once he's sketched an idea, he plays with the problem to make it function, and leaves the machine's nuts and bolts exposed in the base. "What's the point of doing the work if you don't show it to people?" he kids. But look closely, and you'll get a glimpse of mechanical decisions that, despite their humor, are no joke.



HOW PAUL TINKERS
Carving Cartoons

Paul's automata start as drawings, then he animates them into three-dimensional cartoons-in-a-box, carving characters and making them move with mechanics. To spread the good humor, Paul formed the 14 Balls Toy Company with fellow artist Matt Smith, who makes editions of designs—such as *How to Live #17*—that others can buy for their personal amusement. "The only function of my machines is to make people laugh," he says. "So at least I can tell if they've worked."

"The project started when a television program approached me to build a machine on camera, and I had the idea to make a man eating spaghetti. If you don't look too closely, it seems that the hand is lifting the spaghetti, but it's actually the other way around. The soft and floppy skein of the pasta—which is silk embroidery thread—keeps you from noticing the rigid post pushing the hand up to the mouth. There's a reverse engineering to it. Then I thought that it would be convenient to have the usual accompaniments of Parmesan cheese and tomato sauce coming out of the tap.

THINGS THAT INSPIRE PAUL: *THE SIMPSONS*, *THE BEANO* (A CLASSIC BRITISH COMIC), AND THE MICKEY MOUSE MUG HE GOT AT DISNEYWORLD WITH TIM HUNKIN

"To transform the hand crank's rotary motion into the up-and-down and forward-and-back movements of the spaghetti eater, I hooked a reduction gear to the handle, and it drives several cams. One cam is followed by a roller on a lever with a wire on the end to carry spaghetti to the mouth. Another cam moves the man forward with each bite—connected to a linkage that opens his mouth—and one more cam makes him chew as he moves back. Then came a familiar problem in the automata business: The first mechanism took all the space, leaving no room to make the taps spill sauce and Parmesan. I ended up arranging gears and a drive shaft at the box's other end, and making an elaborate crank to connect them all the way to the tub's taps.

ONE OF PAUL'S FIRST PIECES: A STEEL KINETIC CLOCK SCULPTURE HE MADE FOR HIS DAD IN COLLEGE.

"I'm a bit of a toolaholic. I bought myself a little Lie-Nielson block plane for Christmas a few years ago, and I'm still slightly in love with it. It's a very strongly constructed, rigid little tool. But I abuse tools as well—I fall out of love with them, and then they suffer. I often use ones that belonged to my grandfather and dad, as I like the feel of my hand fitting where somebody else had theirs ages ago. Corny, but true. To do most of the detail work in my figures, I use an old scalpel. It's very precise and allows me to slowly creep up on a look I like. I also appreciate that whittling for 30 minutes helps me delay making the next evil decision—it lets me clear my head before tackling a looming problem.

TINKERER DETAILS

First tinkering moment There wasn't a time when I wasn't interested in machinery. I was probably intrigued by the wheels on my pram! I also used to help my grandfather—he was one of those awful workmen who would use a hammer to put in a screw.

Favorite material I'm a big fan of wood, but I hate going and buying it. So I've been very lucky that people just give me wood—old tables and chests of drawers that they couldn't sell at auction.

Getting unstuck I like having lots of projects going at once so I can move from one to the next when I'm stuck.

Advice to new tinkerers Test out your ideas using easy-to-work-with stuff like cardboard and sticks before you try them with a more difficult material.

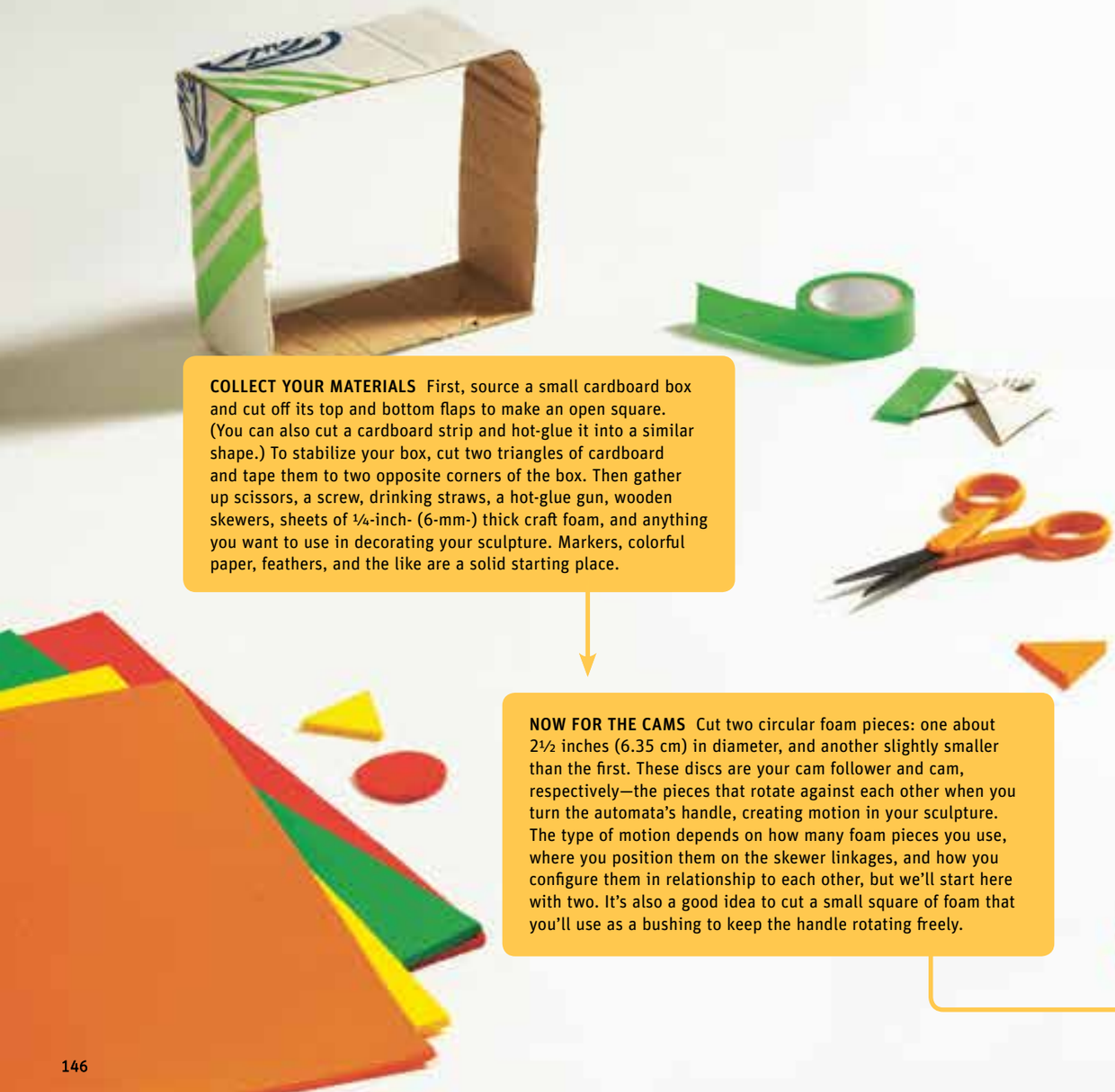
"I've got a very large batch of drawing books, and I have one open all the time. And if I'm making something, I'll do drawings of how I think it ought to go. And while I'm doing that, I might do a drawing of some new thing. So if you look through these books, they seem rather a jumble. But then you see the germs of ideas, and things that got somewhere and things that didn't. Of course, one of the important things about drawing is that it saves you from wasting materials. You can do a dry run with a drawing and decide whether it's a practical project or not.


BELLEW
BISTO

HOW YOU CAN TINKER

Put Together an Automaton

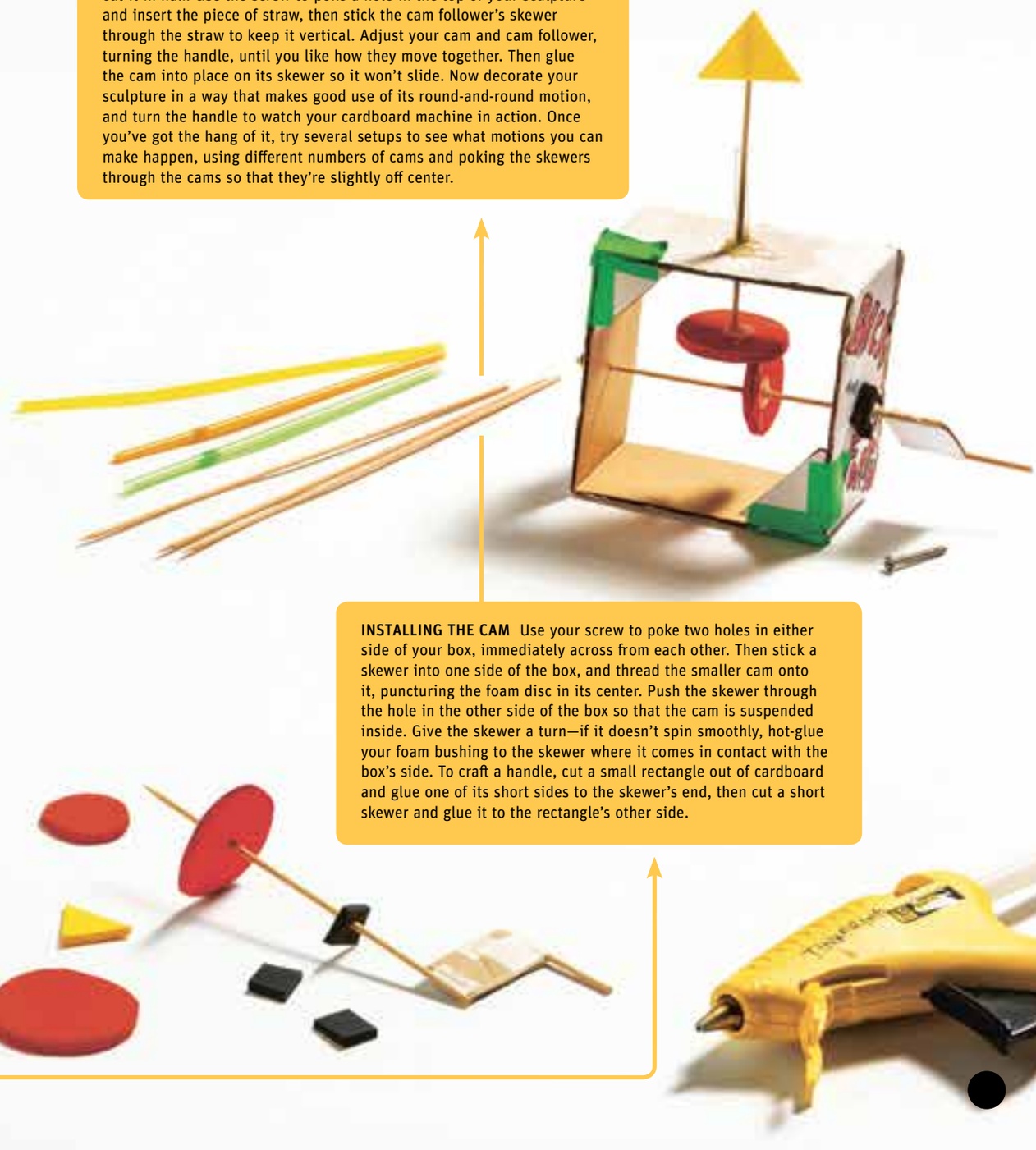
We like automata because they're made up of simple machines, but they can be used to tell complex stories. Configure the cams, levers, and linkages you see here so that their mechanics make a meaningful motion.



COLLECT YOUR MATERIALS First, source a small cardboard box and cut off its top and bottom flaps to make an open square. (You can also cut a cardboard strip and hot-glue it into a similar shape.) To stabilize your box, cut two triangles of cardboard and tape them to two opposite corners of the box. Then gather up scissors, a screw, drinking straws, a hot-glue gun, wooden skewers, sheets of ¼-inch- (6-mm-) thick craft foam, and anything you want to use in decorating your sculpture. Markers, colorful paper, feathers, and the like are a solid starting place.

NOW FOR THE CAMS Cut two circular foam pieces: one about 2½ inches (6.35 cm) in diameter, and another slightly smaller than the first. These discs are your cam follower and cam, respectively—the pieces that rotate against each other when you turn the automata's handle, creating motion in your sculpture. The type of motion depends on how many foam pieces you use, where you position them on the skewer linkages, and how you configure them in relationship to each other, but we'll start here with two. It's also a good idea to cut a small square of foam that you'll use as a bushing to keep the handle rotating freely.

INSTALLING THE CAM FOLLOWER Hot-glue the cam follower (the larger circular shape) to the end of a new skewer. Grab a drinking straw and cut it in half. Use the screw to poke a hole in the top of your sculpture and insert the piece of straw, then stick the cam follower's skewer through the straw to keep it vertical. Adjust your cam and cam follower, turning the handle, until you like how they move together. Then glue the cam into place on its skewer so it won't slide. Now decorate your sculpture in a way that makes good use of its round-and-round motion, and turn the handle to watch your cardboard machine in action. Once you've got the hang of it, try several setups to see what motions you can make happen, using different numbers of cams and poking the skewers through the cams so that they're slightly off center.

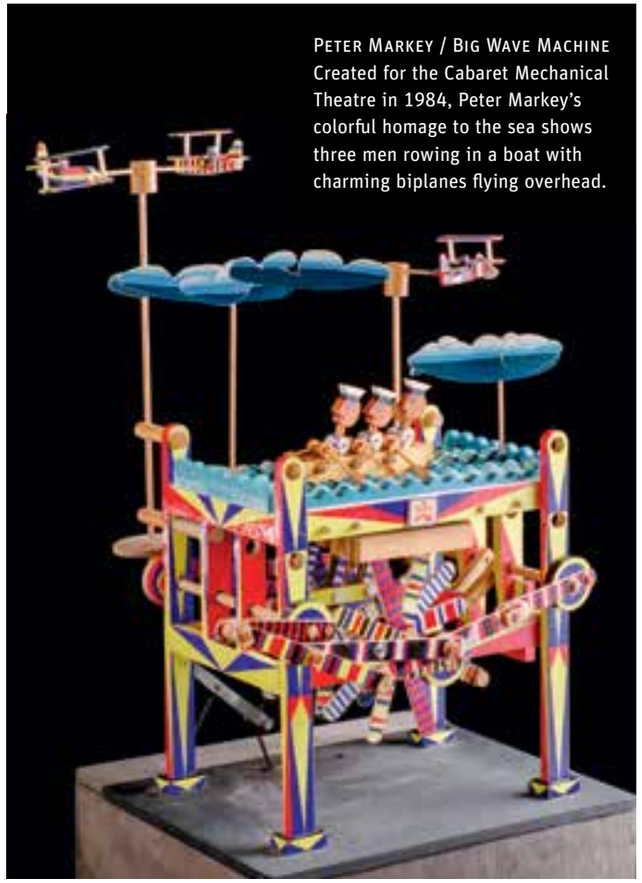


INSTALLING THE CAM Use your screw to poke two holes in either side of your box, immediately across from each other. Then stick a skewer into one side of the box, and thread the smaller cam onto it, puncturing the foam disc in its center. Push the skewer through the hole in the other side of the box so that the cam is suspended inside. Give the skewer a turn—if it doesn't spin smoothly, hot-glue your foam bushing to the skewer where it comes in contact with the box's side. To craft a handle, cut a small rectangle out of cardboard and glue one of its short sides to the skewer's end, then cut a short skewer and glue it to the rectangle's other side.

AUTOMATED MARVELS

The tradition of automata goes back to ancient Greece, but the novelty of these charming, self-operating machines (and their endless narrative possibilities) never wears off.

Carlos Zapata / The Automata Repairman
Got an automaton on the fritz? No worries—Carlos Zapata's delightful repairman is on his way. Colombia-born Carlos also added tiny figures (like a fellow gazing sadly at a broken automaton) in the mechanics underneath.



Peter Markey / Big Wave Machine
Created for the Cabaret Mechanical Theatre in 1984, Peter Markey's colorful homage to the sea shows three men rowing in a boat with charming biplanes flying overhead.

Fi Henshall / Secretary Bird
In the work of Fi Henshall, scrap tin, old wood, and various bits from the shed converge into lighthearted, folk-inspired machines that star birds, fish, and near-mythological female characters.

Keith Newstead / Tinkering Studio Robo-Bird
British artist Keith Newstead crafted this automaton specially for the Tinkering Studio. In the piece, a fellow turns a crank to make the beak of a mechanical bird snap open and shut, but it surprises him by biting his nose, making his eyes cross and his nose light up bright red.

Pablo Lavezzari / Barracuda
Turn the crank of Argentine artist Pablo Lavezzari's steampunk-esque automaton and see its sail-like fins and gills flutter, teeth-lined jaws snap, and mechanical innards move in a fearsome yet elegant swimming motion.