AUTOMATA MAGAZINE

Andrés Gonzalez'
Birds in My Head

1/3—May/June 2019

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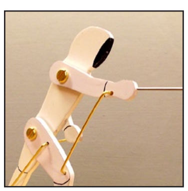
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DEPARTMENTS

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EDITORIAL

How many turns of the crank?

by Marc Horovitz

A reader, relatively new to building automata, recently asked, "How many times will people be willing to turn the handle on an automaton to get it through its entire cycle?"

I'd never thought about there being a maximum number of turns, after which the viewer lost interest. My feeling was that continued interest had more to do with people's engagement with the piece than the number of times they'd be willing to turn the crank.

In my experience, if an automaton captures their attention and curiosity, people turn the handle for five minutes to see what will happen next. I've also seen those who express interest, then turn the handle two or three times before they wander off, without even seeing the whole cycle and regardless of the action they did see.

There are two important components here—the interest that the piece can arouse in a viewer and the nature of the viewer. The latter component is complex and unfathomable, based on a multiplicity of factors that include the viewer's intelligence, experience, education, interests, personality type, etc.

If the person turning the handle has no real appreciation of what they are looking at, or just sees the automaton as a toy, there's probably nothing that will hold their interest for long. On the other hand, if the viewer is captivated by the motion, the colors, the character of the figures, and the mechanics, that viewer may stand there for minutes on end, running through several cycles.

There are no hard and fast rules. The most important person to please when designing and building a piece is you, the builder. When you put your heart and soul into designing and building your automata, your spirit will re-emerge through your work and will speak to the right kind of people—those you would most wish to be attracted to your work.

•

I would like to introduce two new columnists to our pages. **Kim Booth**, already known to our readers, will be treating us to a fun new project each issue through his column Get Moving. In Building Blocks, **Paul Giles**, a mechanical engineer, will be writing about the mechanics of automata. We welcome them both and look forward to their work.

•

Several readers have contacted me saying that the live links within the magazine's PDFs don't always work. Readers often view the PDFs on mobile devices, like phones, tablets, or iPads, not on computers.

I've done some research into this problem and do not have any good answers. Adobe evidently has different PDF readers for different devices; these readers lack uniform compatibility across all platforms, hence the problem.

I read about this issue on Adobe forums—a lot of people are upset about it. Adobe responded to the complaints by saying that they are aware of the problem and that it is part of their backlog of things to be addressed. This reassurance was issued in 2015. Apparently they haven't gotten to it yet.

I apologize for whatever inconvenience this causes. In this and future issues, I'll include fully written-out hyperlinks so that, if necessary, they can be typed into your browser or copy-and-pasted into it. Aside from that, I can only hope that Adobe will address this problem in the near future. Thanks for your patience and understanding.

NEWS

Fourteen Balls Toy Company is offering *How Much?*, an automaton made of maple and lime wood, on a Douglas-fir box with maple and birch mechanism. Only three are available. Dimensions: 240mm high x 90mm x 90mm. Price: £575 + shipping (subject to availability). Full info: *http://www.fourteenballstoy.co.uk/howmuch.htm*

EVENTS

Morris Museum

A Cache of Kinetic Art: Simply Steampunk: March 15-August 11, 2019. The second installment of a four-year exhibition explores the theme of steampunk art, incorporating the aesthetics of 19th-century industrial design and steam-engine machinery. These creations exhibit marvels of design, engineering, storytelling, and fantasy that demonstrate the ingenuity of steampunk art. *https://morrismuseum.org*

Cabaret Mechanical Theatre (CMT) has announced the following touring exhibits:

The Mechanical Circus is a collaboration between CMT and Rijksmuseum Boerhaave, the Netherlands. Banbury Museum, Banbury, UK, May-Sept. 2019.

Puke Ariki Museum, New Plymouth, New Zealand. November 2019-April 2020.

Marvellous Machines features automata, hands-on interactives, workshops, and a series of artists events. Ipswich Art Gallery, High Street, Ipswich, UK.
July 20-October 31, 2019.

The Fantastic Fairground Factory is a new CMT Touring Exhibition. Peek into the Mechanical Marvels behind the Scenes at the Fair. Debut venue: Tullie House Museum and Art Gallery, Carlisle, UK. July-October 2019.

Poisoned Milk and Other Fairytales features automata, with a focus on extended workshop activities and tinkering opportunities. phaeno, Wolfsburg, Germany. November 2019-February 2020.

A Day at the Architects: Paul Spooner—New Works 2019 Rodić Davidson Architects, London, UK. Now through September 30, 2019. More info: *https://cabaret.co.uk/exhibitions/current/*

CALL FOR ENTRIES

Morris Museum

A Cache of Kinetic Art:

Tiny Intricacies: March 13-July 12, 2020

Timeless Movements: March 12-July 11, 2021. Our multi-year juried exhibition series, *A Cache of Kinetic Art*, showcases contemporary automata and their inventive creators. For artists, the prospectus and entry forms for the 2020 and 2021 exhibitions can be viewed at *https://morrismuseum.org/mechanical-musical-instruments-automata*

In the next issue of

AUTOMATA MAGAZINE

- **David Bowman** describes *Tefnut*, the Egyptian cat
- **Tom Haney** reveals the inner workings of his *Phrenology Head*
- **Michele Marinelli** exhibits some of the automata in the Guinness Collection at the Morris Museum
- **Ken Draim** introduces us to *Three Muses*
- And much more!

Birds in My Head

A mixed-media automaton

by Andrés Gonzalez • Santiago, Chile • Photos by the author

Birds in My Head.
The author created this elegant, mixed-media sculpture that combines two of his interests: ceramics and automata.

I am the kind of person who likes to venture into many fields. I like to build machines and I have made small robots, steam engines, automata, and CNC machines. Also, for seven years, I have been going to a nearby workshop once a week, to take pottery classes. A ceramic piece is static but I decided to make something different—a sculpture in which I could integrate a mechanism—an automaton. This article is about what came out.

This ceramic piece is a reproduction of the head of a Minoan goddess. The original piece is a vase that has birds around the rim of the head, so I decided to replace the ceramic birds with mechanical ones. I will bypass the construction of the ceramic head to go straight on to the mechanical parts of this work.

The first thing I did was to make a paper prototype of the birds so that I could visualize their correct size and also to test a motor and its rpm. I made the prototype using a piece of 10mm-thick (3/8") plywood, a bamboo stick, steel wire, paper, and masking tape for the hinges. I chose a small geared motor that runs at 50 rpm, and made a 1/2" brass cam. Fortunately, everything mostly worked the first time. The three birds were the correct size but the motor, at 50 rpm, was a bit slow. I later chose another motor.

Once the proof of concept was done, the next step was to start building the real thing. When I made the ceramic head, I put three stands inside the vase, to which the mechanism would be attached. Three 3mm (1/8") threaded brass columns were glued to these stands with epoxy. I cut the base for the mechanism from 3mm clear acrylic. I drilled three holes in it that corresponded to the brass columns, for attaching the acrylic base to the head.

A few years ago I built a CNC router. Although it is made of wood, I soon discovered that it could cut aluminum. For this project I tried cutting brass; it turned out perfectly.

To make the birds, I decided to use 0.5mm (.015") brass sheet. I made the bird drawing in a design program on the computer and the file was then translated into the appropriate language to be processed by the CNC router, using a program I have. In a few minutes the birds were cut and only needed a little sanding to clean them up (**photo 1**).

To mount the wings I started with a 1/16"-diameter brass tube. I cut 8mm-long (5/16") pieces of the tubing, which I silver soldered to the wings and to the birds' bodies to form hinges (**photo 2**). Another piece of tubing was soldered under each wing as an attachment point for the wire that will move it.

For the birds' stands, I used 1/8" brass tubing. With a slitting saw, I made slits in the tubes into which I could solder the birds, and also through which I could pass the wires that control the wings (**figure 1**). Using a rotary table with my milling machine

1. The bird's body and wings were cut from brass sheet on the author's homemade CNC router.

2. Wings are attached to the bodies by hinges constructed of brass tubing.

enabled me to accurately cut the slits 90° apart. When soldering, I did not want to use too much heat, so I used soft solder to attach the birds to the brass tubes. Once everything was soldered, the wires that move the wings were connected.

For the base of the mechanism, I used my CNC machine to cut two aluminum supports (**photo 3**). A third piece of aluminum, cut by hand and cleaned up in the milling machine, formed a beam to hold the brass tubes. Everything is threaded, assembled, and fixed to the acrylic base with 3mm screws.

For the mechanism, I decided to use simple cams to raise the wings, betting that the wings' weight would make them flap. That way, I would not have to make a crankshaft or use elastic bands or springs to make them fall. A piece of 4mm (5⁄32") steel rod is used for the power shaft; two brass bushings hold it in place in the aluminum frame.

Each cam is made of two pieces, instead of turning it from a solid bar on the lathe, which would have necessitated removing a lot of material and would take a lot of time. Instead, I used a 1⁄4"-diameter brass rod to make the spigots and a 3⁄4"-diameter brass rod for the cams. The spigots were silver soldered to the cams (**photo 4**) and a grub screw secures them to the axle. Finally, a brass collar secures one end of the axle, while a timing pulley is at the other end.

The motor, pulleys, and timing belt were rescued from some kind of plastic ID-card printer. A brass adapter was made for the pulley to attach it to the axle. The motor is a DC, 18V geared motor. How-

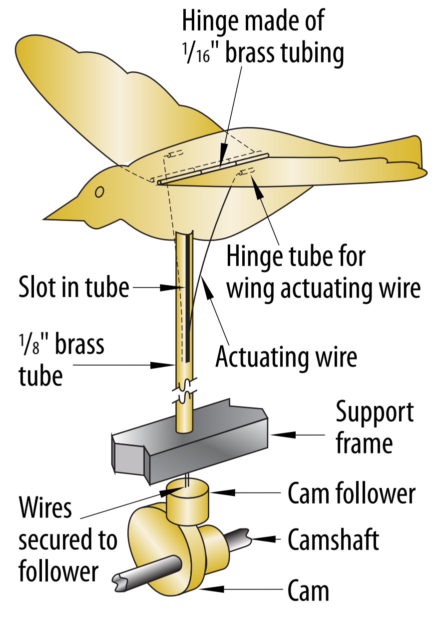


Figure 1
Bird mechanics

3. These two pieces, milled from aluminum, form the base of the mechanism.

4. Cams were each made from two pieces of brass, silver soldered together.

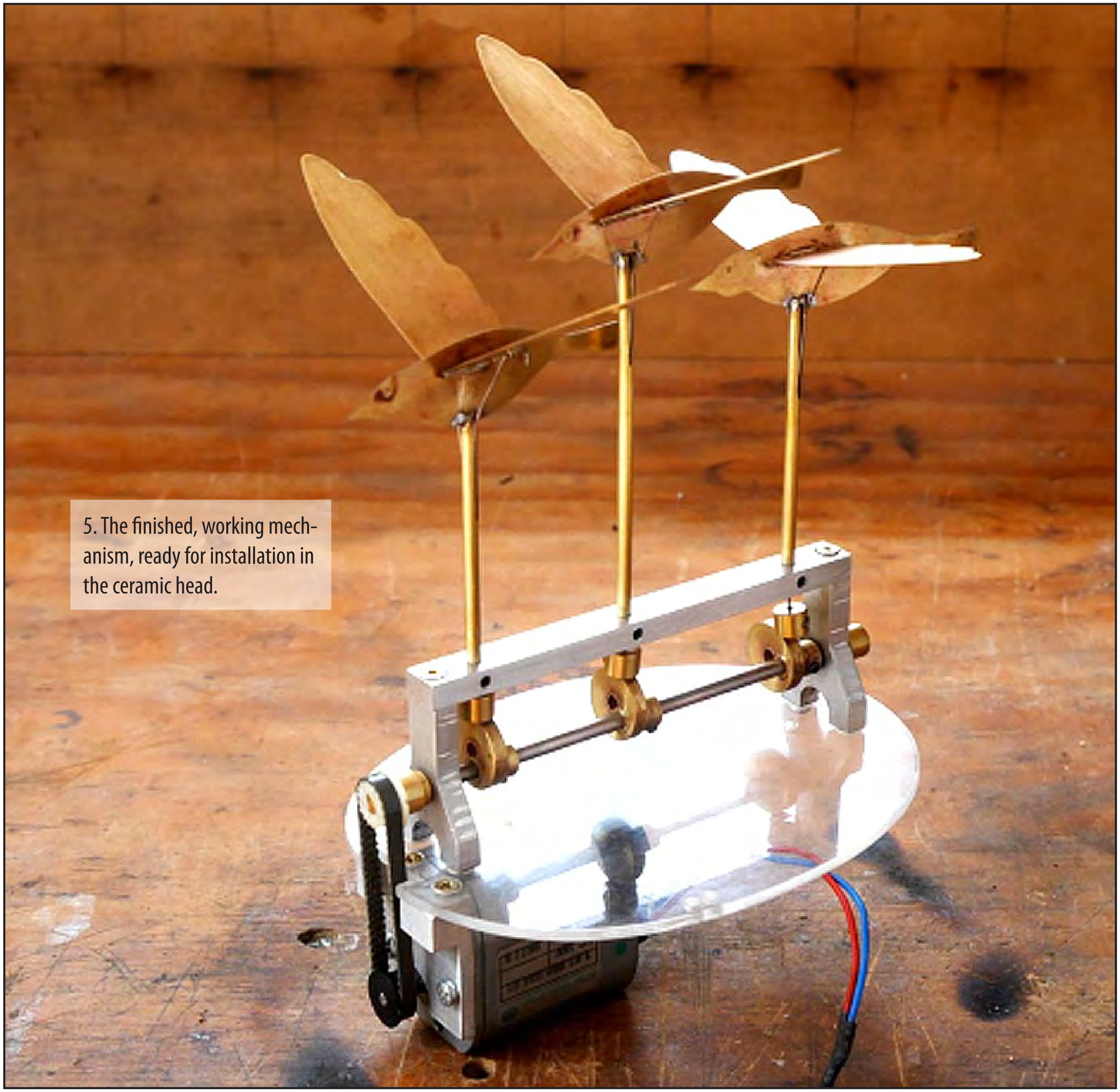
ever, I only run it at 12V to slow it down a bit more. I made an aluminum support to hold the motor in place under the acrylic base.

To attach the birds to the aluminum beam of the mechanism support, I first drilled three ⅛" holes along the beam. Another three holes were drilled, perpendicular to the first ones, then threaded. I used 3mm grub screws to hold the birds' stands in place.

The last step was to make the cam followers, for which I used pieces of ⅛" brass rod. The followers are simple brass collars attached to the brass rods, each with a grub screw to secure it to the steel wire that acts as an actuating rod for the wings.

The machine was then ready—complete and working (**photo 5**). Finally, I installed it in the ceramic head. Using the piece of clear acrylic for the base had an unexpected effect. A lot of people seeing the automaton working think that the head is full of water. And that gave me an idea for a new project. AJ

A video of *Birds in My Head* can be seen here: *https://tinyurl.com/birdsinmyhead*

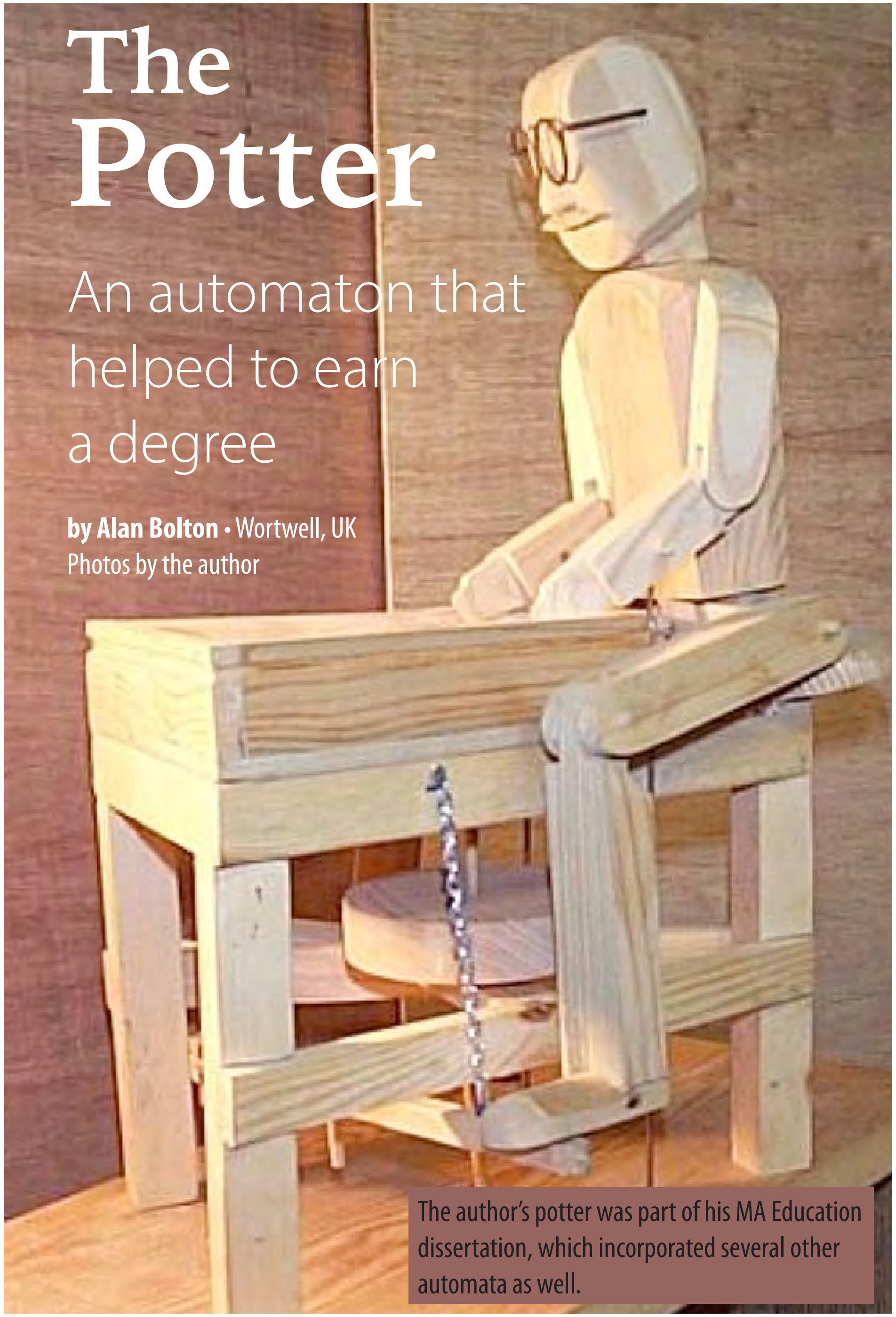


5. The finished, working mechanism, ready for installation in the ceramic head.

The Potter

An automaton that helped to earn a degree

by Alan Bolton • Wortwell, UK
Photos by the author



The author's potter was part of his MA Education dissertation, which incorporated several other automata as well.

I am not sure whether the choice of a potter as an automaton was subconsciously a cathartic exercise, as I still miss being a potter and have fond memories of working in my studio with our old dog, who used to sit beside my wheel for hours. Perhaps the choice was simply because I knew beforehand that the mechanism of the automaton—i.e., the linkages and cranks—could be virtually a copy of the kick mechanism of my old wheel.

I had already intended to construct the potter and had, in fact, produced numerous drawings as part of the Automata Module for my dissertation when earning my MA Education degree from Anglia Ruskin University in '04. I had not initially envisaged the potter as me, but more as any potter at a wheel, possibly with a dog lying nearby whose head would follow the crank.

After taking the various components for *The Potter* into consideration, I decided upon a scale of 5:1. Using my own body measurement and what I could remember of my first potter's wheel, I worked out the sizes of the various components for my model. Simple half-lap joints provided the means of movement for my character.

I designed and made the automaton kick wheel in virtually the same way that I made my original full-size wheel some 25 years ago. All the cranks and linkages of the original wheel were made of metal but, for the rest of the project, I decided to stick to wood throughout as much as possible for my characters and their surroundings. I would like to have been capable of making all of the mechanisms out of wood but I knew I was not up to that standard of work and would not have time to learn the required skills.

Materials

I liked the irony of constructing a potter at his wheel completely out of wood. I used pine for most of the parts but this would not have been strong enough for smaller parts, which would need to be drilled and used as mechanical components (such as cranks and linkages). For these I used well-matured oak. Beech would have been better but I like the juxtaposition of the dark and light colors.

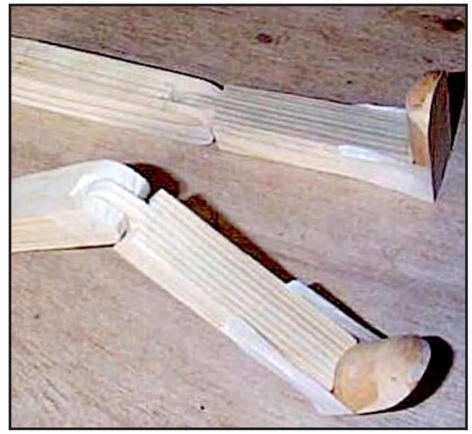
I had a large selection of offcuts of different woods and had recently acquired quite a number of old pallet boards, so I thought it worthwhile to try to incorporate as much recycled material as possible into my piece. Pallet wood is usually pine, a soft wood, hence easy to work with. It is light in color, open grained. However, the pine used for pallets is not the best quality.

I left my potter's limbs square in section (**photos 1** and **2**), as, at the time, I wanted them to retain their origins in a piece of straight-planed timber. This was to change as time went by but, when I was shaping my potter, I was working on preconceived notions and had definite ideas of how I visualized the finished piece.

I had not planned on trying to be too accurate in shaping my model but I already realized that, if I wanted my figure to be accepted as a character in a little performance (my definition of an automaton), it needed to be as believable as possible.

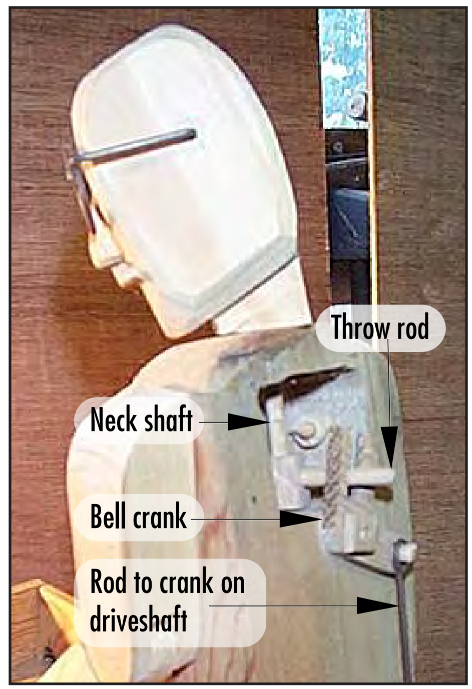
As the potter developed, however, I realized that it had definitely become a representation of me. Therefore, I decided to add some defining features. I gave him a pair of round, metal-rimmed glasses and a large mustache (see **lead picture**) that friends and relations said were my distinguishing features at the time. I made both legs swivel in case I wanted to make the right leg perform some movement. I eventually decided that no movement was necessary there, so the leg was glued in position.

1. The potter's arms before his hands were attached. Arms and legs were left square.



2. Note the simple but effective knee-joint hinges on the legs.

3. The head turns to peer disconcertingly at onlookers. Glasses and mustache resemble the builder's own.



4. The head-turning mechanism. The bell crank attached to the back controls the throw rod attached to the neck shaft.

I had initially hoped to incorporate some audible element into the potter, so I decided to make his head turn to the side (**photo 3**), this movement to coincide with his voice. Although the audible element was ultimately discarded, I still wanted movement in case I could incorporate sound in the future. Plus, I liked the idea of the head turning, to unsettlingly face the beholder. This movement was achieved by means of a rod connected to a crank on the main driveshaft. The other end of the rod was attached to a bell crank that, in turn, operated a lever attached to the neck (**photo 4**).

I had also decided to make the potter's arms move up and down, as if centering a large lump of clay. The arms had to swivel, both at the shoulders and at the elbows, to achieve this because they required actuating at the wrists to get the up-and-down movement.

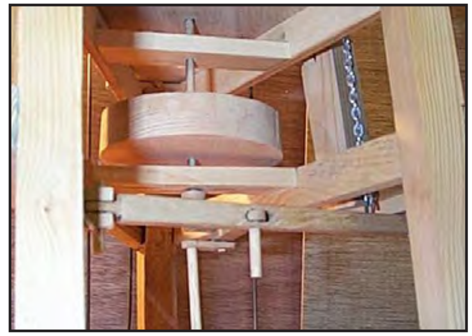
The three-legged frame for the wheel (**photo 5**) was a direct copy of how I built my original wheel. The wheel tray was also made in the same style, with a molding around the rim. This was made with a router, which was to prove an invaluable tool.

Making the components for the kick-wheel mechanism proved difficult at first because, although oak is quite a hard wood, it can also be weak at the grain, where it can easily split. Cutting out and drilling the mechanical components had to be done slowly. Once finished, they were fine. The flywheel was a piece of pine sanded round. The vertical shaft is a length of dowel rod.

The kick-arm and crank assembly (**photo 6**), which eventually connect to the main shaft, were made from oak. The slots needed to be carefully routed. I had to use a proper length of chain to allow the kick-arm to be able to oscillate, carrying the potter's foot. A simple pin in the kick lever and three holes underneath the potter's foot allowed the appropriate adjustment to be made and the kicking movement to be achieved.

Once the potter and wheel were complete, I could put them together and mount the whole assembly onto a pine box, which

5. Three-legged base for the potter's wheel.



6. The wheel's kick mechanism. The main shaft comes up through the floor, powering the wheel itself. The large wooden flywheel can be seen here. A crank on the shaft actuates the foot-power mechanism.

7. The potter's left foot is attached to the wheel lever. When the wheel rotates, the leg operating the kick lever appears convincing.

8. Controlled by cams from below, the potter's arms raise and lower simultaneously to simulate the throwing of a pot.

was to house the hidden drive. I assembled the sides of the box using a basic lap joint. The potter at his wheel could then be mounted on top.

Dowel pegs that located the three legs of the wheel on the box also held the assembly fairly securely, even though not glued. I would have to remove the assembly many times to mark and drill holes for connecting rods. The first links between "above" and "below" were extensions of the main wheel (and therefore power) shaft. I'd already marked and drilled holes for the shaft and connecting rod that would eventually turn the head.

I now had the potter at his wheel and, if I turned the main vertical shaft by hand from underneath, the kick-wheel mechanism moved and his leg looked as if it was doing the kicking (**photo 7**). Also, the head turned when the rod was lifted and dropped. Seeing my first real automaton moving was quite exciting, even if it still needed its operating mechanism.

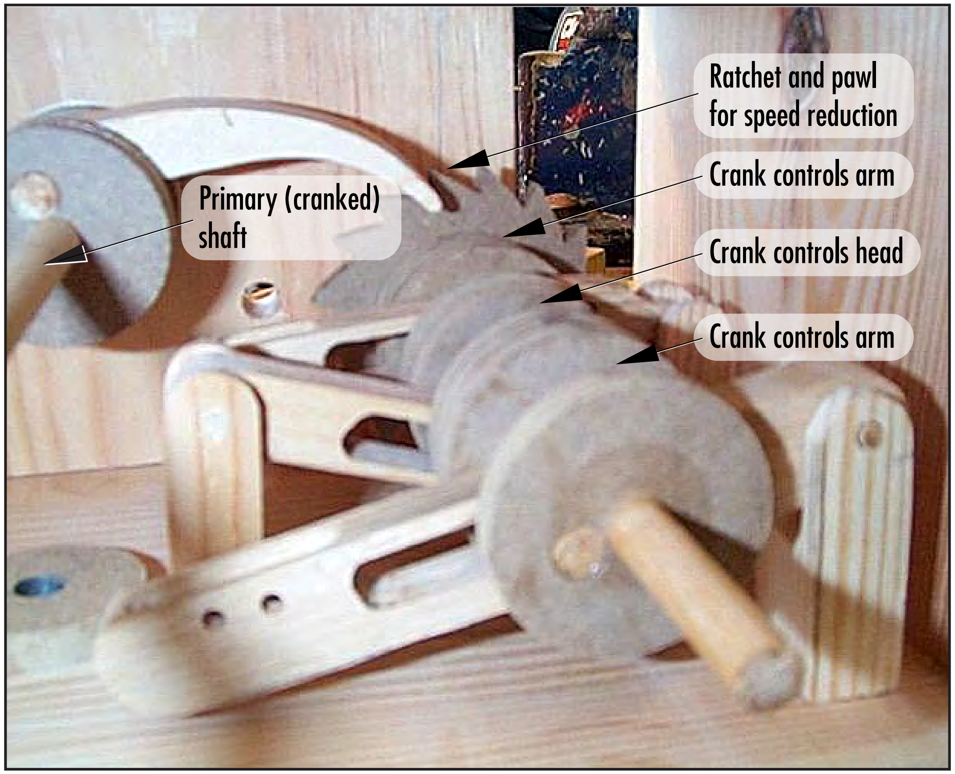
Mechanism

The movement for the arms proved to be much more difficult. The arms were originally designed to work with a single rod operating a link between them. However, I realized that the arms would have had to move up and down in parallel if they were locked together by a linkage. I had already shaped the torso of the potter to bring the arms in more, to make the figure look more realistic, so I had to revise the arms' operation. I used two, separate operating rods instead (**photo 8**).

The originally designed movement for the left leg, which was to look as though it was working the wheel, needed no adjustment. Reversing the mechanism of my original wheel worked perfectly. However, it became apparent that the power for the shaft that would drive the wheel shaft, and hence the potter's leg, was going to need modifying.

I had planned to use a drum-and-disc mechanism to power the main shaft, which can be used to change the direction of rotary motion 90˚. Because of too much resistance, I chose to use a pair of pinwheels instead.

My original pinwheels, which had pins parallel to the shaft, were useless and kept locking up. I then made pinwheels with the pins projecting from the wheel at right angles to the shaft. These were just as bad. Ron Fuller's advice that an indexer was necessary to produce accurate gears and ratchets, depressingly sprang to mind. What I needed to do was spend time adjusting and experimenting until I got it right. Many automata makers use pinwheels in place of gears and I knew that I would have to do the same. I was eventually able to make pinwheels that worked perfectly but, at the time, I needed to move onto something more positive, so I started on the mechanism to operate the head and arms.



9. Powered by the cranked shaft, the secondary shaft controls the hand and head motions. The ratchet and pawl reduce the speed of rotation from the primary, cranked shaft (left).

The main shaft, when turned at the appropriate speed for the wheel to turn, was much too fast for the potter's turning head and lifting arms. I needed to gear down the speed of a secondary shaft that would operate the head and arms. I initially tried to achieve this with two different-sized toothed gears but they had to be so close together to make efficient contact that the shafts virtually locked up. The solution was to use a ratchet-and-pawl mechanism. Although this resulted in a slightly jerky movement, I found it satisfactory.

Once I had the secondary shaft moving at the right speed, I decided on the positioning of the various actuator cranks to operate the head and arms. The shaft was then split into sections to incorporate the various components (**photo 9**).

Though the movements of my finished potter were predetermined and only the most basic, it seemed to lack that narrative quality that I feel an automaton really ought to possess. If and when I eventually do incorporate sound, I will have the potter say something to the onlooker—then it will achieve that quality. Without that narrative component, however, it remained akin to a sophisticated moving/cam toy for me. And it was that recognition that led me to the development of other automata.

A visit to

The Mechanical Circus

An unexpected holiday treat

by W.T. Ware • Fareham, Hampshire, UK
Photos by the author, except where noted

Although the was space not large, the exhibit was well laid out and well attended.

While visiting my relatives over this past New Year, I became aware of an exhibition of automata, *The Mechanical Circus*, being held at The Forum in Norwich, Norfolk, UK. This was a collaboration between Cabaret Mechanical Theatre and Rijksmuseum Boerhaave, the Netherlands. As I was staying in nearby King's Lynn, I found it was possible to visit the show. This would entail a 90-minute bus ride but I felt it would be well worth it.

On arrival in Norwich I procured a town map and got directions to The Forum, only about a ten-minute walk away. The approach to the building was through a tunnel of Christmas lights, which gave a wonderful display of changing colors leading up to the entrance.

I entered a vast open area in the center of the structure, where there were various refreshment and eating facilities plus the entrance to the Norfolk and Norwich Millennium Library. The exhibition was in the Gallery, situated on the ground floor of the building, where the entrance was easy to find.

The Gallery was not large but was well suited to the exhibits on display. Lighting was reduced, giving the atmosphere of a big top, and the automata were individually lit.

All but two of the exhibits were fitted with a mechanism that allowed the action to be viewed by pressing a button. One exception was activated by inserting a 50-pence coin into a slot. The other was operated by physically moving its wooden gears.

There were 20 exhibits by nine automata makers. These included Patrick Bond, Lucy Casson, Andy Hazel, Fi Henshall, Peter Markey, Ron Fuller, Keith Newstead, Pierre Maver, and Paul Spooner.

The exhibition was well attended by young children and their parents, all of whom were actively pressing buttons and being amused by the action of the various automata. Comments I heard included, Who made these? and Where do they come from? indicating the general lack of awareness of these wonderful automata and their makers. Let's hope that exhibitions such as this one will help to spread the word about automata. AJ

Three Physical Jerks—Paul Spooner, 2001

Mermaid Wave Machine—Peter Markey, 1989

Peacock—Keith Newstead, 1992

Boy Stabbing Peas—Andy Hazel, 2016

Tippoo's Tiger—Paul Spooner, 1989

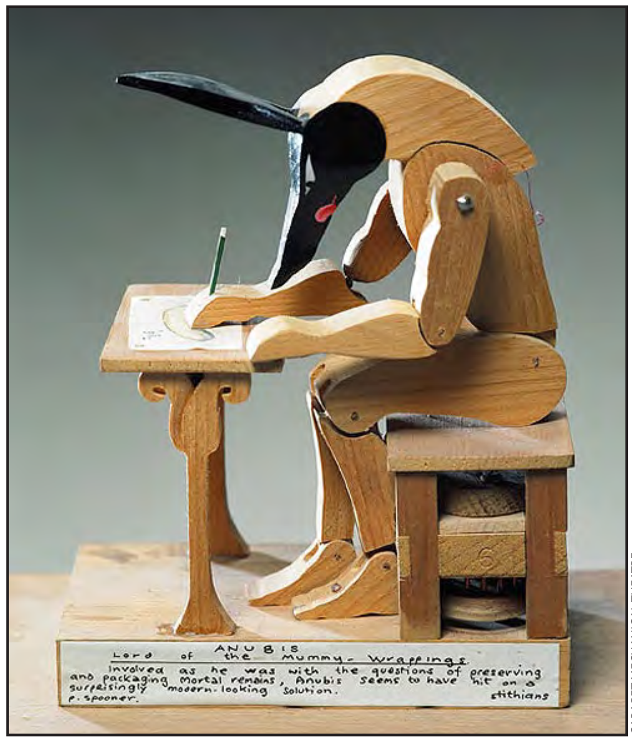
Circus—Ron Fuller, 1983

Kicking Ladies—Peter Markey, 1984

Geisha—Pierre Maver, 2005

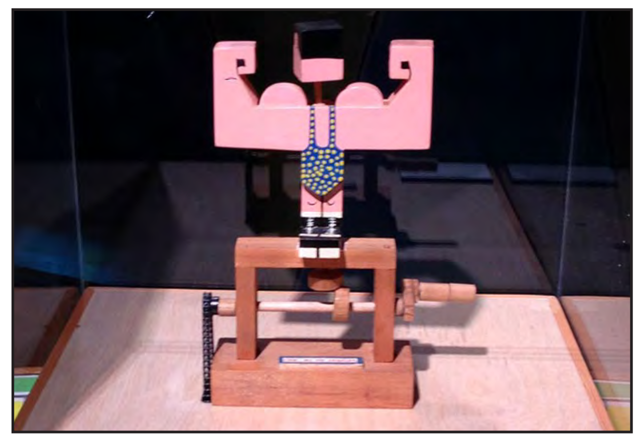
Interplanetary Gears—Patrick Bond, 2007

The Dead Sea—Keith Newstead, 1991



CABARET MECHANICAL THEATRE

Anubis, Lord of the Mummy Wrappings—Paul Spooner, 1981



Muscle Man—Peter Markey, 1989

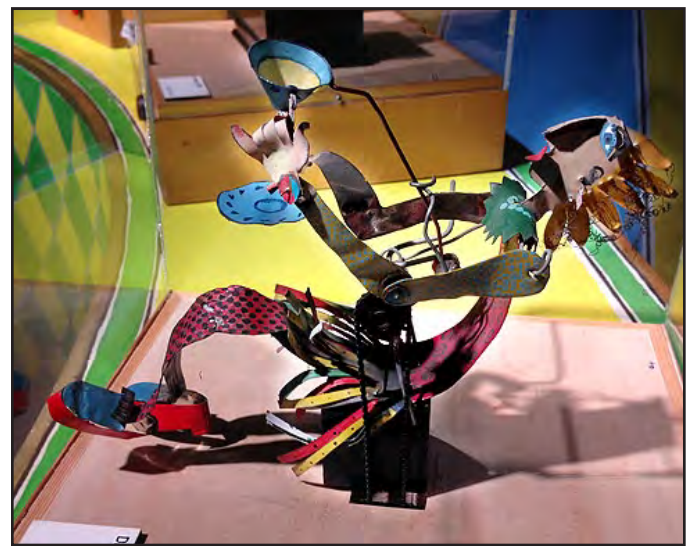
Bulwark the Dancing Bird—Fi Henshall

Steampunk Pegasus—Keith Newstead 2017

CABARET MECHANICAL THEATRE

Barecats—Paul Spooner

The Little Reader—Paul Spooner, 2015



Drinking Tea—Lucy Casson, 1986

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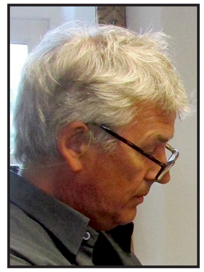
Tipu's Tiger

Download and build this paper automaton



by Keith Newstead
Falmouth, Cornwall, UK
Photos by the author

The *Tipu's Tiger* automaton kit was originally commissioned by the Victoria & Albert Museum in London as an item for their gift shop. The original automaton is part of their collection, so they thought it would be nice to offer a cardstock version as a gift item. In the original, the man is being mauled by the tiger but in my version the tiger licks him affectionately.

Sadly, this kit is no longer for sale but I still get requests for it. Here is your chance to print it out and have a go at constructing it.

To assemble the kit, you will need a sharp craft knife, scissors, and a steel rule or straightedge. The best glue to use is a PVA wood glue; super glue (CA cement) can also be used.

If you are printing the kit on cardstock, use the thickest that will go through your printer. It is also a good idea to add a thicker layer of card to the cam discs, for sturdiness. This card kit can also be used as a reference when building a wooden version.

Download the *Tipu's Tiger* here: *https://automatamagazine.com/subscriber-area/videos/tiger/*

A video of the finished tiger in action can be seen here: *https://www.youtube.com/watch?v=Ar7GEstKvew*

Welcome to the

MECHANICAL ART WORKSHOP

A program that brings automata making to the people

by Stephen Guy • London, UK • Photos by the author, except where noted

RHODRITHOMAS

The author's Ensemble workshop in action at the V&A Museum, London, 2011.

"Hello. My name is Steve. Welcome to the Mechanical Art Workshop. Today we are going to make mechanical artworks—what you might call automata or mechanical toys." So begins the introduction to another of my workshops. Over the years, devising and running automata workshops has become something of a career. I'm not quite sure how that happened but I'm delighted that it has—it's been huge fun and quite rewarding. I run workshops at all sorts of events and places: schools, galleries, science festivals, community projects, Maker Faires, and theaters. People often think that the workshops are only for children but they are for adults too. Grown-ups as well as kids are entitled to take time out and play around engineering art.

As with the story of many automata makers and enthusiasts of a certain age, my story started when I discovered, in London's Covent Garden, the legendary Cabaret Mechanical Theatre—that uncategorizable shop, next to the wine bar, in the lower level, that housed strange slot machines and pumped out noisy tunes from an old nickelodeon. That was in the early 1990s and I've been involved with Cabaret on and off ever since.

My own interest in automata evolved toward events and performances, workshops, and the development of educational resources, including interactive machines for exhibitions. I often do this for Cabaret, while sometimes I work as Fire the Inventor, and sometimes just as myself. A self-employed designer-maker can have multiple identities.

Pesky mechanisms

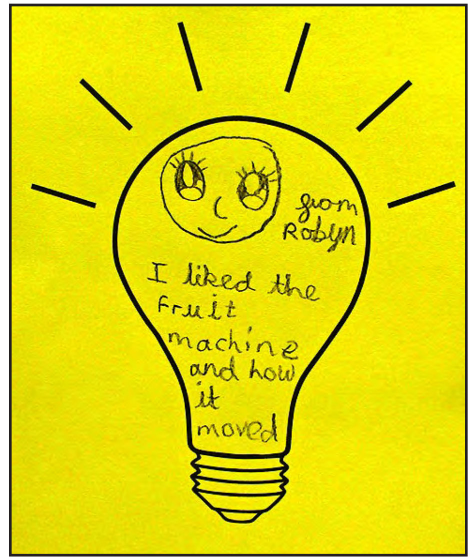
One of the joys of running automata workshops is hearing gleeful exclamations of "It works!" and "It's moving!" when the last cam follower is pushed on, the handle is turned, and something else spins into action. Completing a first functioning machine can be a striking experience—to be able to turn one component and see another move in a different place, as if by magic.

These eureka moments are often followed by hushed concentration and the rumbling murmur of spinning camshafts, as students in a school class closely examine their newly made rotating linkages. Why is one component spinning, another going up and down, and another one remaining stubbornly still?

A lot of careful work and preparation goes into getting to that point. For machines to work properly, they must be built to exacting standards using precise measurements. Machines are not amenable to wobbly parts, flimsily stuck on with Sellotape, Pritt Stick, and optimism. Constructing a smooth-running and reliable mechanism requires a certain kind of concentration, logical thinking, and skill. The mechanism maker is bound by the rules of physics and the discipline of the engineer, and cannot so easily create work with the free-flowing personal impulses of other art forms, like painting.

That combination of art and engineering is, of course, a fabulous

The Fruit Machine allows visitors to play around with the mechanism and moving objects.

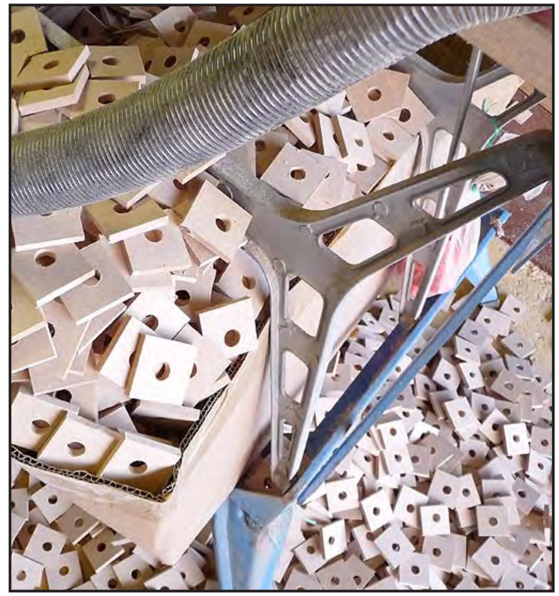


Playing with *The Fruit Machine* was a light-bulb moment for one young visitor, at Compton Verney Museum, UK, in 2018.

BELOW: *Fire the Inventor*, a cam-powered sign at a workshop event.

way to learn about mechanisms and the science behind them, which is why automata/mechanical-toy-making projects are so popular in schools. They perfectly fit the STEAM aspiration of joining Science, Technology, Engineering, Art, and Maths. This echoes earlier centuries, when automata makers were working at the cutting edge of technological discovery and innovation, and where they fused theater, performance, science, and engineering into one glorious, entertaining (STEAM!) activity. I always explain this historical aspect to students, to give a real-world context to the workshop and to emphasize that they're not just making a simple toy but dealing with serious technology.

The happy face of a first-time builder.



Mass-produced components for cam box kits pile up on the author's workshop floor.

Building an automaton from scratch can be a daunting and time-consuming process and can end up being an off-putting experience if the result is a wobbly mess—even more so for those who might have a low estimation of their own skills. That's why I began to think about starter kits to enable a mechanism and chassis to be built fairly easily and quickly, with detachable and reconfigurable mechanical parts to allow for experimentation. More time could then be spent exploring how the mechanisms work, rather than on making the supporting structure. Once the mechanism is completed, the students are free to harness the moving parts in whatever way they want to, to create their own kinetic artwork.

Such resources need to be inexpensive and their construction time flexible enough to accommodate varying time slots in schools and at other venues and events. To these ends, I've developed three basic types and levels of workshop resources: a double-cam box kit, a wood-and-metal kit with crankshaft, and The Ensemble—a collaborative workshop.

The cam box kit

The double-cam box kit consists of a bespoke cardboard box, chopsticks, and pre-made parts. The mechanical components push-fit together without glue, allowing makers the opportunity to shift components around and see how this affects the movements. The lack of glue also speeds up the making process, as glue takes a while to dry and can bung up moving bits if you're not careful.

The workshop is a two-stage process. The first is to build a reliable mechanism that powers two spinning chopsticks. I emphasise that this stage is an engineering project, needing careful and methodical construction. "No rushing ahead before I give instructions, as mistakes can be made," I say strictly. In schools, the students can sometimes get frustrated at the slow pace but are then super pleased at the end, when their machines work properly. They actually get to appreciate the finer details of how to make strong joints and connections, and the extra skill required to do so without using glue. It's a sort of exercise in deferred gratification.

Stage two is the art session, when they can re-invent the moving chopsticks into kinetic artworks, freely using the art, craft, and junk materials I supply. This is the moment they've all been patiently and excitedly waiting for: the green light to start the decorating. I give them some design tips and advice. "Think about using flexible materials for extra movement. Ping-pong balls can be attached with pipe cleaners. Try to coordinate two movements. Be careful with the hot-glue gun."

Teachers use the workshop for different outcomes. Some need the students to complete their automata within a two-hour slot, while others want to focus on making and understanding the mechanisms, doing the artwork later, in another class without me. Sometimes the automaton project is an end in itself, while at others it's combined with another subject that the group is studying, and the final moving designs are themed around that topic—say characters from a play or a scene from ancient Egypt.

There's also a single-cam version of the box kit that is quicker to make. This we use for drop-in workshops, where speed of throughput is the priority. At some events, footfall can be extremely high. Our all-time record was at the 2013 Abu Dhabi Science Festival—937 people in eight hours! It took a team of 12

LARA MUTH

ABOVE: Signpost to an automaton workshop in a remote rural area.

LEFT: The author with The Ensemble at the UK Craft Council's automata exhibition opening event, 2016.

people to manage that, nonstop over the whole day.

I've done this workshop in a variety of locations. One of the most interesting was in the old engine room at Tower Bridge in London, which now houses a museum showing off the elegant 19th-century steam engines that opened and closed the bascules (well worth a visit, by the way).

The wood-and-metal kit workshop

The wood-and-metal-kit workshop is more advanced, requiring some basic metal and woodworking tools. Either the venue has to have an equipped workshop or I supply the tools. This workshop introduces a metal crankshaft as well as MDF cams. Wood is used for the main frame, and adjustable wire fittings are employed to support moving shafts. Participants construct a fully functioning skeletal mechanism, which then becomes a springboard for experimentation and hands-on prototyping. More movements can be added and it can be hacked around in any way and adapted to individual requirements. Chains, gears, pulleys, and belts are also available to extend the range of mechanical options, so it is suitable for both relative beginners and more advanced makers.

The creative potential of the workshop is expanded by having available an eclectic range of craft materials and a remarkable amount of wonderfully kitsch bits and bobs. The latter are junky bits and toys that I've trawled from charity shops and my studio, and which I think can be hacked into kinetic life. Sometimes it looks like I'm setting up a jumble sale rather than a workshop.

I generally run this workshop for adult groups and, occasionally, for secondary schools. Last September I ran it at the Hauser & Wirth Gallery in Somerset, UK, to complement their major exhibition of work by Alexander Calder. Rather marvelously, the workshop room was lined with photos of Calder's studio, which helped inspire an atmosphere of inventiveness and ingenuity. Creative playfulness was the order of the day. "It really opened my mind to the notion of re-engaging with play," said one participant.

The Ensemble workshop

The Ensemble workshop is a different concept, in the sense that it is collaborative and people cannot take their handiwork home. It's part workshop, part performance, and part exhibit. It's a drop-in event where people make their own individual machines using cams and drives, then rummage through trays of curious objects and dismembered toys (yes, the jumble sale again!) to assemble strange and occasionally downright creepy kinetic sculptures—for me, the weirder, the better.

The individual automata are then linked together to create a single composite machine, an impressive snaking line of spinning cams, colors, and shapes, powered by an electric motor. As it grows, it becomes an eight-meter long, attention-grabbing centerpiece artwork and (I like to claim) The Longest Automaton in the World.

The workshop is an entertaining route to making basic mechanisms and automata. It's quite sociable too, as people join forces to link their individual creations together and patrol the expanding line of machines to repair any breakdowns and keep things turning. People make return visits to see how the sculpture is developing and to show off their pieces to friends and family. This workshop has had a variety of outings, from Maker Faires to theaters, from science festivals to galleries, and replica versions have been in Cabaret exhibitions at The Exploratorium in San Francisco and two science museums in China.

VICTORIA & ALBERT MUSEUM

Individual machines are linked to create The Longest Automaton in the World, at London's V&A Museum, in 2011.

I've yet to mention that when I run workshops, I bring along a small traveling exhibition of (mostly) my own automata, interactive demonstration machines, and plastic windup toys. All can be handled, turned, wound up, poked, and let loose. Being able to play with automata and study their exposed mechanisms is an important element of the workshop, or should I say traveling road show. The exhibits provide context and ideas, excitement and laughter, a focus for discussion, and an immediacy to seeing engineering in an unexpectedly lighthearted way. Indeed, one school books me in every year, just to bring the collection and chat about it.

Wood-and-metal-kit workshop, run in conjunction with Cabaret Mechanical Theatre, at the Paul McPherson Gallery, London, 2014.

Time to stop

"Time's up! Stop work. Please start clearing up, we've only five minutes left!" School workshops nearly always end in a mad dash, as children scramble to put the finishing decorative touches to their artworks in the last few minutes, just as the glue guns are cooling and parents are turning up to collect their offspring. There's a buzz of excitement in the air and the kids can't wait to take their creations home. Some children say they now want to be engineers.

In just about every school workshop I've run, the teacher tells me afterwards that they've never seen a certain child so engaged and interested, or able to concentrate on a single task for so long, or be enthusiastically asking and answering questions. It's a curious thing that some children, who may be poor at academic subjects or have concentration and behavioral issues, can really shine with talent, skill, and knowledge when it comes to a mechanical making project. As one boy exclaimed, "That was awesome! That was the best class ever!" Those pesky mechanisms, with their inflexible laws and principles, were, for him, a channel for confident self-expression. He'll make a fine engineer.

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Creating a Monkey automaton

How a simple stick figure becomes a primate in motion

by Chris Chomick and Peter Meder
St. Petersburg, Florida, USA • Photos by the authors

When designing an automaton, we decide what kind of character will fit with a specific movement: a frenzied motion suits an intense-looking character, while a slow-and-graceful motion is more appropriate for an elegant figure. The particular hand-crank mechanism described in this article creates a happy, playful movement, so a monkey seemed the perfect choice.

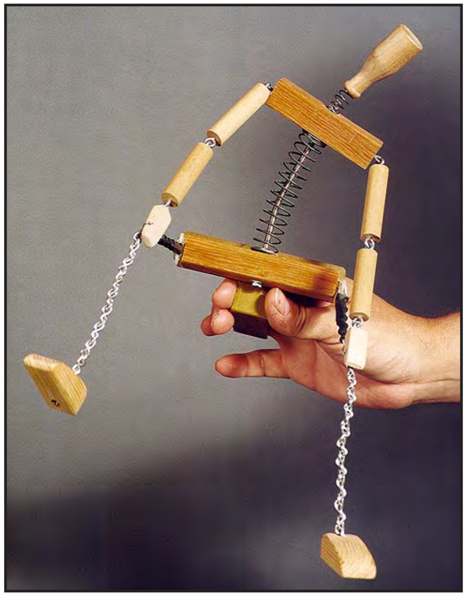
We made a basic stick-figure armature (**photo 1**), with springs in the neck and torso. The arms were loosely jointed, with hands attached to the knees so they followed the legs' up-and-down motion. The balance and movement of the springs seemed relatively

Bonzo is part of a series of one-of-a-kind monkey automata collaboratively made by artists Chris Chomick and Peter Meder. All of their monkeys use the same basic mechanism.

natural, as the figure eased in and out of the motion on its own.

This prototype automaton originally seemed quite simple but became more complicated with the added weight of a solid-resin head, hands, and feet. Although the individual parts seemed relatively light, they made the armature droop (**photo 2**) and hard to move. Extra counterbalancing springs were needed, to bring it back into balance (**photo 3**).

Since this was just a working prototype, the parts were made of wood scraps and other materials on hand. Everything was light duty and not meant to last, but only to see if the design would work.



1. A basic stick-figure armature was constructed to test the flexibility and potential action of the finished automaton.

2. With the added weight of resin in head, hands, and feet, the model drooped. Reinforcements had to be figured out.

3. A balancing-spring spine solved the drooping problem.

Controller mechanism

The controller designed for this prototype is a stacked crankshaft, which was chosen for mechanical flexibility (variable speed and direction). To test the mechanism's integrity, all of the holes were roughly eyeballed and the pieces glued together. This showed promise, so the next step was to machine the parts with precise measurements, using more robust materials.

Our desktop machine shop enables us to make parts that are accurate within tolerances of a thousandth of an inch. Included are a Unimat lathe/mill, a Sherline lathe, a Sherline CNC milling machine, a cut-off saw, a jigsaw, a jeweler's drill press, and all of the cutting tools that complete the setup (**photo 4**).

To make the crankshaft strong and accurate, we center drilled the discs, using the miniature lathe. This hole became the reference point for the other disc measurements. We originally thought the crankshaft would not require this degree of accu-

4. The authors' workshop includes a miniature lathe, mill, drill press, and more.

racy, but the holes that link the parts required techniques used in gear cutting (**photo 5**). Our machine tools have digital readouts, so accuracy is assured if the piece is carefully set up and clamped. A keypad is used to advance the discs to the keyed-in position. Parts can be safely drilled using tools like this because all setups are done before the cutting bits are put in motion.

The next stage was silver soldering the discs (**photo 6**) to create a concentric crankshaft that would not wobble and wear out the bearings. The finished crankshaft can be seen in place in the box, in **photo 7**. Another disc was used as a handle and the finished controller was polished. This type of controller enables the mechanism to be cranked either forward or reverse, and at varying speeds.

Controlled and passive motion

There are two kinds of automata motion: controlled and passive. In our hand-crank monkey automata, cables are attached to each side of the neck. These control the head movement by being pulled alternately, rocking the head from side to side. The

5. An assembled crankshaft (top) and all the necessary parts for another. Crankshaft parts are made of brass and must be made with great precision.

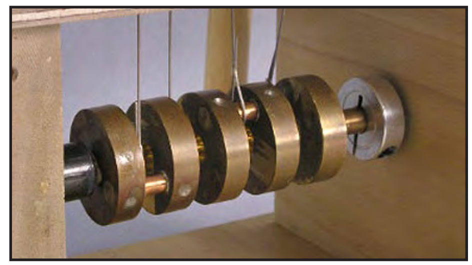
legs also have controlled motion; cables attached to levers at the pivot points of the hips cause the legs to move up and down when pulled by the control mechanism (**photo 9**).

Passive motion creates the illusion of additional movement without having to add to the mechanism. Passive movements in the monkey automata are provided by springs in the ankles, which allow the feet to move independently. Arms have passive motion because the legs control their movement.

Automata construction

Certain factors have an effect

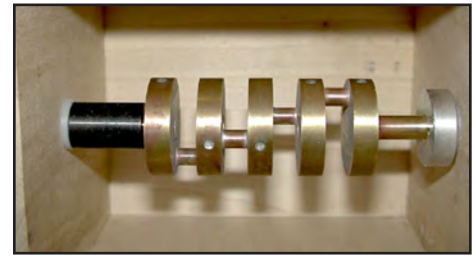
6. The crankshaft is held in a "third hand" for silver soldering. The central axle will be cut out to form the separate cranks.



8. Finished crankshaft with cables. Cables are secured around the crankpins with crimps.

on the construction of an automaton. In particular, weight affects balance and fabric restricts motion, so what works best is to start with an armature that will move almost on its own.

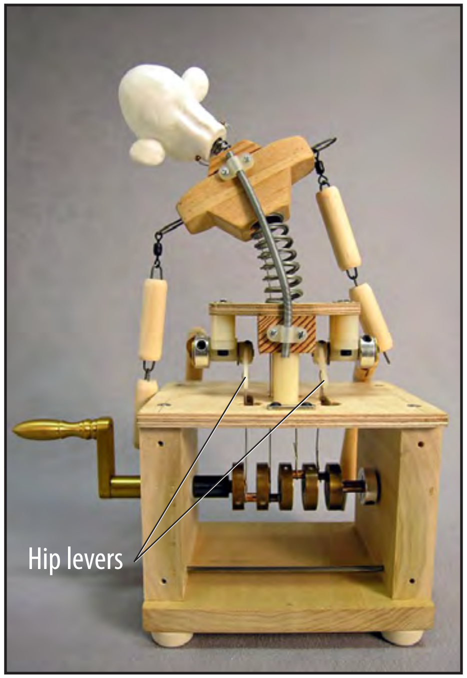
The cables we use to create the movement are made of 49 hair-fine steel threads that are sheathed in nylon, making them



7. A finished crankshaft installed in a box prior to the cables being attached.

9. Cables are attached to each side of the neck, controlling the head's side-to-side movement. They can be seen running down the center of the large spring.

very strong. This type of cable is available in jewelry-supply stores for stringing beads. Crimps used to attach the cables to the crankshaft are silver tubes (**photo 8**), which are tightened using special



10. A finished mechanism. As the crankshaft rotates it produces a cyclic wave motion. Cables attached to the hip levers cause the legs to pivot up and down. The five-disc crankshaft controller allows the automaton to move either forward or reverse at varying speed.

11. *Jayfred*, ready for final assembly. He's made of wood, springs, brass, resin, and epoxy clay. He has glass eyes and hand-painted hands, head, and feet. His hide is black mohair fabric. *Jayfred's* 14"-long tail has a braided-wire armature inside, bendable to any position.

12. *Jayfred*, complete. Cranking the handle creates a rhythmic side-to-side motion with alternating leg kicks.

crimping pliers.

What we like best about this hand-crank mechanism is the interactivity. The automaton operator is the puppeteer, the showman. With a wind-up mechanism, the operator is merely an observer, but a hand-cranked automaton allows the person to control its speed and direction. Stopping and pausing the automaton is as dramatic as moving it (**photo 10**).

Monkey costumes

Designing a costume for an automaton is different from designing for a static figure because the clothing should add to the motion. We have to work closely with each other at this stage to ensure the automaton figure will retain the desired movement. Costumes must be designed with plenty of room around the cables so that the fabric or seams will not upset the balance or interfere with the automaton's movement. Sometimes, though, it may be necessary for the clothing to dampen (confine) certain motions. For our monkey automata, the primary movement happens at the waist, so a stiff fabric, such as mohair fur, will work if the shirt top can move independently from the bottom. The pictures of *Jayfred* and *Marco* (**photos 11-13**) show them undressed and dressed.

The hand-crank mechanism is the same for all of the monkeys that we produce, but their movements appear different because they have distinct personalities. The crazed looks of *Bonzo* and *JoJo* evoke high energy. *LuLu*, with her dainty pink tutu, *Jayfred*, with his sly grin, and the elder monkey, *Marco*, all appear to be more subdued.

A video showing the movement of the hand-cranked

13. *Marco,* in various stages of dress.

Chomick + Meder

Chris Chomick and Peter Meder are figurative artists who have worked together for 40 years. They combine the knowledge and strengths from their different art backgrounds to create their art and automata. Peter builds the interiors and supports (armatures, mechanisms, display boxes) and Chris creates the exteriors (sculpting, painting, costuming). You can find out more about their creative endeavors on their website: *https://chomickmeder.com/*

Jojo (left) and *Lulu* are variations on the theme. Each monkey is a one-off, with a meticulously painted face and finely crafted costume.

automaton *Marco Monkey* can be seen here: *https://www.youtube.com/watch?v=v3_NyVf_mvM&feature=youtu.be*

Inspired by antique automata from the Victorian era, the box is draped in fabric (often velvet) and finished with a heavy fringe. The internal crankshaft design enables the brass hand-crank mechanism to operate at variable speed, forward or reverse. The monkey figure moves in a rhythmic side-to-side motion with alternating leg kicks. The loose-jointed arms are secured to the legs; this creates the illusion of more movement without having to add to the mechanism.

Life choices

What initially started as an experimental prototype design became a series of one-of-a-kind monkey automata. Our chosen career is strange enough for two reasonably mature adults but this adventure kicked it up a notch. We always enjoy coming up with our various characters but there is something wonderfully absurd about making a fez or sewing a tutu for a dancing primate. We can't help but love our job.

Cabaret Mechanical Theatre—a history

Part 3: Moving on

by Sarah Alexander • London, UK • Photos by CMT, except where noted

In March of 2000, Cabaret Mechanical Theatre (CMT) left its home of over 15 years in the lower level of Covent Garden Market. At that time the annual operating costs, including rent, rate, and service charges, were more than £100,000 per year. Even by today's prices, those would be a challenge (**photo 1**).

A contemporary automata exhibition was hard to categorize, and Cabaret was neither a recognized arts organization nor a fully commercialized venture. Attempts to secure funding from the Arts Council and other potential sponsors had failed. Income from touring exhibitions and larger projects, such as the *Ride of Life*, made significant contributions during the Covent Garden years, but eventually we found it proved impossible to stay in London. The phrase "flogging a dead horse" frequently came to mind (**photo 2**).

1. *How Much!* by Paul Spooner & Matt Smith.

2. *Flogging a Dead Horse* by Paul Spooner.

Moving on

The decision was made to relocate to a new permanent home, at the Kursaal, in Southend-on-Sea, a coastal town in southeast England. Although the new attraction at the Kursaal was popular, we soon saw that it was not going to be a profitable venture. Despite the space being rent free, a share of the profits transpired to also be a share in the losses. In fewer than six months after leaving London, the business was close to collapse.

In September of 2000, Scenery West—a USA production company based in Los Angeles—entered the scene. We invited the company (whose director was a collector and customer) to make us a proposal. Their proposal was a joint venture that was to create a USA-based Cabaret Mechanical Theatre. On that basis, the exhibition at the Kursaal was closed and the exhibits were shipped to California. Plans were drawn up, new designs were created, and potential venues were approached. However, after two years we had only reached a stalemate, and a new direction was urgently required to avoid losing the collection altogether. Thanks to (now deceased) Marvin Yagoda and other philanthropic patrons, most of the collection was again rescued and re-housed.

Rebecca Hoffberger, director of the American Visionary Art Museum (AVAM), in Baltimore (**photo 3**), was a great admirer of CMT and welcomed part of the collection to the new Jim Rouse Visionary Center at AVAM. At the same time, Paul Spooner's *The Last Judgement* and several other works were relocated to Marvin Yagoda's Marvin's Marvellous Mechanical Museum, in Detroit.

The absence of a permanent home for Cabaret Mechanical Theatre in the intervening years brought its own challenges but also gave us the freedom to work with venues and develop our touring exhibitions with more international appeal. Our popular *Mechanical Circus* exhibition (**photo 4**) is a collaboration with Rijksmuseum Boerhaave in Leiden, the Netherlands.

3. The American Visionary Art Museum in Baltimore, Maryland, USA.

4. *Mechanical Circus* on tour.

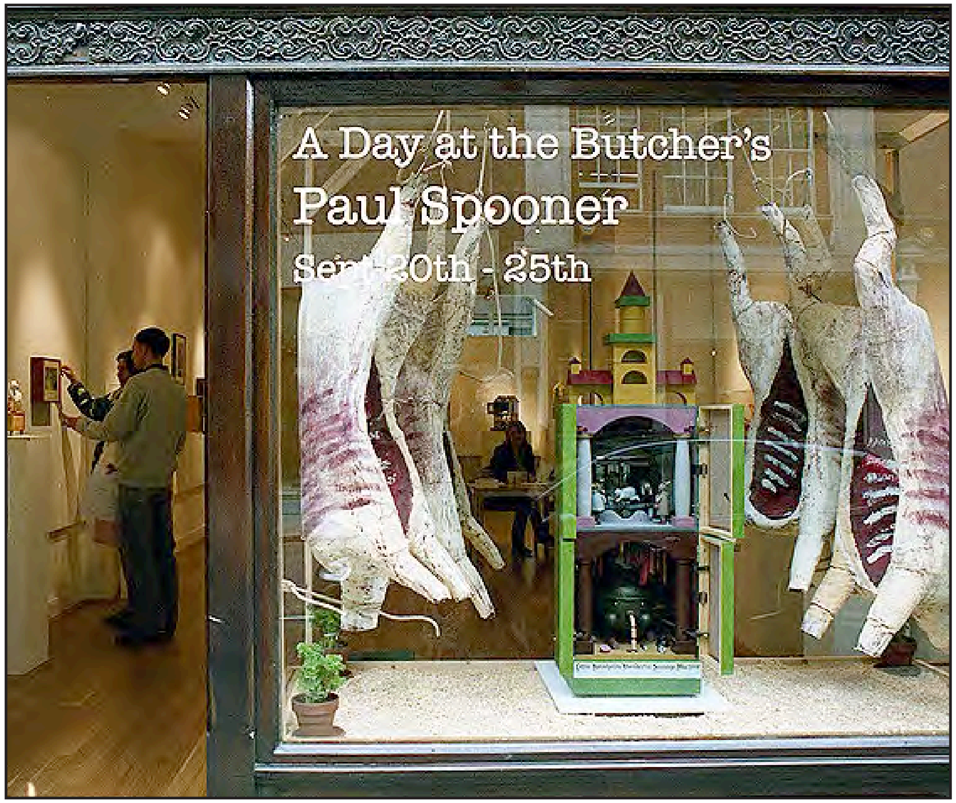
5. Stephen Guy's Masterclass.

6. A MindFest workshop.

Using automata as inspiration for makers has also become an integral part of our exhibitions. Last year, artist and maker Stephen Guy offered a Masterclass that became the starting point for successfully involving the local community in our *Automata on the Pier* exhibition in Hastings, UK (**photo 5**). (See also Stephen Guy's "Mechanical Art Workshop" in this issue.)

Playful Invention

In 1999, just before leaving Covent Garden, we received an invitation to join the advisory board for the Playful Invention and Exploration Network (*https://tinyurl.com/playfulinvention*) from the Media Lab at MIT. Over the next three years we attended MindFest events around the USA (**photo 6**), often using our Designing Automata Kit that was pioneered by Sue



STEVE TANNER

UPPER LEFT: 7. A food-based automaton at the Exploratorium in San Francisco, California.
LEFT: 8. Automaton builder at the Abu Dhabi Science Festival, United Arab Emirates.
ABOVE: 9. *A Day at the Butcher's* by Paul Spooner.
RIGHT: 10. *Little Reinhold's Wonderful Sausage Machine* by Paul Spooner.

Jackson. The kit has since been discontinued but it was a popular addition to our exhibitions during the early touring years.

The series of MindFest events led to many more opportunities for sharing ideas and encouraging participation. Mike Petrich and Karen Wilkinson, of the Tinkering Studio at the Exploratorium in San Francisco, were quick to encourage us to develop this work, inviting us and many of the automata makers from the UK to the Exploratorium for residencies and exhibitions. Our making-automata-from-food workshops proved to be an engaging activity, too (**photo 7**)!

In 2013, we took part in the Abu Dhabi Science Festival. Queues formed for the entire 10 days of the festival, as over 6,000 people made their own automata from Stephen Guy's cardboard automaton kit (**photo 8**).

New works, new artists

Back at home in the UK, we arranged several one-off exhibitions and we continued to add to the collection. Paul Spooner began making his butcher's-shop series, "because [he] wanted to join the fun of model meat making." The result was his *A Day at the Butcher's* exhibition, in London in 2004 (**photos 9** and **10**).

More recently, Paul has been making organs and other air-driv-

STEVE TANNER

11. *Les Demoiselles* by Paul Spooner.

en works, including his magnificent *Les Demoiselles* (**photo 11**), an organ that pays homage to both Ron Fuller's and Peter Markey's work. *Mozart's Goat* (**photo 12**) was made in 2018.

We have also welcomed the work of several new artists to our collection. French artist and magician Pierre Mayer creates automata based on magic tricks. His clever *Geisha* hides a ball, which also rolls up her arm (**photo 13**). Fi Henshall takes delight in creat-

12. *Mozart's Goat* by Paul Spooner.

GARY ALEXANDER

15. *Banana Boat* by Kazu Harada.

ing small worlds. Her enchanting work, like *Hansel and Gretel* (**photo 14**), is often made from reclaimed parts.

Japanese artist Kazu Harada

13. *Geisha* by Pierre Mayer.

16. *Pirates* by Wanda Sowry.

worked with Matt Smith as an apprentice automata maker before going back to Japan to create his own collection and exhibition. *Banana Boat* (**photo 15**) is one of his early works. Wanda Sowry's automata celebrate the variety of wood that she uses in her work (**photo 16**).

14. *Hansel and Gretel* by Fi Henshall.

17. *Automata Maker* by Lisa Slater.

Lisa Slater was inspired to make automata after visiting CMT in Covent Garden. Her *Automata Maker* (**photo 17**) is a self portrait.

Carlos Zapata has developed his style and now mainly makes larger, more sculptural pieces, like *Mermaid of Zennor* (**photo 18**).

We continue to commission and add new works to our collection, like Keith Newstead's *Baba Yaga* (**photo 19**). The collection now has over 160 automata exhibits.

Our latest exhibition of new works by Paul Spooner is called *A Day at the Architects* (**photos 20** and **21**). The exhibit will occupy the window display at Rodić Davidson Architects, in London, until September 30th, 2019. Architect Ben Davidson visited us in Covent Garden. He said:

> The influence of Cabaret Mechanical Theatre in Covent Garden, in part, defined my direction in life. I remember visiting in my teens on family trips to London from Cheltenham, where I grew up. I was utterly fascinated, and the influence formed part of my decision to study architecture and my continued love of experimentation, exploration, and tinkering with models and mechanical things.

Worldwide exhibitions

Cabaret opened twelve touring shows worldwide in 2018. Our exhibitions have now been visited by over ten million people (**photos 22-24**). Since leaving London,

STEVE TANNER

LEFT: 18. *Mermaid of Zennor* by Carlos Zapata.

RIGHT: 19. *Baba Yaga* by Keith Newstead.

BELOW LEFT: 20. Viewers take in *A Day at the Architects*.

BELOW RIGHT: 21. *A Day at the Architects: Cork Cathedral* by Paul Spooner.

22. Mechanics Alive! in Bangkok, Thailand.

23. Cabaret exhibit in Korea.

24. Automata on display at the Exploratorium in California.

our shows have toured to Spain, Germany, France, China, Singapore, Australia, Thailand, South Korea, and the USA; later this year, New Zealand will be toured for the first time.

Over the past year we have been updating our branding and we are launching three exciting new touring exhibitions, with automata and interactives at their core. The *Fantastic Fairground Factory* will open at Tullie House, at the end of June this year. This exhibition is playful and incudes helter-skelter marble runs and a mechanical shadow-puppet theater.

Mechanics Alive! has been re-invented and will feature a RoboThespian and wind tubes and chain-reaction interactives. *Cabaret Mechanical Marvels* celebrates the history of CMT. We are also progressing with plans to find a new permanent home for CMT in the UK—watch this space! A!

Sue Jackson: 1938-2016

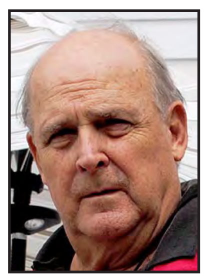
Although founder Sue Jackson had retired from the day-to-day running of Cabaret Mechanical Theatre in 2012, she was still very much involved in the business that she had created. In the photo at the right, Sue shows Cabaret's Designing Automata Kit to a Thai princess during the touring exhibition in Bangkok.

Sue was delighted that the Crafts Council was organizing a new touring exhibition, *A Curious Turn* (UK, 2016-18), seen below, which highlighted the role that CMT had played in the revival of automata making. Sue's sudden death in April 2016 was a shock to us all, but her legacy continues to delight.

The Cleveland Grandma

One man's love affair with a fortune teller

by Tim LaGanke • Novelty, Ohio, USA • Photos by the author



William Gent Manufacturing Company's Grandmothers Predictions, colloquially known as the *Cleveland Grandma*, was manufactured between 1929 and 1932.

"If the recently organized Penny Arcade Owners Association would hold their next convention in Cleveland, it would be a university education for all of them." That is what the editor of *The Automatic Age* said in 1931, and there was a good reason for that statement. In those days there were not many people in the world who recognized the creativity and mechanical ability of a man from Cleveland, Ohio, who built, sold, and operated some of the finest arcade machines ever produced. His name was William Gent and he was known for producing one of best fortune-telling machines ever made, now known as the *Cleveland Grandma*.

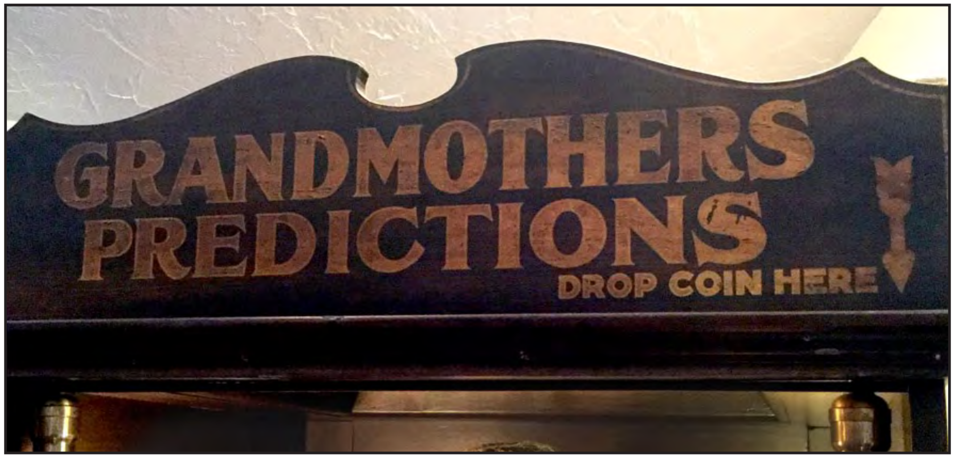
In 1931, visitors to the Cleveland convention of the

Coin Machine Operators Association of America had an opportunity to visit the most beautifully situated coin-operated-machine factory in existence—the William Gent Manufacturing Company. The factory stood on the bank of a river, into which one could cast a fishing line out the window, taking a couple of hours off from strenuous labor to catch some fish. From such an environment came the clear thinking and the perfect workmanship that produced a number of substantial arcade machines. What a pleasure it must have been to work in those bucolic surroundings.

Mr. Gent was an old-time arcade operator and coin-op-machine inventor in the US, who fully understood every phase of the coin-machine business. His arcade at Euclid Beach Park was recognized as a model for penny arcades around the world.

One of Mr. Gent's most outstanding successes was the *Grandmother's Predictions* machine. This large fortune teller swept the country and made tremendous profits in chain stores, department stores, and amusement parks.

The factory also manufactured scales and other coin-operated machines of various types, and Mr. Gent was the first president of the Coin Machine Operators Association of America.



The cabinet was topped by a wooden marquee proclaiming "Grandmothers [sic] Predictions."


Grandma's head was a waxwork, made in Dresden, Germany.

The brass coin slot.

My Grandma

I would like to tell you about my machine and some of the many Grandmas that I have restored and owned over the last 35 years. In 1972, I made my first trip to Mike Munves, a coin-op-machine distributor in New York City that was the home of one of the largest collections of arcade machines in the world. There were four or five floors of the greatest stuff that you could imagine. My good friend Wes Brewer and I had free range of the whole building.

We climbed over Chester Pollard Derbys and wedged ourselves between '27 and '37 World Series baseball machines, got on and off the elevator, and found so many early and great machines that we couldn't decide what to buy. Many of the machines bore pieces of masking tape with people's initials on them, meaning that those machines had already been spoken for.

We had gone there especially to find a *Cleveland Grandma*. On the third or fourth floor, stepping off the elevator, we didn't find just a standard *Cleveland Grandma*, but a great-looking variation—a Grandma with a cat over her shoulder. There were also two or three fortune tellers of other makes.

Wes immediately said that he wanted that *Cleveland Grandma*. It was in good condition and, according to Joe, then the owner of Munves, it had just been picked up from an arcade in Harlem. He said that it had been well used by people looking for a "number" to play every day. We asked him what he wanted for the piece and he said $1,500, which was out of our price range. In those days you could buy a World Series baseball machine for $600-$700, exhibit diggers for $500 each, and iron Mutoscopes (in working order, with great reels in them) for $300-$400.

We filled our station wagon with as many smaller pieces as we could afford with the $400 or $500 that we had with us. Wes told Joe that he would let him know about the *Cleveland Grandma* in a week or so.

I was back home for about a week when I heard of another *Cleveland Grandma*. This machine had come out of the Indianapolis antique-advertising show and had been purchased by a bar owner in Jackson, Michigan. I called him to see if he was going to keep it or if it was for sale. I was told that $2,500 would take it. When I told Wes about that machine, he said, "Let's take a ride and look at it."


Grandma's right arm waves over her fortune-telling cards as her head nods up and down. Her chest rises and falls, as if she's breathing.

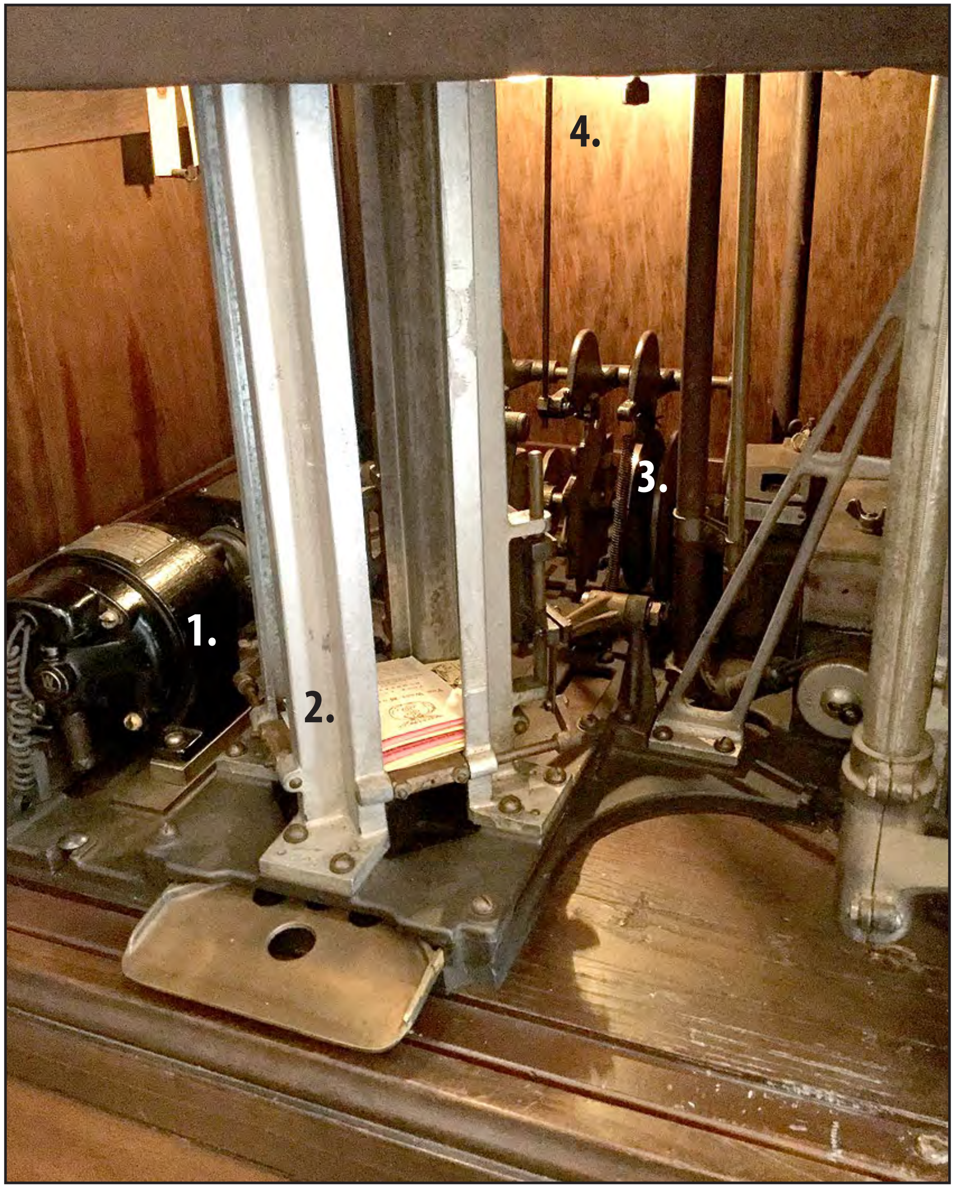
What we found was an almost-perfect example of a brand new *Cleveland Grandma*. Wes bought it and we brought it home. Of all the *Cleveland Grandma* machines that I have seen, this was probably the best. Wes had that machine for a number of years, then sold it to a friend of ours who had it for another 20 years. A few years ago I was asked to sell that machine for him, and magician David Copperfield bought it.

Wes had bought that piece, so I moved in on the Munves machine. It has now been 47 years since Wes and I drove back to New York City to pick up my machine. It was one of those fantastic trips when everything fell together perfectly. It had taken me almost a month to put the $1,500 together and, up until then, it was the most expensive machine I had ever bought.

I was surprised to find Munves waiting for me—they had moved the machine out to the street. At just after rush hour, about 9:30 in the morning, we came around the corner. There was my machine, waiting to be picked up. People on their way to work were stopping, looking, and even dropping coins into it.

Today I consider the *Cleveland Grandma* to be one of the most interesting and historic arcade machines ever made. During the '70s I restored seven or eight of these for other coin-op collectors. Many of the machines were in terrible condition, some needing to have the cabinets rebuilt and parts and pieces of the mechanisms remade. I remember having four cabinets in my garage at one time, all in different stages of restoration. Often, the marquees and/or glass, with the correct painting, were missing.

My wife, Mary, made 15 or 20 dresses that resembled the originals as closely as possible. I remember selling those dresses for $500 each. I am sure that Mary spent fewer than 20 hours making each one. We thought we had a good thing going and it helped us to add more machines to our collection. Today, this *Cleveland Grandma* is still one of our prized possessions.



Interior of the Gent Grandmother Fortune Teller. Every machine is mechanically identical, with a strong, well-built mechanism made of cast-iron and bronze parts. **1.** Westinghouse motor. **2.** The card-vending mechanism, with bronze tray. The fortune card is delivered through an opening in the front door. **3.** Bronze cams, which control all the movements. **4.** Switchable interior work light for servicing the mechanism.

Features

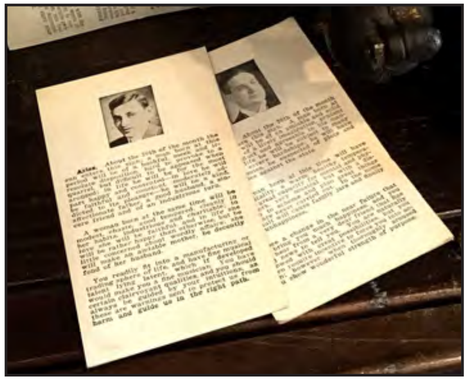
Here are highlights of some of the special features of this machine. At the top is a highly visible, four-sided marquee, stating "Grandmothers Predictions" and, in smaller print, "Drop Coin Here." The machine is housed in a well-made cabinet with glass on three sides. The front glass panel reads "What does Grandma say? Your answer is here."

This machine was made to operate on nickels and, during the 1920s, it sold for $1,500. It took 30,000 plays to pay it off, and you had to supply the fortune cards.

Grandma's hands and head were made of wax in Dresden, Germany. She had moving glass eyes and a chest that heaved, as if she were breathing. The mechanism itself is almost unbreakable, with a strong motor, brass and bronze cams, steel gears, and a perfectly operating coin mechanism. The machine even came with an assortment of spare springs and other parts, all labeled and numbered for replacement. A work light is installed over the mechanism, with a note reminding the operator not to leave the light on, as that could melt the waxwork.

A coin box was built in that looks like it would hold about $500 worth of nickels, and there is a storage area to hold the fortune cards. Every machine has an automatic counter that records every play. It's sealed so it can't be changed. This machine was built to last forever.

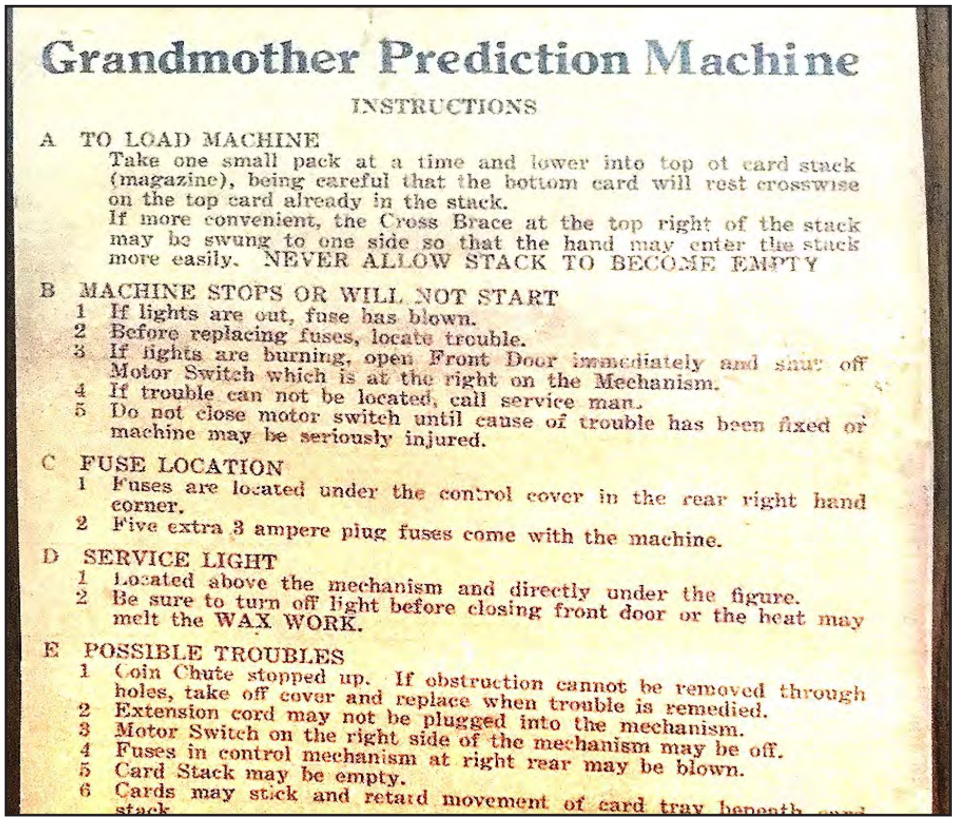
When a nickel is deposited in the slot, it triggers a switch that starts an electric motor that turns a number of revolving cams. These cams move Grandma's right arm, causing it to swing over her fortune-telling cards. Also, her head moves up and down, nodding at the cards and the customer. Finally, hidden card-vending mechanics below push a fortune card out of a slot near the base of the cabinet. The entire cycle takes around a minute to complete. A video of a machine in action can be seen here: *https://youtu.be/4SQ4IpMVLbE*



Sample fortune cards. Cards were manufactured by a variety of different companies.

Fortune cards were dispensed through a slot near the base of the upper cabinet.

The locking coin box bears the name of William Gent's original company.



Grandmother Prediction Machine

INSTRUCTIONS

A TO LOAD MACHINE

Take one small pack at a time and lower into top of card stack (magazine), being careful that the bottom card will rest crosswise on the top card already in the stack.

If more convenient, the Cross Brace at the top right of the stack may be swung to one side so that the hand may enter the stack more easily. NEVER ALLOW STACK TO BECOME EMPTY

B MACHINE STOPS OR WILL NOT START

1 If lights are out, fuse has blown.
2 Before replacing fuses, locate trouble.
3 If lights are burning, open Front Door immediately and shut off Motor Switch which is at the right on the Mechanism.
4 If trouble can not be located, call service man.
5 Do not close motor switch until cause of trouble has been fixed or machine may be seriously injured.

C FUSE LOCATION

1 Fuses are located under the control cover in the rear right hand corner.
2 Five extra 3 ampere plug fuses come with the machine.

D SERVICE LIGHT

1 Located above the mechanism and directly under the figure.
2 Be sure to turn off light before closing front door or the heat may melt the WAX WORK.

E POSSIBLE TROUBLES

1 Coin Chute stopped up. If obstruction cannot be removed through holes, take off cover and replace when trouble is remedied.
2 Extension cord may not be plugged into the mechanism.
3 Motor Switch on the right side of the mechanism may be off.
4 Fuses in control mechanism at right rear may be blown.
5 Card Stack may be empty.
6 Cards may stick and retard movement of card tray beneath [illegible] stack

Operating, maintenance, and troubleshooting instructions for the owner/operator. It includes a list of supplied spare parts.

I estimate that fortune cards were produced by six or seven different companies, including Mutoscope, Exhibit Supply, Munves, Automaton Corporation (Gent), and others who didn't put their name on them. The exact number of *Cleveland Grandmas* is unknown. There are around 75 examples known to exist today, though I have seen serial numbers from 67 to over 350.

Over the last 10 years I have found a new passion—collecting antique advertising automata. My fascination with these machines has grown from my attraction to the *Cleveland Grandma*. It truly is one of the finest pieces of coin-operated automata ever made. In fact, William Gent's original company was called The Automaton Corporation.

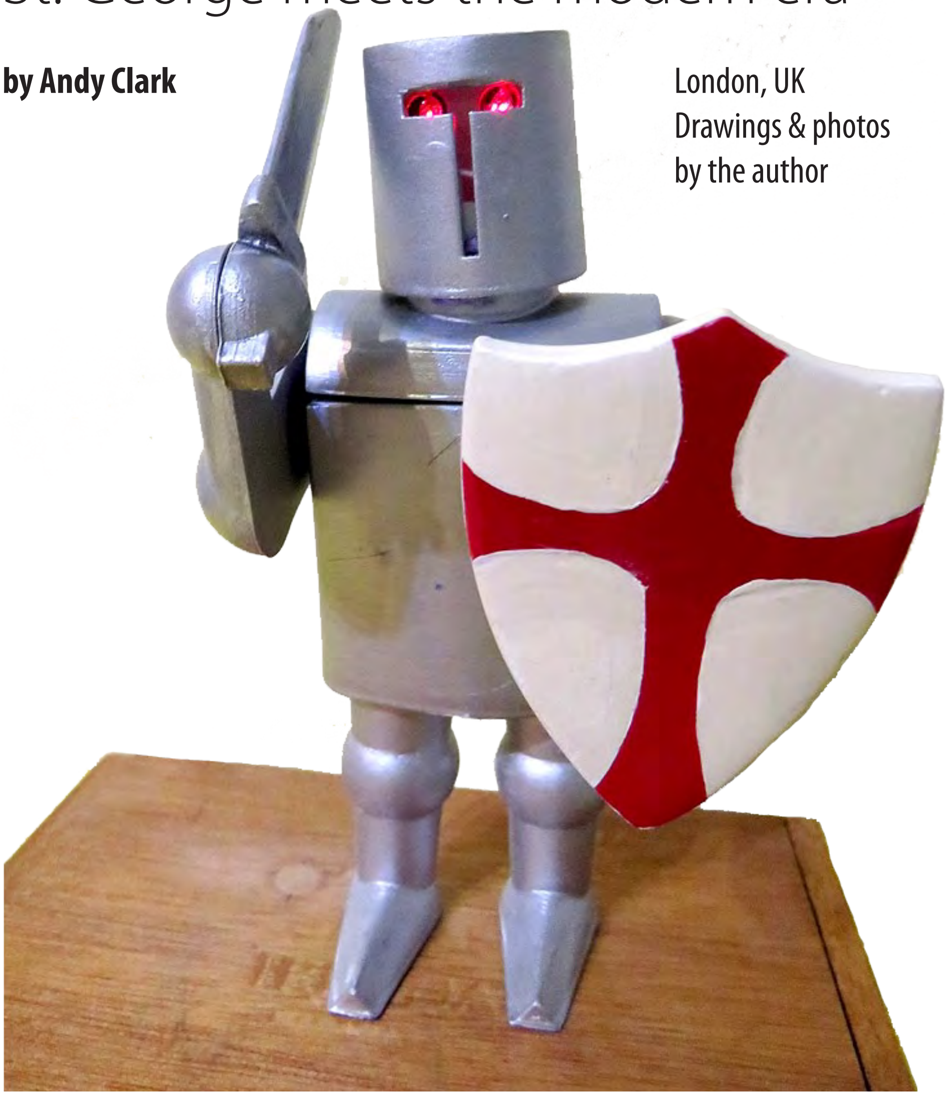
An accidental automaton

St. George meets the modern era

by Andy Clark

London, UK

Drawings & photos by the author



I never intended to create a high-tech St. George. It started with a guy named Clem Martins, who mentioned on a forum that he was entering Qualcomm's Maker Month Contest, a competition to promote Qualcomm's latest small-board computer. "Tell us what you would make with a DragonBoard for a chance to win one of your own," they asked. This was followed up with a $5,000 prize for the best project that actually got made.

I'd won such a challenge the year before but knew how much effort was involved, so I wished Clem the best of luck and voted for his project. Mark, one of my friends, commented that some of the other entries were really way out. Nico, another friend, then followed up with, "Wouldn't it be great to put in a really silly entry?" That got me thinking.

The project

I thought, given that this board was called a DragonBoard, detecting dragons was the natural thing for it to do. So I created my spoof entry and submitted it to the site (**figure 1**).

To my surprise, a few weeks later I got an email from Qualcomm, with an official entry form

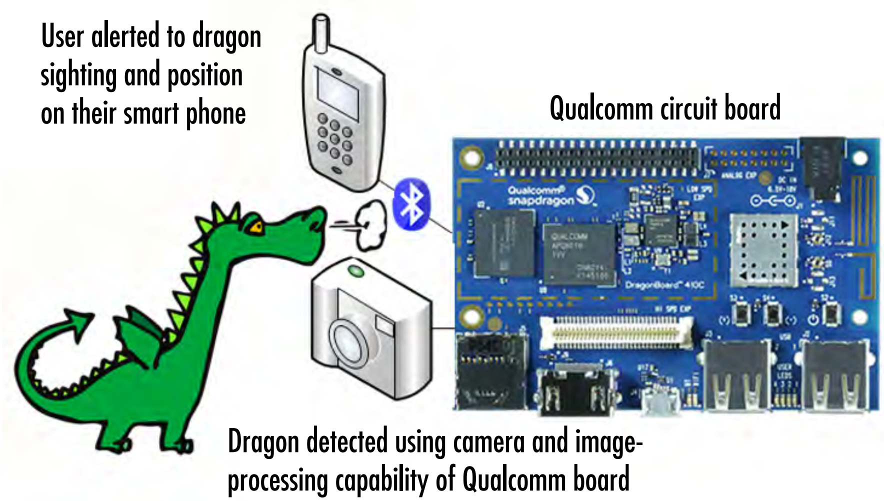


Figure 1—The author's spoof entry

for the $5,000 competition. My project had gotten through the first stage. I found that Clem had also been accepted.

The project had quite a short timescale so I wanted to keep everything as simple as possible. The electronics consisted of the provided DragonBoard, a web camera, and some flashing lights to indicate when a dragon had been detected. The software used an open source, machine-learning module to analyze the images and determine if the image detected was a dragon (**figure 2**). It took some time to get the code trained but it eventually detected dragons successfully. **Photo 1** shows the dragon-detection notification on my phone.

I wanted the lights involved to suggest the eyes of a sentinel who was watching for dragons. However, there was not enough time to make anything, so I called upon Rob Ives, who makes paper and laser-cut automata, and I asked if he had anything that might be suitable. He had a small, blue knight that was just the thing, so I printed that out and assembled it. Wires were run up one leg so that the lights could be put into the helmet. A steel rod up the other leg provided support for the knight (**photo 2**).

The dragon was made by printing out an image and sticking it to some 3mm-thick plywood, which was then cut out with a coping saw. A mirror-image dragon cutout was stuck to the back side. The finished dragon was mounted on a small stick so I could demonstrate the system (**photo 2**).

The automaton

I liked Rob's knight, but using it was always a compromise. I wanted the knight to move, which would be a challenge with the existing paper design. I set about designing a knight in CAD, to be 3D printed; it would be a bit more robust and could wave a sword (**photo 3**). My first thought was to put the mechanics in the base of

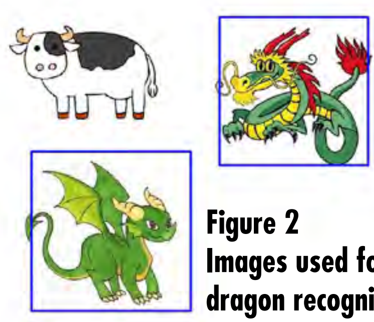
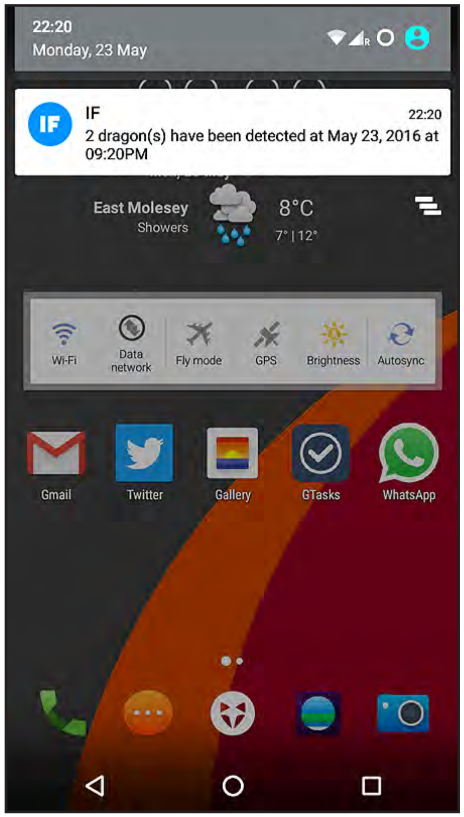
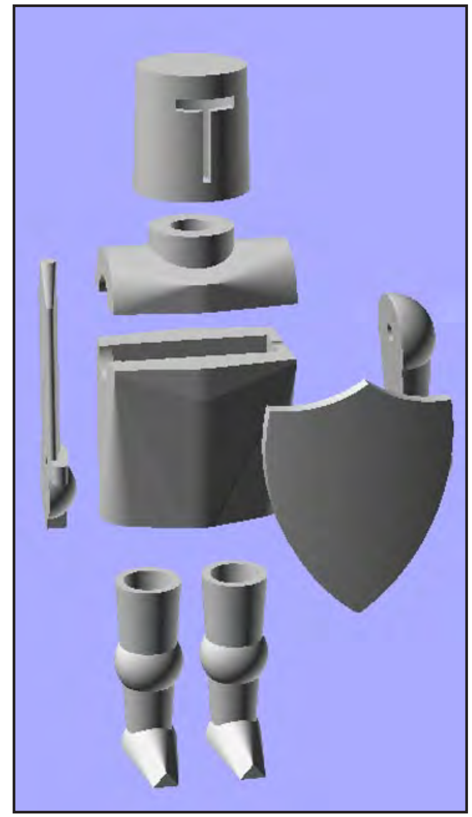


Figure 2
Images used for dragon recognition



1. When a dragon is detected, a notification appears on the author's phone.

2. The paper knight, constructed from a Rob Ives kit, and the dragon.



3. The new knight, modeled in the author's computer, would be 3D printed.

the box and run a thin rod up the leg to activate the arm, but there wasn't much space left in the box, once I'd added the appropriate electronics to drive the servo. Instead, I made the chest of the knight hollow and fitted the servo into that space.

The arms and legs were designed as mirror images of each other, so I didn't have to model those twice in my CAD program. I made the arms so that they could be screwed onto the body and the servo.

One of the key things about creating parts for 3D printing is to ensure they are actually printable. I kept all the parts quite chunky and tried to give each part one flat side, which would face down when printing. The one exception was the shield, as I wanted a smooth curve on the front. There is a handle on the back where it is attached to the arm (the hand is actually part of the shield). The shield was printed face-side down, with supports. After it was printed, the supports were cut off, leaving a rough surface. It's not shown

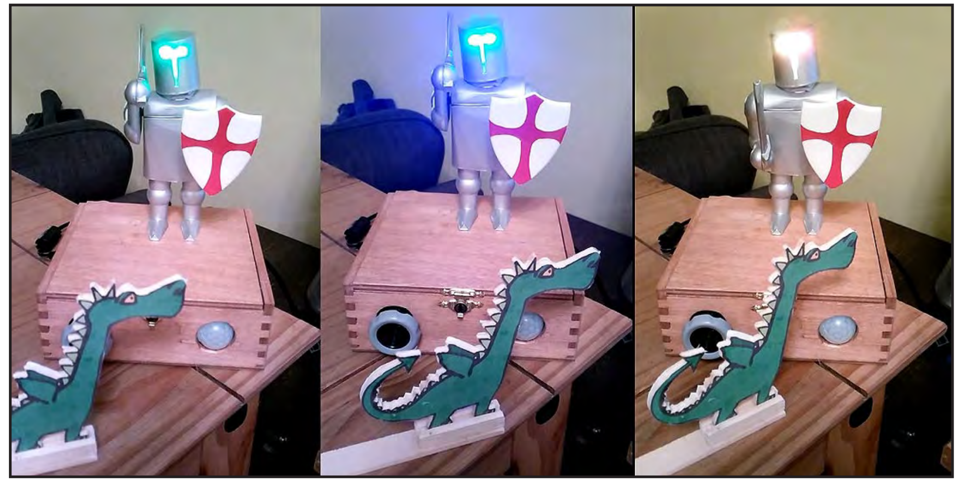
4. Priming the model with spray paint.

in the photo but there is also a small part inside the helmet, to hold the lights. All of the parts were printed in white ABS, mainly because that was what came with my 3D printer.

Most parts were just primed (**photo 4**) but the shield needed more work. It was filled with a smooth filler, sanded, then primed. That process was repeated until I was happy with the finish.

The top coat was enamel model paint. Masking tape was applied to the shield, and a Templar-style cross was cut out with a knife. The cross was spray-painted red for a good finish. The tape was removed and the spaces in between carefully painted with a white gloss coat.

The parts were then assembled and glued, and the wiring was connected. Next was just a case of



5. The knight in action. As the dragon passes in front of the camera, the knight's lights change color and his sword arm descends to slay the offender.

testing (**photo 5**). The new-and-improved dragon detector was then demo'd for a live audience at a meetup in London (**photo 6**).

A video was made of the project and sent to the competition. In a few weeks, the winners were announced. The grand prize went to a quadcopter that surveyed the ground and, hence, could hover quite accurately. My project got an honorable mention and I was also interviewed for the Qualcomm Developer of the Month. A1

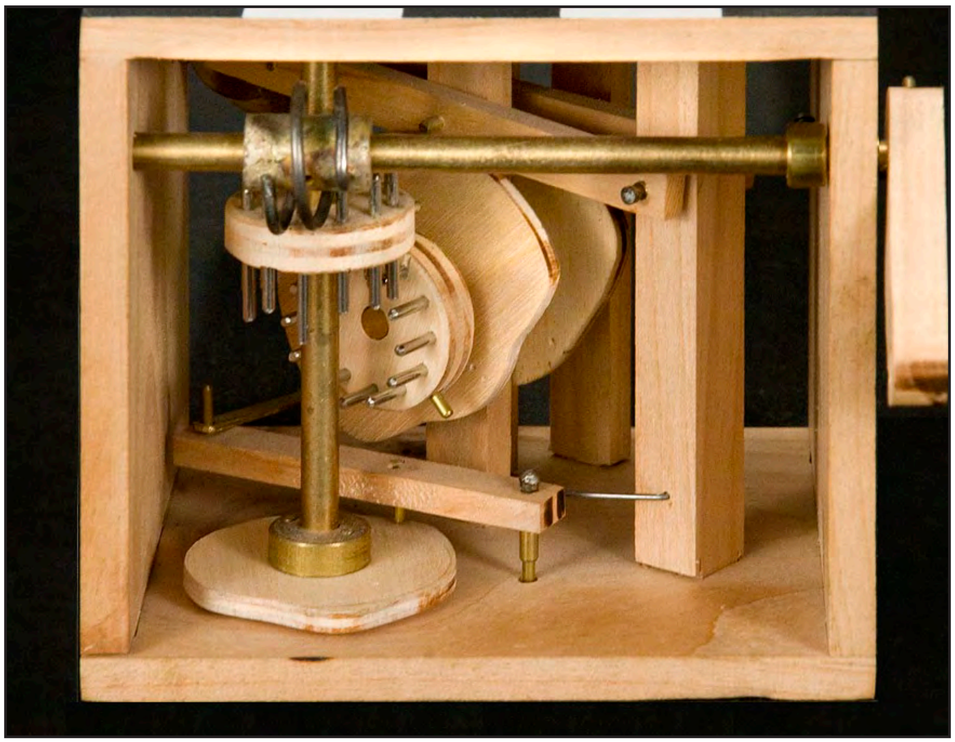
6. The author with his finished automaton, presenting it for Linuxing London.

Andy Clark has been making and repairing things in a shed at the bottom of the garden for 10 years. His quirky and unique projects have won him a variety of awards. Visit his website at *https://www.workshopshed.com*

Building Blocks

Cams: part 1—the design

by Paul Giles •Sun City Center, Florida, USA
Photo and drawings by Marc Horovitz



Cams, seen here behind the pinwheel and at the base of the vertical shaft, are the "brains" of an automaton, often controlling all of the motion. In this article and the next, the author discusses how to design and make a cam to provide the motion you want.

Every automaton project, no matter how simple or amazingly complex, shares one simple element: building blocks. When looking at an automaton, here's how to find those blocks. Don't look inside the project and instantly try to focus on everything that you see. Trust me, it can't be done. The secret is to simply look at the crankshaft—you know, the thing with the handle—then go down the line, one at a time, examining each string of mechanics that feeds from it.

Each of those many secondary lines of shafts, gears, etc. is simply one piece of the puzzle—a building block; each of those building blocks is made up of either more blocks, or pieces that work together. In this column I'll tell you how to construct those building blocks from the ground up. Once you have a better understanding of what those different parts do, you will find it easier to turn the parts into machines that will bring a smile to everyone's face.

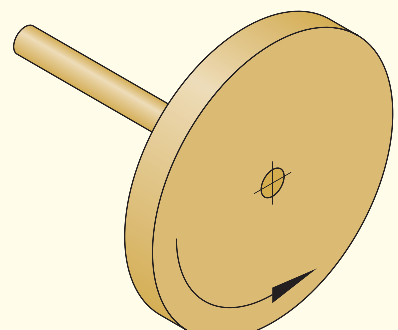


Figure 1
Simple circular cam with a shaft through the center

The basics

In this first article I'll be talking about cams. Cams are those roundish things that designers use to create a certain kind of motion. That motion can be linear or it can follow almost any path that you can create. A cam can also be used in most instances where some kind of repeating action is desired.

The simplest cam might be no more than a circle with a shaft right through the middle (**figure 1**). By itself, this cam doesn't do much except spin. If you add a second, identical spinning wheel at a right angle against the first one, you can make the second wheel spin in place (**figure 2**). When you do this, think about a dog chasing its tail, or a twirling ballerina (**figure 3**).

From here it gets more fun. We're going to get fancy and create what your high-school teacher called harmonic motion. Harmonic motion is just a movement that rises and falls with some kind of pleasing rhythm, like riding a swing at the park. All that you have to do is take the earlier example of a circle with a drive shaft through the center and move that shaft away from the middle (**figure 4**). The farther from the middle that you move the shaft, the higher you can raise an object.

You can do something else now, as well. Go back to the example of the circles at right angles for this. With an offset cam on the crankshaft, you can cause the dog to take a break or that ballerina to pause for an instant after every pirouette (**figure 5**).

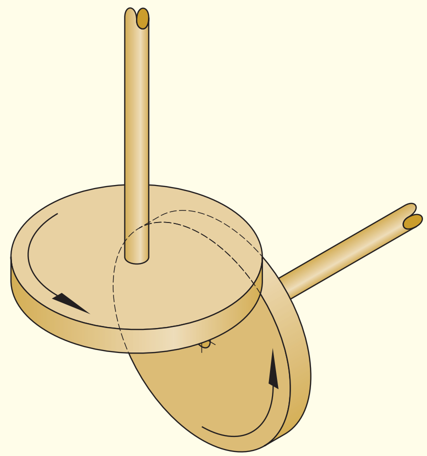


Figure 2
Circular cam with an offset round disc resting on it

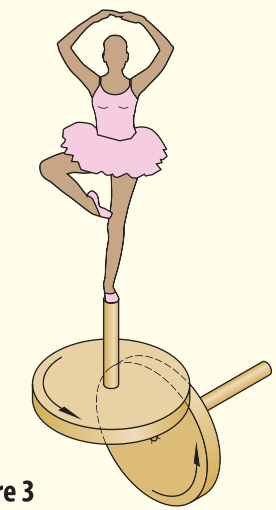


Figure 3
Twirling ballerina

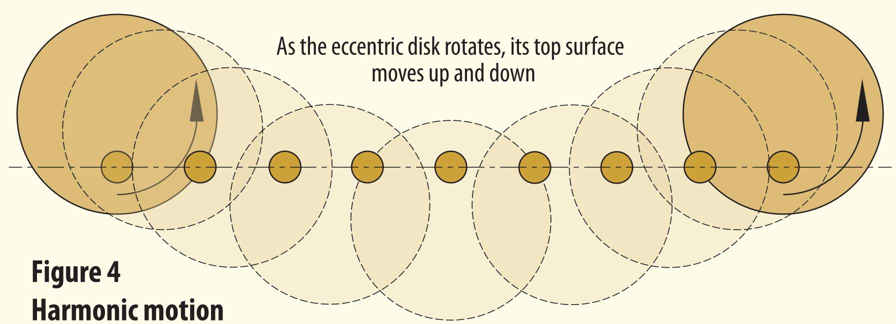


Figure 4
Harmonic motion

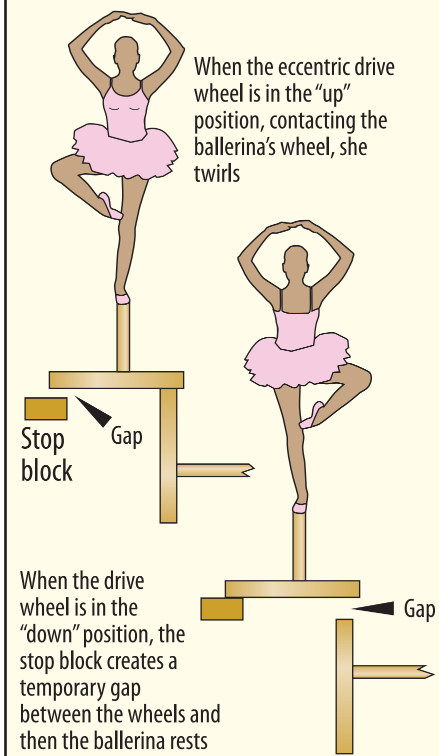


Figure 5—Creating a pause

An easy example

You can see that even the most basic cam can create pleasing motions. Now that you understand the basics of what cams are and how they work, let's move on to an easy example by creating a cam with non-regular motion that will work with your next automaton project. That motion is limited only by your imagination.

The first thing to do when designing your cam is to simply close your eyes—really. Just sit there for a few minutes and think about what action you want. Visualize your building block. What do you want that block to do? What motion? Create that movement in your mind. Don't open your eyes until you clearly see that object dancing in front of you. Now focus on the movement that you just created. In your mind, follow that movement—every up and down, every pause, and every twist.

Now open your eyes and pull out some graph paper and a pencil. Trust me on this, you don't want to use a pen: pencils have erasers. At the top of the page, jot down a quick list of everything that you want your object to do. Call it your to-do list. For this example, we want the motion of slowly rising, stopping for a moment, hopping twice, then returning to the beginning for another go.

You're about to draw a long, straight line from left to right, about halfway down the blank portion of your graph paper. First, though, it's time for a bit of math. I'm going to guess that I want the nominal diameter of my cam to be 1½". (Remember, this is only a number to get us started. If the motion is to be upward, the cam will be growing in size.) We're going to multiply 1.5 (our nominal diameter) times π (Pi = 3.14) to figure out the length of your left-to-right timeline. That will also be the circumference (length of the outside edge) of your 1½" cam circle. The correct answer is really 4.71" but my ruler isn't that precise, so I'm just calling it 4½". You'll never notice the difference in your final cam profile.

The circumference equation is actually $C = d \times \pi$. To say that in English, the circumference equals the circle's diameter times 3.14. That circumference will equal the length of your left-to-right

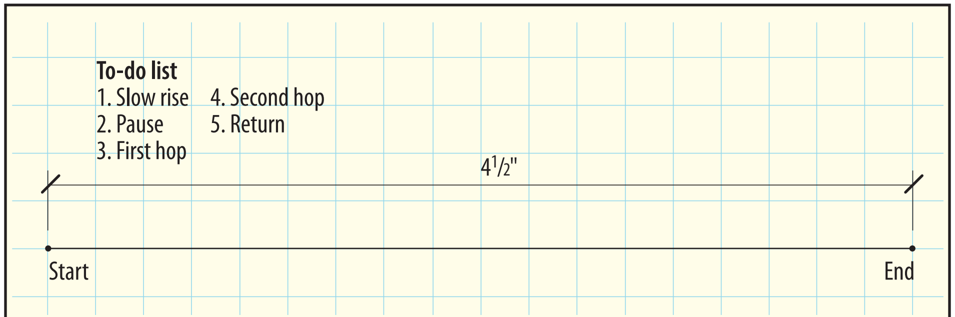


Figure 6—Beginning to plan a cam's timeline

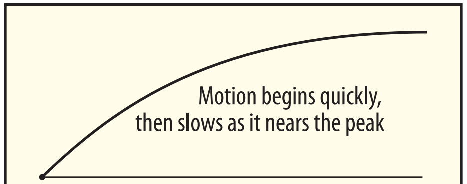


Figure 7—Clockwise curve

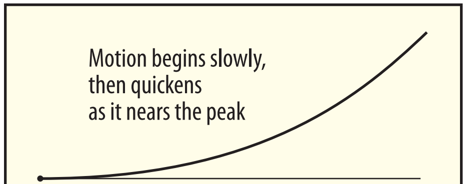


Figure 8—Counterclockwise curve

straight line. That nominal size can be influenced by other building blocks—things like the shaft speed, gear ratios, and even how much room you have left inside the box, but I'll talk about those things another time.

The far left end of the line will be your start position (**figure 6**). The far right end of the line will be your end position. The two end positions must be the same so that the motion can begin its next cycle again from the same place. Think of this line as your "timeline." The lengths of its segments will eventually equate to how long your movements will last.

Go to your start position and, using your pencil, begin to draw the motion that you envisioned for that first slow rise. If you saw your motion as a steady climb, then draw a straight line upward until you reach the height that you wanted. My graph paper has ¼" squares so, if I want my climb to be ½", I will go up two squares. But how far to the right do I go? This depends! Do you want to get there quickly? Then draw a steep line that goes two blocks high. Do you want a slow, easy climb? Then extend your line farther to the right and create a gentle slope.

We don't have to limit ourselves to straight lines. What happens if you draw a clockwise curved line that rises that ½"? The motion will begin quickly but will slow as it reaches the top (**figure 7**). You could just as easily draw a counter-clockwise curved line. Visualize it and you can begin to see that this type of curved line will begin rising slowly but end up rising much faster as it nears the top (**figure 8**).

You could have drawn a lot more than just a rising line of some kind. Go back to your imagination and think about flat lines, falling lines, ratcheting lines, and even more complex squiggles. A flat line that is parallel to the timeline creates a pause or a break in the rising movement. You could use a flat or curved falling line if your character is already at the top of its motion. A ratcheting line describes a jerky, haphazard motion. And those squiggles? Use them to begin adding some complexity or random excitement to your movement. Remember, steeper slopes create faster motion.

Now look at the second item on

your to-do list. A short pause is created by drawing a flat, horizontal line. The longer you make this line, the longer the pause will be. Think of it this way: Do you want to rest as long as it took you to climb the hill? Then your horizontal line will be as long as the left-to-right distance of the slow rise. If you want to rest only 20% of the time that it took your figure to climb, then the horizontal rest line will only be ⅕ as long. Let's say your climbing line is 2½" long. Then, at 20%, your rest line will be only ½" long (**figure 9**).

Next up for our motion example are two small hops. As I see those two jumps in my mind, they look a little like McDonalds' Golden Arches, so those are the shapes I'll draw. I'll also put a very short horizontal line—a pause—between the two arches (**figure 10**). If your own version of these two jumps has one of them higher or farther, then draw your leaps accordingly.

All that's now left of your motion is to return to the timeline end point (**figure 11**). You've already learned several ways to do that: a direct and fast return with a steeply sloped, straight line; a varying-speed return with a clockwise or counter-clockwise curved line; or even a leisurely pace with a gentle slope, maybe even with a horizontal pause line.

In the next issue I'll discuss transferring your motion from the timeline to the actual cam. AL

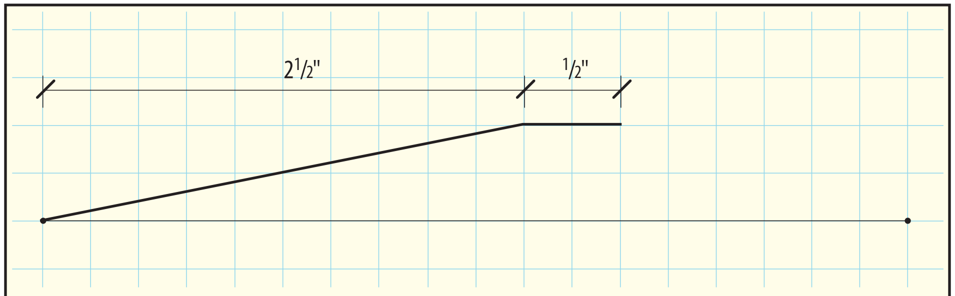


Figure 9—Rise and pause

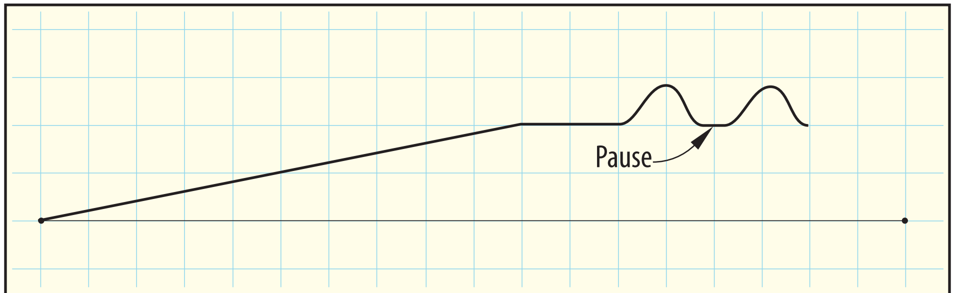


Figure 10—Two hops

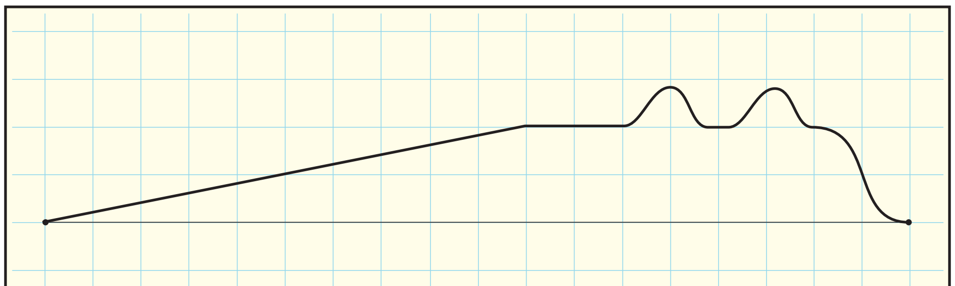
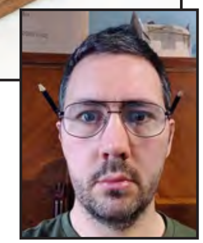


Figure 11—Return to the starting point: timeline complete

GALLERY



Civilized Beast Number 2

by Dave Hall

Derby, UK • Photo by the author

This automaton is from a series of beasts, all civilized. This fish is more civilized than a lot of people I know. You wouldn't mind meeting him in the street.

Made from various woods, metals, etc., he simply gives a small bow and raises his hat. He now lives in the Netherlands, I think.

Video
https://www.instagram.com/p/BiHsDVyle1U/?utm_source=ig_web_copy_link

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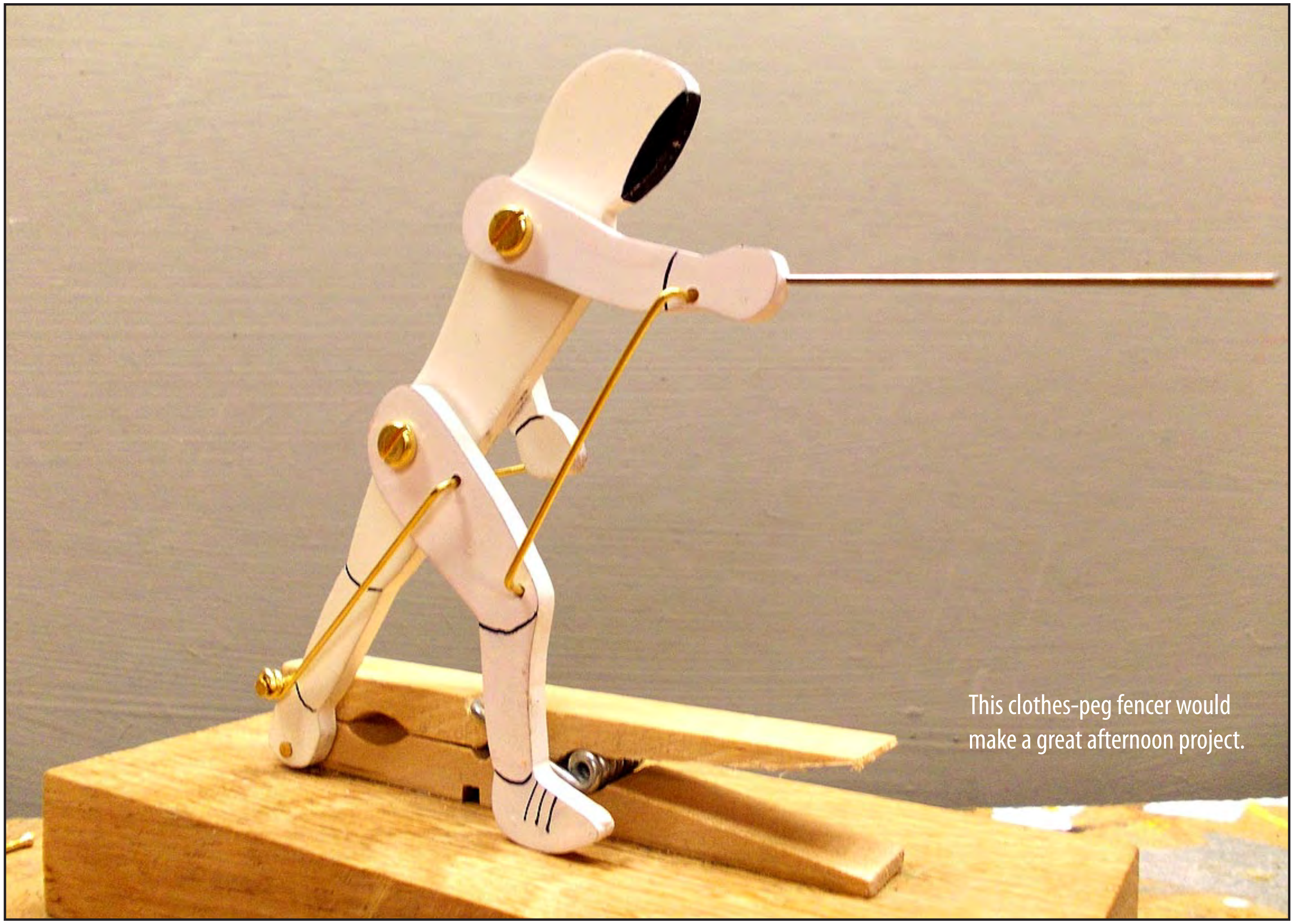
Build a clothes-peg fencer

Everything you need to make this simple automaton

by Lee Hutchinson • Hope, UK • Photos by Poppy Hutchinson



This clothes-peg fencer would make a great afternoon project.

I have to admit to being slightly obsessed by clothes pegs as a means of driving automata (**photo 1**). They are cheap, easily available, simple to work with, and their limitations are part of their charm. Working within the parameters, the maker is challenged to find ever more ingenious ways to create new pieces.

A pecking bird seems the usual place to start; my first venture was a bobbing wagtail. As I got more ambitious, I made mice with disappearing cheese, all manner of birds doing whatever comes naturally, and small people that could be made to saw wood. I even, for a while, tried (unsuccessfully) to link two or more figures together with cables. These dusty, discarded pieces might yet be resurrected.

Introduction

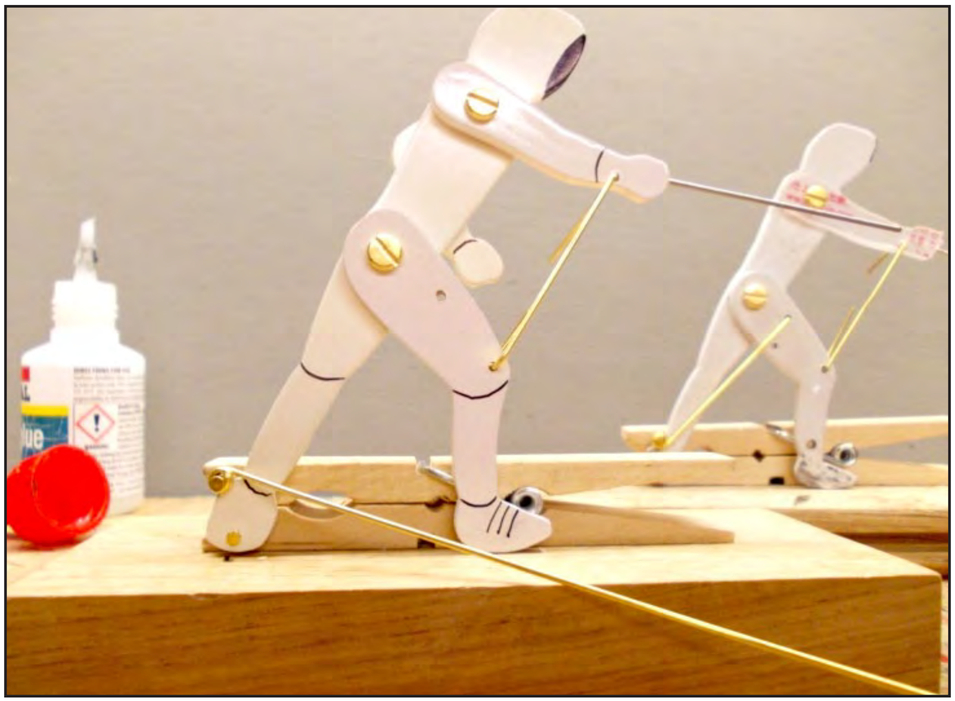
When I first suggested this article, I was going to use a crow as an example, but laying on the bench was a fencer for whom I keep finding opportunities. Luckily (with a little experimentation), he worked out better than expected.

Up-and-down motion is the expected thing with pegs in their basic form. But, as you can see from the prototype (**photo 2,** background), after a few trials of positioning the hole in his leg, some lateral movement could be found. Apart from his other arm not working, he's got a pretty good lunge—that explosive move that can win a duel!

As well as the usual movements, I have discovered, by playing around, that a disc can be rotated through about 90° by a clothes peg's action. With a slight serration to the edge, it can be made into a driving cam for a woodpecker tapping away, looking for its supper.

So, the possibilities may not be endless, but they are fascinating and, with your imagination, there must be hundreds of variations to play with. For anyone who might fancy a go at the fencer, here's what I used and how I did it.

1. Some of the author's other clothes-peg automata.



2. The prototype in the background has a leg that looks like holey cheese!

Tools & materials

Fencer cutting list

3mm Perspex (Plexiglas) or ply
Scrap wood for the base
1 oversize clothes peg
1mm (3/64") brass rod
Brass panel pins, 15mm+
2 M3 nuts and bolts
Wood glue

Tools

Fretsaw/scrollsaw
3mm ,1.5mm, and 1mm drill bit (1/8", 1/16", 3/64")
Drill
Pliers
Small screwdriver

Construction

1. Glue your peg centrally to the wood base. Cut out the pieces required for the fencer (**photo 3**, **figure 1**). Carefully drill into the edge of the moving arm where the hand is, with a 1mm (3/64") drill bit. Push a piece of 1mm brass rod into the hole to make the foil (**photo 4**). Cut this off to approximately 40mm (1½"). You could add a small disc with a hole in it to the rod, to make a guard on the foil (a nice detail).

2. Drill the 3mm (1/8") and 1.5mm

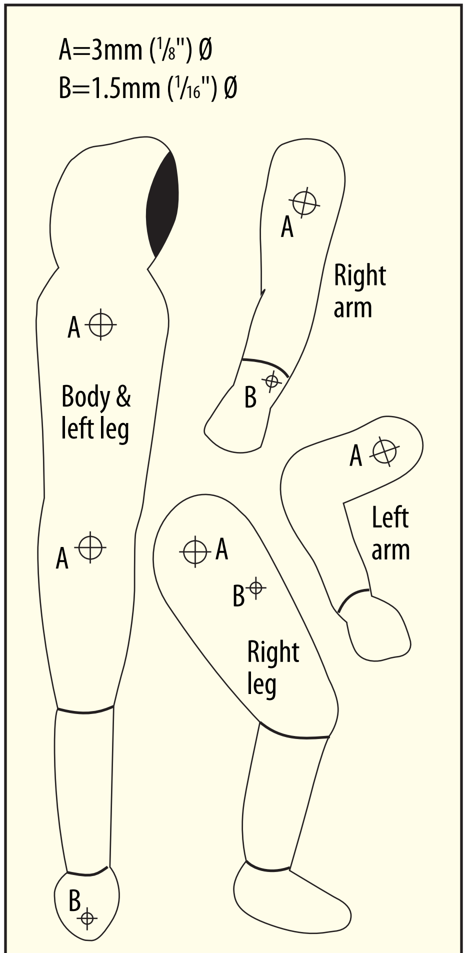
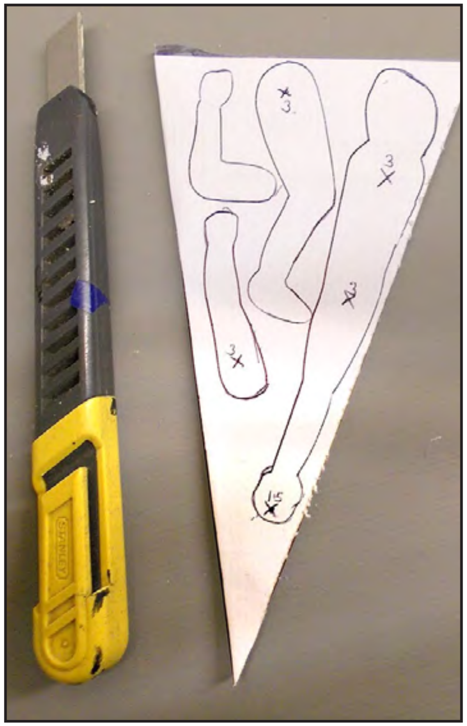


Figure 1
Full-size parts for fencer
Cut out and glue to material

(1/16") holes, as per **figure 1**. Glue on the nonmoving arm and paint the parts (**photo 5**). I rough up the acrylic with 120-grit sandpaper, to provide a key for the paint. Undercoating is not necessary on Perspex, and ordinary gloss paint is ideal.



3. Constituent parts of fencer. The knife shows scale. The fencer is approximately 4" tall.

5. Parts painted and ready for assembly. The clothes peg is mounted to its wooden plinth.

4. Hole drilled into the edge of the Perspex and the foil inserted.

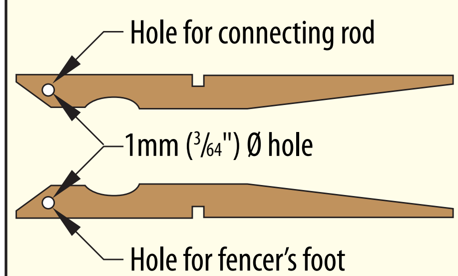


Figure 2—Clothes-peg holes

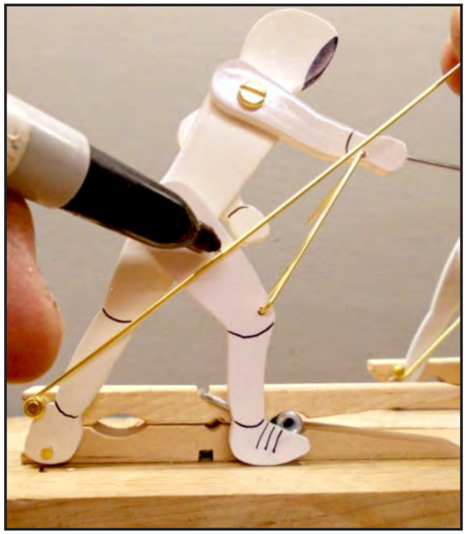
3. Drill a 1mm (3/64") hole all the way through the bottom part of the peg (**figure 2**). Fix the fencer to the peg with a panel pin through his right foot, being careful not to split the peg. Send home the pin sufficiently to hold him tightly to the peg but still free to move. Trim the pin to length.

4. Clean the paint from the holes and assemble the fencer, using the nuts and bolts through the limb joints. Add the details of socks, mask, etc. with a permanent marker or black paint.

5. Position the body so that it always has a forward lean. This is important! Ensure that the legs slide easily. Drill the top part of the peg (**figure 2**) so that a pin placed in the hole will prevent the leg from going back any farther (see the photos).

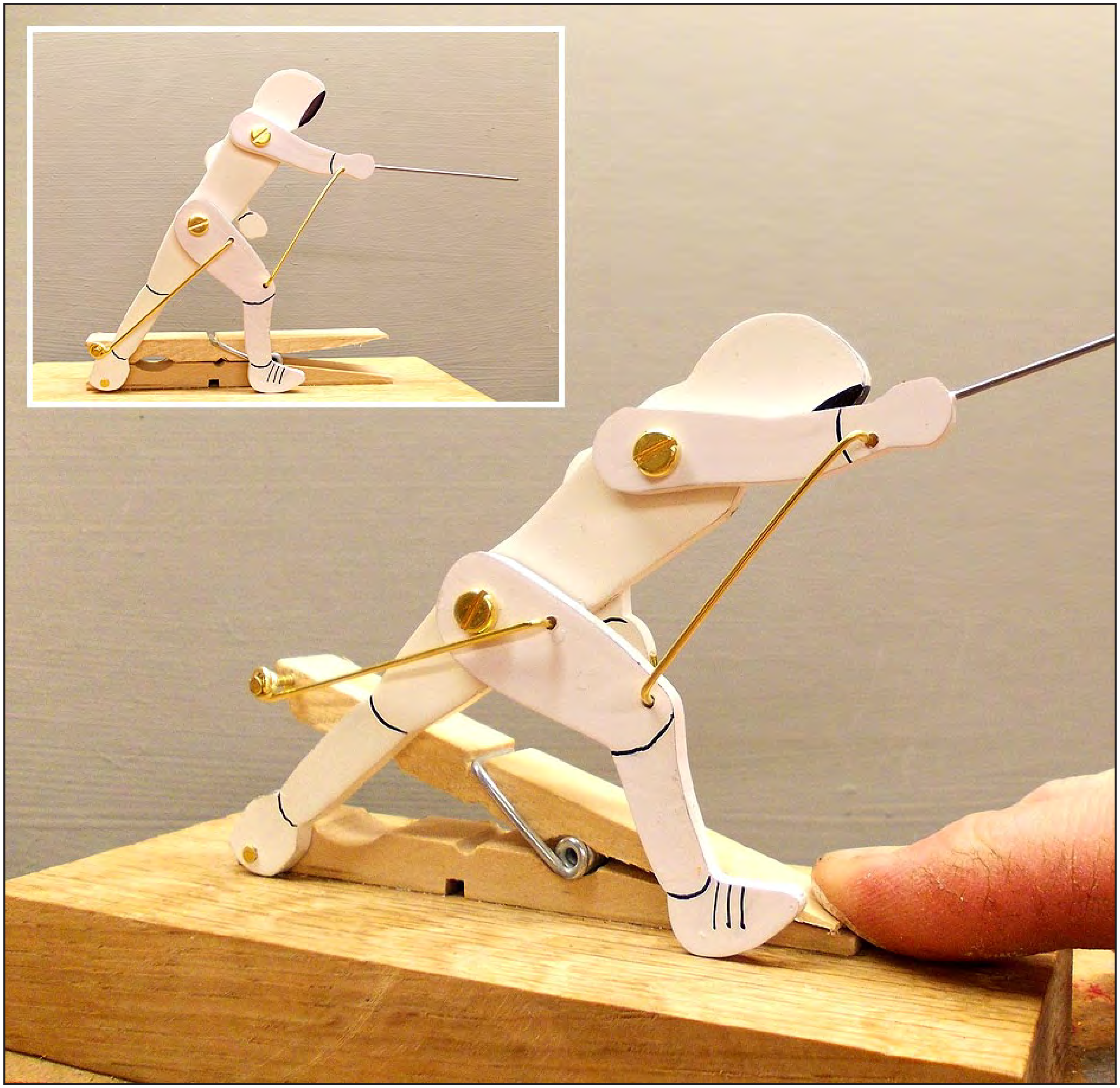
6. Make a loop at the end of a 1mm brass rod, twisting it around the 1.5mm drill shank a couple of times. Keep the loops tight. Slip the loop over a panel pin and fix the pin into the upper part of the peg.

7. With the peg in the closed position and the fencer's leg against the pin, mark the rod at the correct length to reach the upper hole in the right leg (**photo**



6. Marking the length of a connecting rod.

6). Allowing an extra 20mm (¾"), cut the rod. Bend the rod at the mark and push it through leg, then bend it over behind leg. Do the same to link the right leg to the right arm, remembering to allow a few millimeters of play in your connecting rods to make everything work freely. Then squeeze the peg (**photo 7**) and off he goes! AM



7. The fencer lunges when the peg is pressed.

Some of the author's other work can be viewed at Flickr:
https://www.flickr.com/photos/129700133@N04/
Contact him at: leehutchinson51@yahoo.co.uk

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Get Moving

Mechanical Mutt

by Kim Booth
Berlin, Germany
Photos by the author

Mutt, with his appealing eyes, smiles and wags his tail when his legs are pressed.

What can you make that doesn't have a fixed base but can still do tricks? Man's best friend, of course! For simplicity's sake, the design has to be reduced to just those things that make a dog a dog. If you like dogs, their essence is a shiny nose, appealing eyes, a wagging tail, and a smile. If you don't, it all comes down to the teeth. With four legs, one leg can be used to wag the tail and another to work the smile. The nicer the smile, the less there will be to worry about with the teeth.

What do you need?

My dentist says that you must always brush your teeth for a nice smile, so a brush is vital (**photo 1**). Sand off the varnish and cut the brush into two equal halves (**photo 2**). An appealing smile is guaranteed and no one will be worried about the teeth.

Bright eyes complement the perfect smile. With cut-off brass screw heads glued into the holes of two 10mm (3⁄8") beechwood beads (**photo 3**, left inset), the painted eyes always look appealingly up at you, however you tilt the body. Intelligent eyes must never be too close together, so there is a small piece of brass tube between the eyes, sliding on the brass rod glued between the ears (**photo 3**). As the smile is so charming, no one notices the brass rod.

A 20mm-long (¾") beechwood egg needs to have one quarter cut away (**photo 3**, right inset) so that it fits neatly in place on a brush half. High-gloss black paint gives the nose that healthy shine.

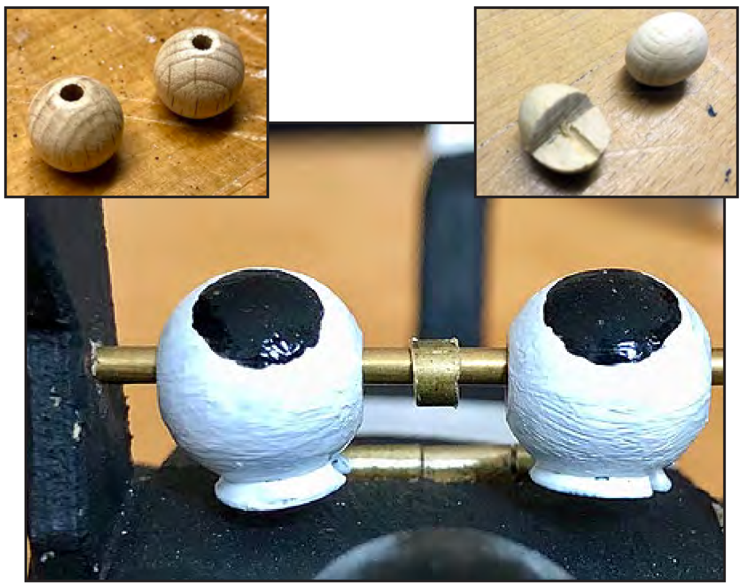
Plywood, 6mm thick (¼"), serves nicely for the dog's body (**photo 4**) and its legs, cut out with a scrollsaw. The back legs are a little smaller than the front legs. The front legs are hinged (**photo 5**) so that you can press them to work the dog's tail and jaw.

The tricky bit

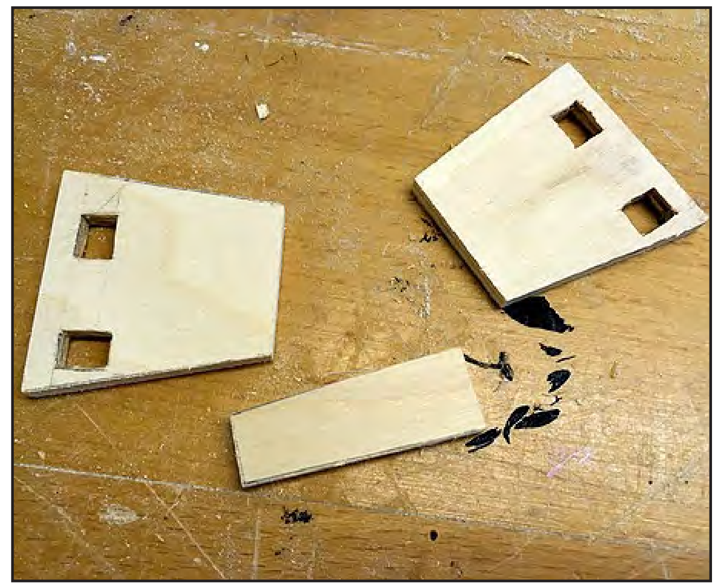
Each side of the body has two rectangular cutouts. The top cutout is to hinge the leg, pivoted on a brass rod inserted from the front, through the edge of the body piece. The bottom cutout takes a crank, hinged on a brass rod inserted from the bottom, also through the edge. When you squeeze the dog's leg against

1. This brush provides *Mutt* with a convincing smile.

2. The brush, cut in half.



3. Wooden beads, shown without the brass screw heads, are the eyes. The finished eyes are kept separated by a short length of brass tubing floating between them.
RIGHT INSET: A quarter of a wooden egg is cut away to form the nose.

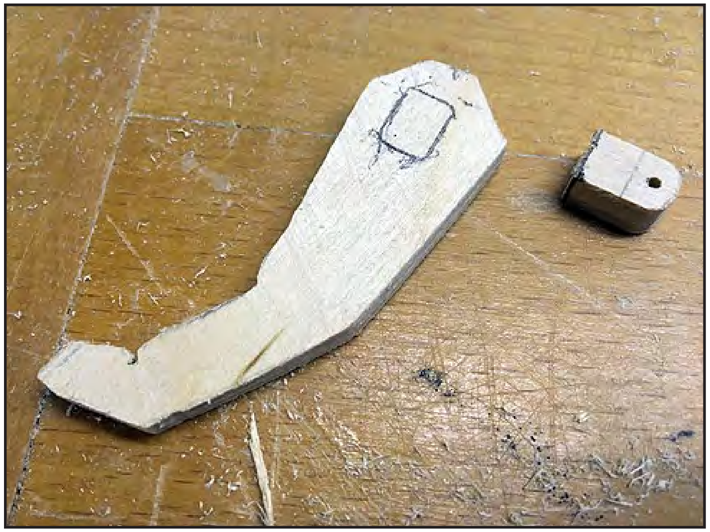


4. The body is cut from 6mm plywood. The cut-out holes are for front-leg hinges and cranks.

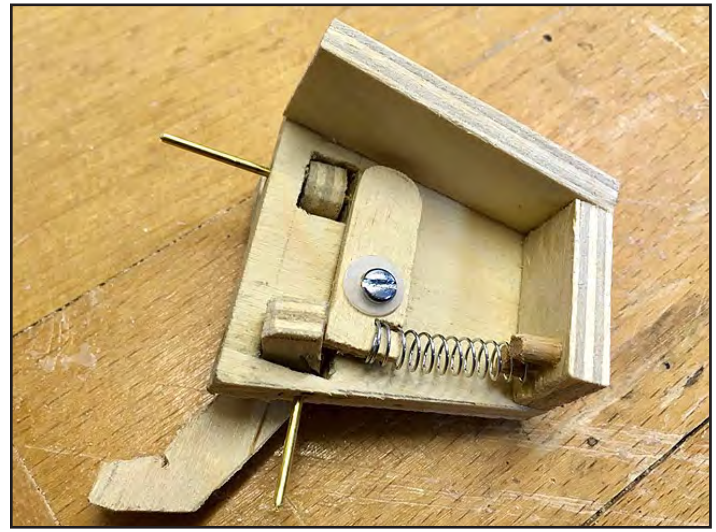
its body, the crank is pushed in and its action pushes the top jaw open via a sprung lever. Tricky huh? **Photo 6** shows the mechanism and this video (*https://youtu.be/aXlmTwl-puw*) shows it in action, which I hope will make it easier to understand. Pressing the crank from outside moves the lever, which then moves the jaw via the brass rod

Each tuft in a brush is just pushed in, with exactly the right number of bristles to fit snugly. To remove a tuft, just grab it with a pair of pliers and pull (just like a dentist!). This is how I made space in the dog's upper jaw for the slot needed to take the loop on the end of the brass rod.

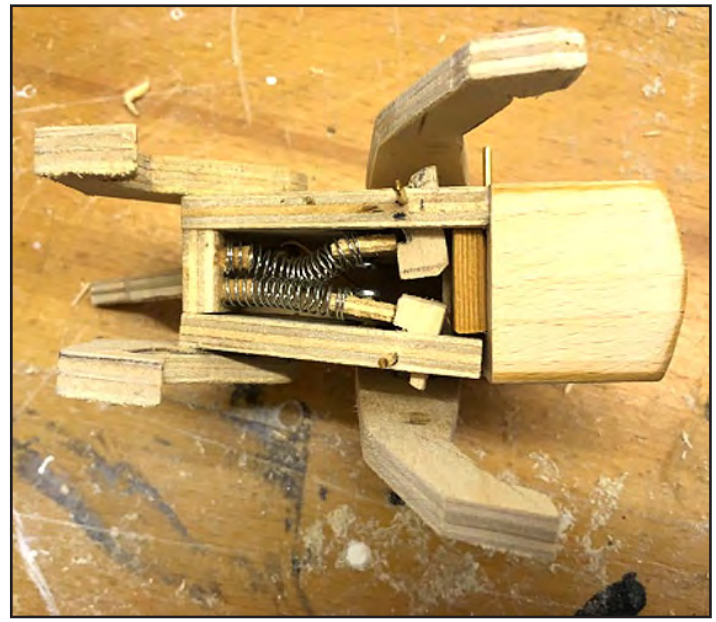
I had to experiment a little to get the tail to wag nicely (**photo 7**) and to look okay when it's not wagging, so its hinge is not exactly central. As you can see from the pictures, not much of the dog is particularly square, but hey—it's a dog, right? **Photo 8** shows the entire mechanism from the bottom. You can see him in his finished glory here: *https://youtu.be/cspsqz7esxc*



5. A front leg with its hinge, which will be glued into the marks.



6. This spring mechanism controls the jaw.



8. The entire mechanism, viewed from the bottom.

LEFT: 7. A brass rod provides the link to wag the tail.

AUTOMATA FOR BEGINNERS

Therapeutic benefits of building automata

by Sarah Reast • Llanbrynmair, Wales, UK • Photos by the author

I believe that one purpose of a therapeutic activity is to challenge the mind or body sufficiently so that other troublesome thoughts and experiences are kept at bay and some respite is achieved, but not so much challenge that one becomes anxious or exhausted.

If model making is your thing, then making mechanical models is a step up from static works. There is an unbeatable satisfaction to be gained from breathing life into otherwise inanimate pieces.

I often wonder at what stage humans became mechanics? Their tool-using and material-manipulating development has been well studied and documented, and the survival benefits of these skills are easy to understand. I assume that early man initially experimented with simple levers and rolling objects and, from that, machines grew. There is, however, a big difference between a simple tool that makes a job easier (such as an axe) and a machine that requires the interaction of multiple components and processes.

The desire to make something work seems deep rooted and, when exercised, is quite rewarding. I have observed on many occasions that children in particular are more motivated to get their automata working than they are to get them looking good. I have done many school workshops with simple cams and linkages and have been challenged to keep the aesthetic and the mechanical processes working in parallel so that both outcomes are achieved. Waiting for glue to dry is the worst thing you can subject a child to when they are just itching to turn that handle and make something move!

In a therapeutic context, this is an impulse that helps to drive an activity that might otherwise be a struggle. I often find the class teacher surprised by the determined focus of a child who normally has attention-span problems or who is less academically able for various reasons.

Combining model making and mechanisms also provides a wider scope for a variety of skills to shine in a big group. There will be those who can craft beautifully, others who are messier but more inventive, and still others who readily get the engineering principals. I love to facilitate an opportunity where absolutely everyone is able to demonstrate their particular talents in some way or another.

I have had the pleasure of working with many different groups in a therapeutic context, from schools

"I find it therapeutic to be able to immerse myself in things like this, so all the stresses in the world and what is happening in your life…you can just ignore them."

(mainstream, special-educational needs, and gifted programs) to adult groups such as The Passage (a voluntary sector resource center for homeless and vulnerable people, in London), and The Men's Shed (community spaces where men can connect, converse, and create), not to mention a whole host of individuals with mobility or health impairments.

Running our business can be quite stressful and a hard slog, but testimony from people who have experienced significant positive impact from the challenge and achievement of model building is what keeps us going. We are often moved by the stories: an elderly dementia sufferer rediscovering old engineering skills and building complex models, despite extreme confusion on all other fronts; the profoundly autistic child who builds and collects our entire range, then asks for Timberkits wallpaper for their bedroom; and the chap running a bit

They're just itching to turn the handle.

She is glowing with pride.

of a model sales racket from his hospital bed while convalescing from a serious illness.

I will leave you with two quotes that say it all:

"My dad was an engineer by trade. He is now 88 and for the past two years has not been able to stand at his workbench and has some health problems that sometimes cause him to become confused and forgetful. He is certainly less able to work things out than he used to be. He has sold his workshop equipment, given away all he has made, and turned into a forlorn figure, sleeping a lot of the time, doing puzzles, or gazing out of the window.

"Inspired by a play I saw about dementia, I bought one of your London Cityscape models for him to make. He used to work in London and I thought this would bring back memories. I was a bit nervous of patronising him by sending something too easy but did not want to overwhelm him with too many parts. I expected him to wait for a family member

Contacting Sarah

If you have questions or comments for Sarah Reast, you can write to her in care of *Automata Magazine*: automatamag@comcast.net Just put "Message for Sarah" in the subject line.

Sarah is the designer and director of Timberkits Ltd., which creates wooden mechanical models sold in kit form. To learn more about her company, visit https://www.timberkits.com/

to 'get him started.' I was wrong! He is thrilled to be re-engaged with something he is good at and, although he says he finds it 'needs a lot of skill and patience,' I could tell in his voice that he has come alive again. He may not be able to remember yesterday, but his brain and hands know instinctively what to do and it is as if he has remembered who he is again."

And this from a lady who works with children excluded from school:

"With all children, whether or not with special problems…the element of control is highly significant (often lacking in their lives), and being able to create something that will work by turning a handle does seem like a kind of magic…the power to amuse people, attract lots of comments and attention, and laughter…even grown-ups are often puzzled how it can work. Not to mention the sheer satisfaction of fitting the box and cams together in the first place. A lot of pride is involved, which is just what these kids need."

If you can combine model making and music, then it gets even better!

REVIEWS

BOOK REVIEW
Making Moving Toys and Automata
by Robert Race
Crowood Press, 2018
https://tinyurl.com/crowood
6¾ x 9½" (242 x 172mm)
96 pages, softbound
117 color photos
Price: £9.99
ISBN: 978-1-78500-491-9

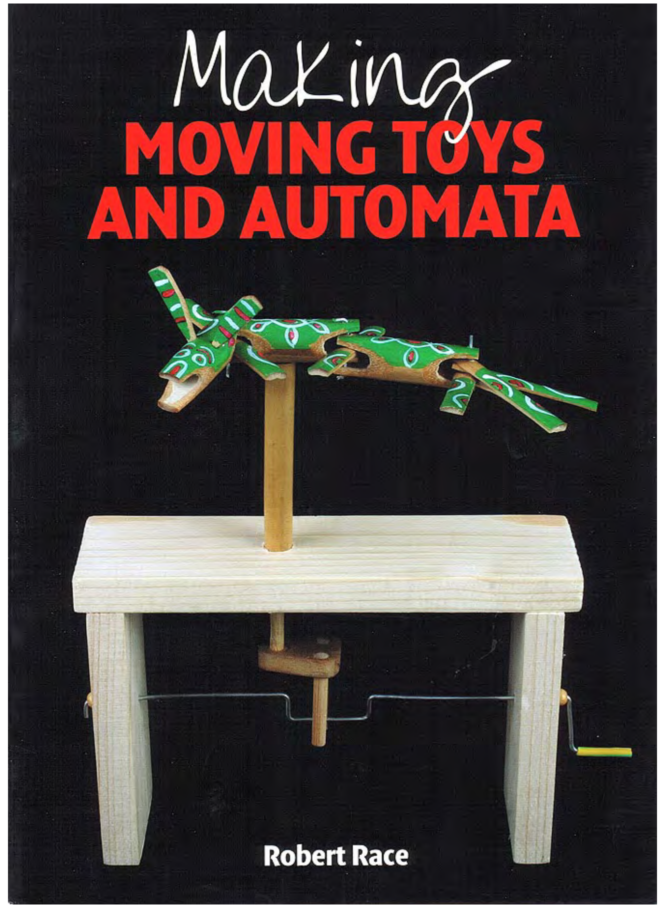
There are a lot of automata books out there aimed at beginners. Robert Race's book takes a little different approach. First of all, he likes to use recycled or repurposed materials, like paper clips, driftwood, old fruit boxes, and bicycle spokes. Most of the tools used in the book are simple hand tools, including saws, hobby knives, pliers, scissors, and awls.

Many of the projects covered in the book are based on old—sometimes ancient—designs from various parts of the world, often with a new twist. Different types of movement are explained through text and examples, usually of toys acquired from many different countries.

The author often discusses variations on the theme, showing how the concept being presented can be used in different ways. One example of that is the Chinese dragon, made of loosely joined bamboo sections and mounted on a stick. When the stick is rotated back and forth, the dragon moves in a slinky, serpentine kind of way. Another way a similar action can be achieved is by making the body of the dragon out of paper folded in an accordion manner.

Each type of action is discussed in detail. The author then takes the readers through the construction of an original automaton, usually hand cranked, but which still incorporates unusual (in automata) ways of achieving motion. His instructions are clear and well written.

Many of the projects achieve a surprising amount of action from quite simple mechanics. For instance, loosely jointed figures mounted to a parallelogram frame will do a lively dance when the mechanism is put into motion.



Clothes-peg automata are touched on, in keeping with the author's love of using found objects. A man tips his hat, a snowman waves his arms. The actions of some of the things in the book need no explanation, being self evident.

String is used in several of the projects. Jumping jacks, where limbs flail when a string is pulled, are easy to make. We are shown how to make one out of a sardine tin. Weights, swinging on (often) multiple strings below the automaton, provide sequential motion in a variety of different ways. I like the way these old-toy concepts are ingeniously incorporated into creative, simple, and beautiful hand-cranked automata.

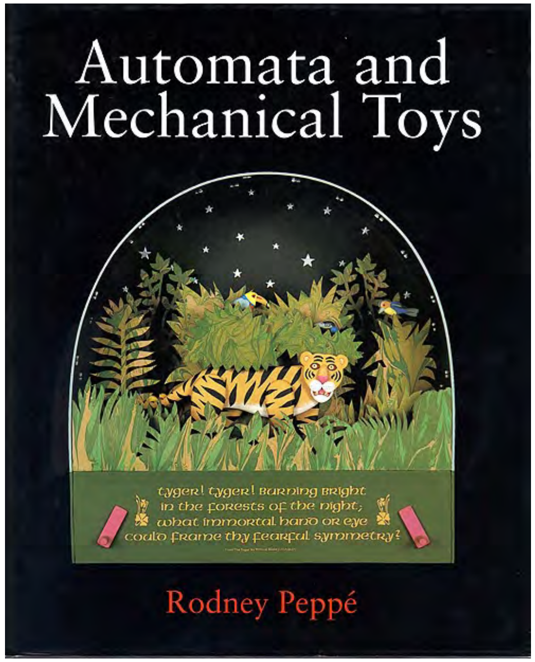
This book is full of fun projects. Many of them would be suitable as collaborative projects with children. All are clearly explained, and they are made with simple hand tools and materials that are either inexpensive or (environmentally better) can be scavenged.

The book itself is well produced. It's pleasingly designed, well laid out, printed on glossy paper, and the color reproduction is first rate. If you are new to automata, or even if you're an old hand looking for inspiration for a weekend or evening project, you might like to have the book on your shelf. I'm happy to have it on mine. —*M. Horovitz*

BOOK REVIEW
Automata and Mechanical Toys
by Rodney Peppé
Crowood Press, 2002
https://tinyurl.com/rpeppe
9 x 10½" (229 x 266mm)
160 pp., hardbound
160 color photos, 44 line dwgs.
Price: £22.00
ISBN: 978-1-86126-510-4

This book takes up where Mary Hillier's *Automata & Mechanical Toys—an illustrated history* leaves off (see the review in the March-April 2019 *AM*). While Hillier went into great detail about the early history of automata, stopping at the 1960s, Peppé devotes a few pages to the ancient past, then digs right in to modern artists, starting with Alexander Calder's mechanical circus from the 1920s, through Sam Smith in the 1960s-'70s, and ending with the Cabaret Mechanical Theatre renaissance in the late 20th and early 21st centuries. Given that, the two books might be considered volumes one and two of a series (perhaps Peppé's choice of the same title suggests this?).

Like most of the recent books on the subject, this one seems to assume that the reader may be interested in making automata, too, so there are chapters titled



Tools and Materials, Techniques, and Making Automata Mechanisms. This latter chapter—the longest in the book—contains 38 pages of drawings, discussions, photographs, and principles, demonstrating a wide range of mechanical motions that would be useful to the modern automatist. Each mechanism is shown in a standard, modular base, much like the boxes you see under so many modern automata. These include the usual cams, levers, and cranks, but also more sophisticated movements, like the Geneva wheel and three different ways (!) to make cog gears. This chapter makes the book an excellent reference work for even more advanced builders.

Between the chapters are artist profiles of current automatists, with numerous photos of their work. These include such high-profile names as Lucy Casson, Ron Fuller, Tim Hunkin, Peter Markey, Keith Newstead, and Paul Spooner, as well as perhaps lesser-known but equally talented makers (including Peppé himself). This, too, is a good reference in which to see a wide range of styles, materials, finishes, and subject matter. Between the mechanisms and the artist profiles, Peppé's book is, I feel, one of the best books available today on automata.

However, there are a couple of disappointments. The chapters Tools and Materials, Techniques, and Painting and Finishing are dealt with surprisingly briefly. The tools section is merely a terse list of tools one might find in any well-equipped woodworking shop. There is no ranking or sequence implied, so the beginning automatist would be lost if trying to outfit a workshop from the list. Similarly, the section on materials is a scant two-page list of things one might want to use in an automaton, without suggestions of which materials are most suitable for what purposes. Perhaps the author assumes that anyone creative enough to do this sort of work will ignore his suggestions and go their own way.

And that might be correct. Despite the promise of plans, the Theme Projects chapter merely quickly describes the sections of the author's *Twelve Days of Christmas* piece, showing an assembled jumping-jack folk toy—not much on plans or inspiration there.

These deficiencies are more than made up for, though, by the breadth of the mechanisms chapter and the many photos of others' outstanding works. Peppé has published another book with nothing but plans, for those who want to follow another's ideas.

Although over 15 years old, this book does not seem dated or behind the times. The technical information and the artistic inspiration are right up to date. The book is still in print and apparently still selling well. Easy to see why: it's an indispensable book for the automatist. —*V. Bass*

The End