AUTOMATA MAGAZINE

Paul Spooner's
The Last Judgement

1/2—Mar/Apr 2019

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EDITORIAL

What is an automaton?

by Marc Horovitz

When the early makers of automata, all the way back to Leonardo da Vinci and before, built their marvelous devices, it was their intent to replicate man—both his motions and his capabilities. Their machines were astonishing in their complexity. The writing automata built by the Jaquet-Droz family in France in the 1700s almost defy belief, not only in their intricacy but in the fact that they worked so well.

Fast forward to today. We now have everything from simple hand-cranked wooden figures made to do everyday tasks (i.e., chopping wood), to amazing robotic creatures controlled by computers, complex circuitry, stepper motors, and industrial-quality mechanics, that will do just about anything asked of them. All of these might be considered automata by today's broadening definition.

What about nonrepresentational kinetic sculpture, though? And how about things that do not represent living beings but are still replicas of commonly seen objects—are these also automata? Or what about the elephant and sea creatures featured in David Soulsby's story about his visit to L'ile de Nantes in the last issue? Are these automata?

Given all of the above, "automaton" seems more difficult to define today than ever before. Perhaps it all comes down to personal preference—you must come up with your own definition of what an automaton is. For myself and the purposes of this magazine, I would consider most of the above to be automata.

There is, however (in my mind), a difference between automata and kinetic sculpture, although there is admittedly a sizable gray area between the two, especially when it comes to mechanisms and materials and how they are used. I think that automatists could learn a lot from kinetic sculptors, and vise versa. We need to keep our minds open but, given the things I've seen already and the people with whom I've been communicating, I don't foresee that as a problem.

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The first issue of *Automata Magazine* was gratifyingly well received. I sincerely thank you all for making it so. I hope that you'll like this issue just as much.

I am also most grateful to all of you who have sent in material for publication in future issues. I've received a wonderful variety of stories from collectors, makers, teachers, and others. I think you'll find the upcoming issues of *AM* entertaining, educational, and stimulating.

This doesn't mean, of course, that I won't come begging again for more material. A magazine can never have a large enough backlog. Having an ample supply of stories on file allows me much more leeway when balancing an issue so that there's enough material in each to be of interest to all of *AM*'s subscribers. So please don't hesitate to send your articles, or ideas for stories that we can discuss.

I've immensely enjoyed meeting you through these virtual means and also talking over your projects and learning a little about you as individuals. I must say, automata people are a fascinating group.

This will be the last free issue of *Automata Magazine*. We're still putting the finishing touches on the subscription page and will send you an email soon to let you know that it's ready.

Until next time.

Marc

NEWS

Cabaret Mechanical Theatre (*https://cabaret.co.uk/*) has four new miniature automata from the St. Legers. *Lucky Cat* waves his arm and *Harlequin* hides in a box. See them ***here***. Also at Cabaret is a new *Applause Machine* from Martin Smith and *Treaty of Tordesillas*, a paper cutout automaton from Andre Pimenta.

EVENTS

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

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

Puke Ariki Museum, New Plymouth, New Zealand, November 2019 to 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.

Neugierige Maschinen features automata, with a focus on extended workshop activities and tinkering opportunities. phaeno, Wolfsburg, Germany. November 2019 to February 2020.

Paul Spooner—New Works 2019. Rodic Davidson Architects, London, UK. Dates TBA.
More info: *https://cabaret.co.uk/exhibitions/current/*

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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 imaginative creations exhibit marvels of design, engineering, storytelling, and fantasy that demonstrate the ingenuity of steampunk art.
https://morrismuseum.org

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*

Send your news items, new-product information, and events to us at:

automatamag@comcast.net

In the next issue of

AUTOMATA MAGAZINE

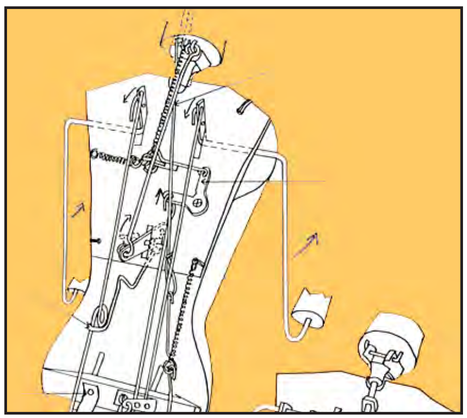
- **Chomick + Meder** discuss the construction of their monkey automata
- **Tim LaGanke** describes *The Cleveland Grandma*, a well known coin-op fortune-telling automaton
- **Lee Hutchinson** shows how to make a clothes-peg fencer automaton
- **Sarah Alexander** wraps up her history of Cabaret Mechanical Theatre
- And much more!

LETTERS

Questions

I have a couple of questions/ topics on which maybe your readers can provide some insight:

Juta and Jim McCord (Mouseworks, Canada) seem to have disappeared. Back in 2007 I ordered one of their terrific kits and *Contemporary Automata* book which, to this day, is one of the best educational books I've ever seen. But in 2008 their website and email went dark. Does anyone know what happened to them?



The above image is from a scrap of wallpaper Renato Boaretto had on his now dead website. I couldn't get a response from him concerning from which book this was taken, and am still looking for a book that deals with these "higher functioning" automata. Any ideas? *—Brian Dunn, Nipomo, California, USA.* Brian.Dunn@qsc.com

Boyer Museum

Thank you for your article about the Boyer Museum in the last issue of *AM*! It is amazing how certain automata makers, despite their impressive capabilities and the fact that they have been busy for decades, have not been noticed by the greater public. Paul Boyer belongs to a generation whose work has gained only regional fame due to the limited media outreach of those times. Also, his machines were probably never classified as art but just "funny toys."

What many people do not know is that a few works by Paul have been sold and are privately owned. Here are pictures of two of these. The details are lovingly designed and painted, and the characters are humorous and do not correspond to commercial ideals of beauty. Somehow the woman at the barrel has also lost a leg, like Paul, but her shoe is still there.

The use of motorized American automata, such as these two examples, may be difficult or impossible in Europe if 110V/60-hertz motors are used. In Europe, 220V/50 hertz are common. It was not foreseeable, though, that these two pieces would travel so far away from Belleville, Kansas. Nevertheless, these have a unique beauty that is worth preserving. *—Sergio Pinese, Switzerland*

Send your letters, tips, likes, dislikes, ideas, etc. to:

automatamag@comcast.net

The Last Judgement

An alarming view of the afterlife

by Paul Spooner
Stithians, UK
Photos by the author, except as noted

1. *The Last Judgement* was the author's wittily macabre entry point to Cabaret for years.

Sometimes I raid the oeuvres of better artists to get ideas for my own work. In the case of *The Last Judgement* (**photo 1**) I went straight to the top and appropriated a painting by Jan van Eyck (**photo 2**). It's in the Metropolitan Museum of Art in New York and I've never seen it. All I'd seen was a little illustration in black and white but that was enough to set me off making a skeleton, with the bodies of the damned spilling out of its insides. It's pretty tame compared to the original but one has to simplify in order to make mechanical things. This is an account of the building of this piece (to the best of my recollection) and its subsequent fortunes.

In the beginning

The business plan was to make a coin-operated machine to be installed in the window of Cabaret, Sue Jackson's shop in Falmouth, in time for the Tall Ships race in 1982. I don't remember Sue suggesting a subject but I am sure it wasn't this one. Nor was it finished until well after the ships, the visitors, and their money had all departed.

I made the chains of little figures first, then fitted them into a frame with a ratcheting drum that lowers them, four abreast, at the front of the rib cage, then recycles them behind. The figures are made of lime wood, shaped with a fretsaw, roughly carved, then pivoted with cocktail sticks.

I've still got the templates for the figures, which were made of aluminium and Formica (**photo 3**). That's a man's body shape on top, distinguishable by his scrotum, of which more later. The only photograph I have of the work in progress is of the beginnings of the rib-cage construction (**photo 4**).

I'm not a religious person; my feeling is that all accounts of God, Heaven, Hell, and the rules for leading a holy life are too various and smudged with the fingerprints of mortal man to merit credibility. You can sense that scepticism in the two zones that top and tail the rib cage.

2. The original Jan van Eyck painting is gruesome in the extreme.

4. The skeleton's rib cage under construction.

3. Templates for carving the multitudinous figures of the damned.

The lower chamber

After the machine has run for a few seconds, the doors to the lower chamber swing open, revealing a scene of demons relaxing in their canteen (**photo 5**). They are taking part in leisure activities; two of them are playing billiards, one taking a shot while the other chalks his cue. The billiard table is slightly dished so that the balls usually return to the spot for the player to hit them again. There is a spaghetti eater, another demon saws at his steak, one stabs at the last pea on the plate, and another reads while stirring her coffee. Behind the counter a demon cook shakes a basket of chips. All of this was enjoyable to make.

Actions are transmitted mostly by means of wooden pulleys, and rubber belts removed from VHS players or drive bands made for model steam engines.

There are also the gearboxes from two Black & Decker electric drills in there. The motor was a Fracmo, taken from a scrapped cash register. Mechanical cash registers and typewriters were being dumped wholesale at the time. I should have gotten more.

I also had fun making the little bottles of HP Sauce and the TV, which, like all TVs in Hell (and mine on earth), has a fuzzy black-and-white picture that rolls round and round because the horizontal-hold doesn't work.

The rationale for this scene was humane; the demons should be entitled, like all workers, to time off in congenial conditions.

The skull

When the onlooker has had a chance to inspect these activities, the doors close and the skull, which had been looking down on the lower chamber, raises its eyes. The top of the head lifts to uncover rows of pews, in which are seated six worshippers singing lustily (but silently—I didn't have the sound technology and, anyway, it was behind thick glass—**photo 6**). The skull's mouthparts, driven by the congregation's mechanism, joins in the singing.

5. Demons enjoying their leisure time off work.

At the time, I told people that these worshippers were Methodists but I prefer now to think that their fervor is more evangelical in nature. The skull's lid then drops and the motor stops.

I remember installing the machine in Sue's shop. I had to cut a hole in the window frame and fit a slotted brass plate (**photo 7**) with a chute that led coins into a small, corrugated-cardboard box that had once held a light bulb. There was no control over the denomination of coin—as long as it fitted the slot, it worked the machine but, because I'd stamped "10p" on the brass plate, that's what most people put in. After the installation we went to the pub and, on returning, found that the skeleton's takings had paid for the drinks.

When Cabaret became Cabaret Mechanical Theatre and moved to Covent Garden in London, the skeleton was put into a case made by Jonathan Craig. It was heavy and painted shiny black. The back panel had been part of the wind chest of a church organ. It was a piece of mahogany, planed flat, drilled to coincide with the pipes, grooved to stop one pipe's wind reaching the next's, and rubbed all over with graphite. It was a beautiful piece of wood that looked as if its grooves and holes contained a message in an unknown alphabet. I got it for nothing from Russell Richards, who had a second-hand timber yard, then in the middle of Stithians, now gentrified out of existence.

You can see the panel in the lower left corner of **photo 8**. The picture was taken late at night, when all shop fitting and installations at the market in Covent Garden had to be done. In the photo, I'm painting the sign that orders passers-by to put money in the slot because it will be good for them to pay their way. Mrs. Thatcher was on the throne at the time.

6. The virtuous raise their voices in song. The skull sings in time with the music (even though there is no sound).

7. The money slot, which would actually accept any coin that would fit.

Because Cabaret was now in a big city, *The Last Judgement* got a lot more notice than it did in Falmouth. The skeleton was seen by more people, notably when a video came out (*https://www.youtube.com/watch?v=8WWGN_4tNes*) in which Rush, the legendary rock band, performed to the accompaniment of visuals that included *The Last Judgement* and *The Dream*, (the latter now to be experienced at London's home of coin-slot euphoria, Novelty Automation in Holborn: *www.novelty-automation.com/*).

After Cabaret

When Cabaret gave up the premises in Covent Garden, the skeleton shared in the vicissitudes of that era, which is the subject of Sarah Alexander's article in this issue. *The Last Judgement* ended up at Marvin Yagoda's Marvellous Mechanical Museum in Detroit, USA. Marvin was a good friend and has been sorely missed since his death on the first day of 2017. He'd bought the skeleton in a move that contributed a great deal to the rescue of Cabaret's business when its American adventure went sour.

Marvin had the skeleton on show at his museum but he received a certain amount of criticism; people didn't like the nudity and they felt that it was theologically unsound. When such objections arose in this country, I could get away with explaining, for instance, that the little chaps' willies were made from cocktail sticks and only 1.6mm (1/16") in diameter and their scrota (see above) were only as big as dried peas. Over here, we don't consider this to be threatening.

The theological argument didn't arise at all in this country but Marvin had to put up with a lot of it in Detroit, where the subject is evidently studied with greater intensity. He asked me to produce a notice that he could put up on the wall next to the machine, that would satisfy those with moral objections. I sent him the one below, which seemed to hold off the criticism for a while:

•

THE LAST JUDGEMENT

It's not easy to find out the truth about The Afterlife.

All we can say with certainty is that The Wicked shall suffer forevermore and The Righteous shall be there to watch.

The rib cage

The figures you see descending here are the earthly bodies of those who chose the paths of evil in their lives.

They are going down to a place where there is no one to hear their agonised cries—no one who cares, anyway.

The rest area

Making sure that the torments run smoothly and continuously is a team of dedicated operatives, blameless individuals who are just doing their jobs and who require rest rooms and other comforts to make their off-duty hours as tolerable as possible. As an added protection, there are labour laws that prescribe their conditions of employment.

Here we see a well-stocked restaurant, with leisure facilities in which the demons can relax and unwind between shifts.

The skull

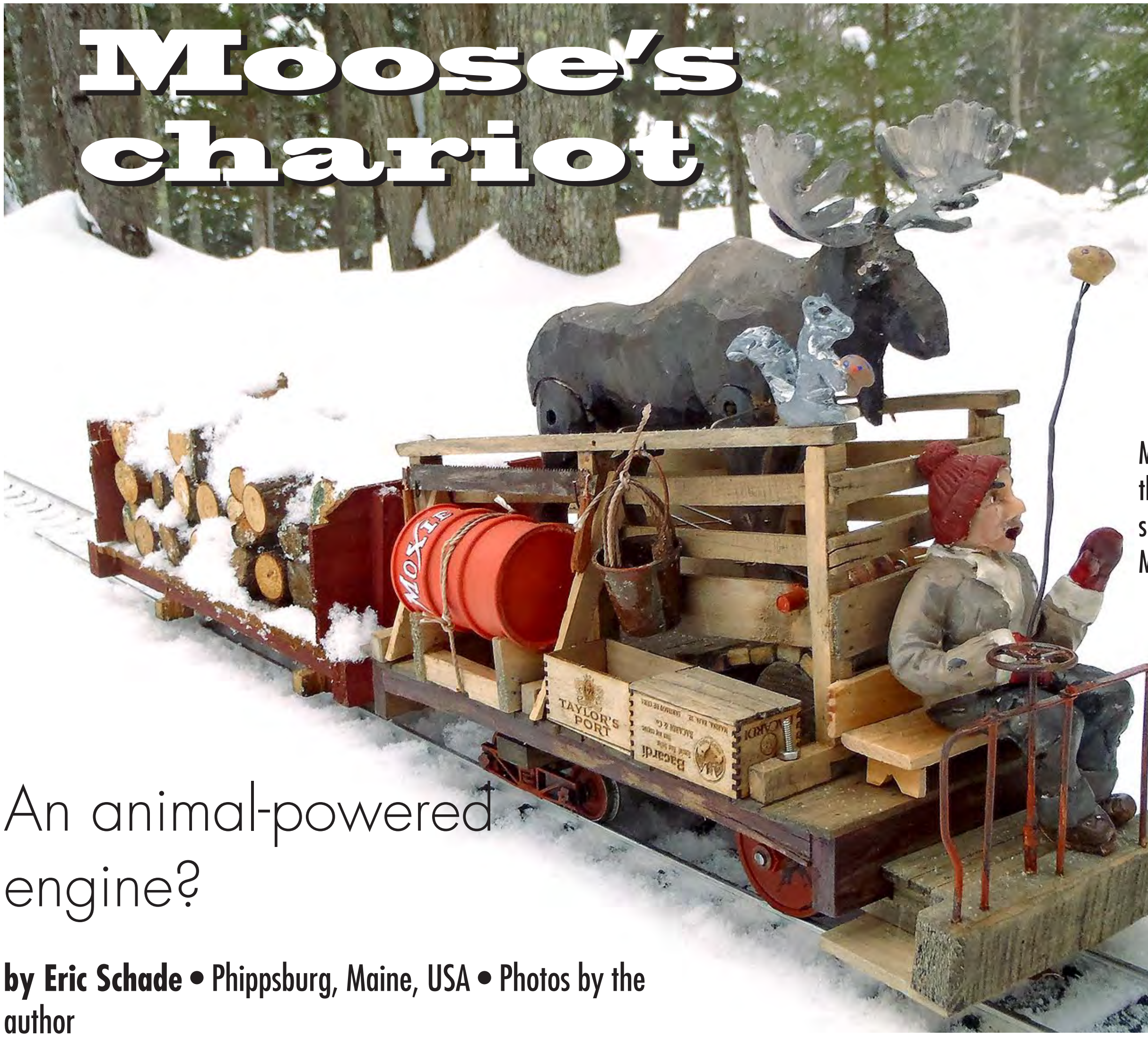
The uppermost section of this display is fitted out with pews in which The Righteous throng to celebrate their good luck. From them flows all wisdom concerning The Life Hereafter and The Wages of Sin. The management greatly appreciates their assistance in checking the veracity of this commentary.

•

Since Marvin's death, I've heard that *The Last Judgement* is no longer displayed at the Marvellous Mechanical Museum. I'm sorry about that. Perhaps if a visitor could prove a genuine scholarly interest and was not likely to sustain moral injury, they might be allowed a peek. And I hope the moral objectors don't find out about the Metropolitan Museum of Art in New York; there's some bloody awful stuff in there.

8. The author installing *The Last Judgement* at night, at Cabaret Mechanical Theatre in Covent Garden in London.

Moose's chariot



Moose's chariot rides the rails on a cold, snowy, January day in Maine.

An animal-powered engine?

by Eric Schade • Phippsburg, Maine, USA • Photos by the author

This automaton project had several varying inspirations. It all started with a "My Large Scale" online challenge. This garden-railroading forum has an annual challenge that encourages participants to try something new and creative. This particular year, the challenge was to build something based on a simple wooden flat car, the size of which was given. The amount of money one could spend was limited. The goal was to use the car as a jumping-off point for a unique creation.

I had seen photos of horse-powered treadmills that were used to power agricultural equipment. I thought that something like that might be fun. Of course, anyone can have a horse working for them. I had read a book to my boys called *If You Give a Moose a Muffin* by Laura J. Numeroff, illustrated by Felicia Bond, which stars a very smart moose who always wants more. So a moose it was! Some old timers may recall squirrel and moose cartoon stars, so my moose has a friendly squirrel helping out.

As per the Challenge instructions, I made a sketch on the back of a napkin (**photo 1**) that shows the moose on his treadmill, powering a crude railway car pulling a log car. Now you might say that the moose would be better off just pulling the log car, but the snow and ice between the rails hurt his feet, so he needed a better way. The napkin sketch was detailed just enough that I could figure out what I needed to do, but not how to do it.

I had a blown-down tree and some pine logs that I could use for material. Using my bandsaw and table saw, I could convert a rough log into useful wood for the project. This kept the price down, of course, and kept the wood from going to waste. I sawed out some strips of various

1. This project started with a pencil sketch on a napkin, watched over by a plastic moose.

2. Materials were sawn from a pine log, using a bandsaw.

3. Moose himself was freed from a piece of pine, using the bandsaw, then carved to shape with chisels and a sharp knife.

4. Legs were fitted into sockets in the body and loosely screwed into place so they could move freely. Ears are separate pieces.

5. Moose's antlers were made from bits of 2″ PVC pipe, softened with a heat gun to flatten the material, then sawn and filed to shape.

6. The antlers were then reheated to make a proper moose rack.

sizes to make the car (**photo 2**) and set aside a good chunk to be carved into the moose.

Construction

I started the project by carving a moose out of the pine (**photo 3**). Its legs had to be movable, so he could walk. I used a Forstner drill bit to cut out sockets in his body, into which would fit carved legs, held in place with little wood screws. It took a couple of tries to get the legs to look right and to have the necessary freedom of movement. The ears were separate pieces glued in; they would have been too delicate to carve from the block of pine (**photo 4**).

A proper moose needs antlers, at least if he's a he and the season is right. Real moose lose their antlers in the fall and the Challenge was in winter, but what is a boy moose without antlers anyhow? I wanted the antlers to stand up to some abuse, so carved pine was out. I had some scraps of PVC plumbing pipe that might just work. I sawed a short length of 2″ pipe in half, then heated it with a heat gun (as used to strip paint) to soften the plastic until I could flatten in out. I then sawed out antler shapes from the PVC plastic and formed them a little with a file (**photo 5**). Finally, I reheated the plastic and bent the antlers to shape. Moose seemed quite pleased with the results (**photo 6**).

The treadmill

To make the treadmill, I sawed a bunch of slats from the pine (**photo 7**), cut them to length, and drilled holes through them. I then strung them together with nylon sailmaker's thread, making a flexible walkway (**photo 8**). I tied the ends of the string together to form a loop of the wooden walkway belt.

A roller at each end of the strung-plank loop spread the walkway into a proper tread-

7. The treadmill was made of pine slats, with holes accurately drilled.

mill. I added some metal axle rods on which the rollers rotated (**photo 9**), and some gears to transfer all Moose's energy to the wheels (**photo 10**). Bits of wood were added in a workmanlike manner to flesh out the chariot body. Fencing keeps Moose onboard his chariot while it totters down the rough track. I used a wash of India ink and isopropyl alcohol to weather the wood, giving it an old-time look (**photo 11**).

I thought Moose would appreciate a nice fur coat to keep him warm in the winter air. For this, I used acrylic craft paints (**photo 12**). Rather than using just a single color, I mixed several colors with the brush as I worked. **Photo 13** shows him ready to go to work.

Making the legs work

To make Moose's legs move properly, I used some thin wire to link the legs together—right front to left rear, and left front to right rear (**photo 14**, **figure 1**)—so that the diagonally opposed legs would move together as he walks. A second wire from each set was run forward to a crank axle in front of the moose (**photo 15**). This axle was geared to the treadmill and wheels so that his legs would work as the treadmill goes around.

For power, I tried a micro-gear motor but found it too weak to propel the chariot. I ended up

8. The slats were threaded onto loops of sailmaker's thread.

9. Two rollers with metal axles were added to stretch out the treadmill.

10. Gears transmit Moose's energy from the treadmill to the wheels.

11. Details were added to give the chariot character. A fence helps keep Moose in place.

12. Moose was brush painted with acrylic craft-shop paints.

13. Moose ascends the treadmill.

14. Wire links connect opposite legs to give Moose a proper gait.

15. Motion is from a crank axle geared to the treadmill and wheels, and wired to the legs.

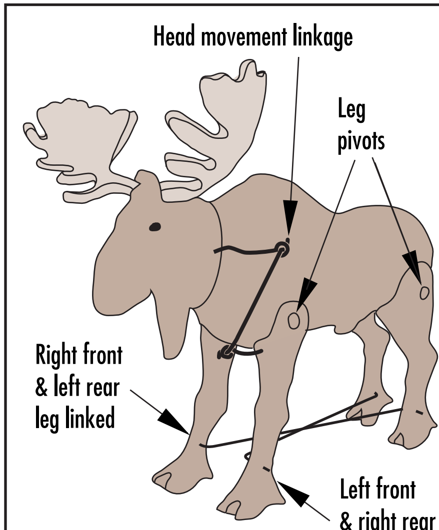


Figure 1—Linkages

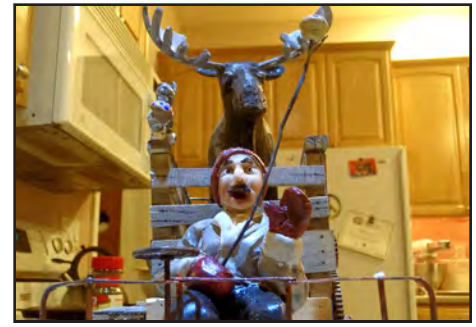
using an R/C servo that I modified to spin endlessly. To do this, I removed all of the electronics from the servo and soldered wires directly to the little motor inside. I also had to carve off the “stop” on the plastic output gear. To control the motor, I used a hand wheel in front of the human operator. I soldered a tab onto the base of the wheel’s staff that would contact a screw to make or break the electrical contact to the motor (**photo 16**). Four AA batteries hidden under the treadmill power the motor (**photo 17**).

Moose is strong but needs help managing the chariot. A driver in a wool cap keeps things running smoothly by applying the brake when going downhill. He also encourages Moose with a blueberry muffin on a stick. Squirrel keeps a stock of muffins at the ready, in case Moose actually catches one or requires more enticement to exert (**photo 18**). When things get really slow, a barrel of Moxie is available to give him the strength to do what needs doing (**photo 19**). There are also a couple of cases of the “good stuff” for the driver, too, should the need arise. The characters and muffins I sculpted from oven-bake polymer clay, then painted with acrylic craft paints. The barrel and laser-cut crates came from my junk box.

I had thought about cutting off Moose’s head (horrors!) and remounting it so that it would rock back and forth a bit as he walks. Having to write this article provided the impetus, and I took my little Japanese saw to his neck. Yep, it was as bad as it sounds, but I was able to reattach his head using a brass rod (**photo 20**). I slipped a bit of tubing over one end of the rod and peened over the end of the rod to prevent the tubing (and thus the head) from pulling out.

16. This homemade switch, operated by a brake wheel, turns the chariot on and off.

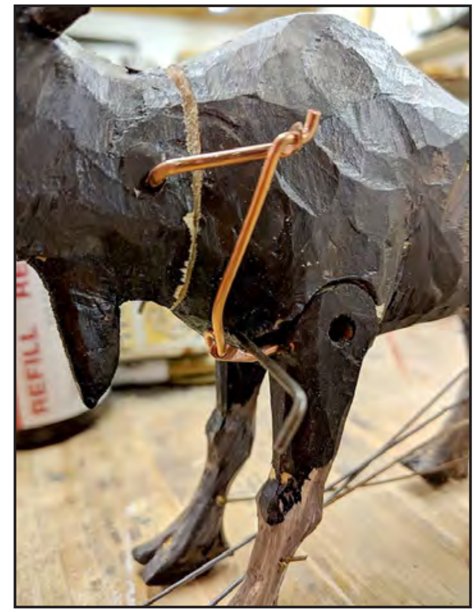
17. Power to the reworked R/C servo is supplied by four AA-cell batteries under the floor.



18. A driver, squirrel friend, and muffin encouragement were made from oven-baked Sculpey clay.

19. A drum of Moxie and some crates of wine and spirits are scale-related bits.

20. In order to make Moose’s head waggle, it had to be amputated and reattached. A brass rod nesting in a tube allows a rocking motion.



21. A linkage between the front leg and the head keep the head rocking in time.

See Moose in action here: *https://youtu.be/wuDo-aXrb5p8*

With the proper holes drilled and the rod inserted, Moose was back in fighting trim.

I decided the motion would be right if I used one leg to control the head's action. I used copper wire to make a simple linkage between his left front leg and his neck (**photo 21**, **figure 1**). When the leg reaches forward his head tilts to the right. He looks great with his head rocking as he saunters down the track. A little touch-up with some brown paint might be in order, but that is for another day.

With new batteries, Moose's chariot toddles along pretty well. Sometimes the treadmill sticks for some reason but Moose keeps trying and almost always succeeds in getting the works moving again. The crank axle and linkages give Moose's legs a pretty convincing walking motion (**photo 22**).

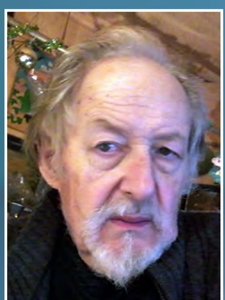
Kids of all ages get a kick out of seeing Moose ride the rails at train shows. The addition of his waggling noggin may turn more heads than just his! This project was something new for me and was fun to share online.

22. Moose's chariot turns heads when it is seen sashaying down the track.

My world of toys and automata

How an automatist came to be

by John Cervenka
Sydney, Australia
Photos by the author



John Cervenka's very first customer was the late Malcolm Forbes, who purchased a toy passenger liner. Over the years John has built many toy boats, ships, battleships, and ocean liners, always striving to create an impression of the real thing in the viewer's imagination.

This battleship represents a naïve impression of a steam man-of-war toy, just as early toys were representations of new, unfamiliar inventions—locomotives, automobiles, and planes. The ship is a working automaton. It has a rocking motion in a tinplate sea, while the gun turrets turn, the propeller turns, the soldier on watch turns, and the captain turns. Simply everything is turning, turning….

An email appeared in my inbox some time ago. I do not normally open emails from unknown senders but the title was tempting—"Automata Magazine." I couldn't resist, I being not only an enthusiastic toy collector but also an artist, making toys and working automata in tinplate. The message was to announce the creation of a new magazine dealing with the subject of automata, by its American publisher, Marc Horovitz.

This was a hit up my avenue. I consider toys and automata as objets d'art, where so much imagination and technical know-how is involved in their creation. I'm a long-time admirer of automata and their magic—those legendary, expensive toys for adults, locked away and only taken out on special occasions to entertain friends and visitors. They are, in my opinion, the ultimate in toy creations and I occasionally create my own. But let's begin at the beginning of how it all started for me.

The clown on a motorcycle and the whale, both made of metal and powered by clockwork, were two of the toys that sparked the author's interest and later led him to become a maker of tinplate automata.

My world of toys and automata

It began one day, a long time ago, but it seems like it was only yesterday when I bought my first toy. Sitting there on the ground, among other unwanted things at a trash market that we frequented on Sundays, was a beautiful tin toy—a clown on a motorcycle—which I couldn't resist. I was fascinated by this toy. The next Sunday I looked for another toy and found both a clockwork whale and a car. It is said that when you have three of something, you have a collection.

I was hooked. At weekends we attended garage sales and as many trash-and-treasure markets as we could find. The pickings were rich and, also calling on toy shops and going to auctions, I kept adding to my growing collection. This was also helped by my wife Vera, who shared my enthusiasm.

Sometimes repairs to the toys were required, but missing parts were hard to find unless one had another of the same item. There are no spare-parts shops for toys. Recycling parts, bits and pieces, and useful shapes from broken toys proved to be a good source of supply for spares, which I recommend. Do not throw anything away!

Wanting to know more about these toys, I acquired various books on the subject, discovering a world of fantastic toys of times past heretofore unknown to me; a world of highly elaborate automata and wonderfully beautiful toys; a world of toys called by collectors and experts "toys from the golden age of toys," which began in the 19th century around 1860 and ended by 1914.

I wanted those toys and automata but soon realized they were beyond my means. Then an idea struck me—could I make toys like that myself ? Easy to say, harder to do. But, after all, why not?

In my profession as a theater stage designer (scenographer), besides designing sets, costumes, and props, it is customary to make models of the sets to provide the management, directors, scenery workshops, and so forth, with a vision of the upcoming stage production. These models, special props, etc., are usually made from card, balsa wood, and anything else that is handy. So, if I could build a detailed, colored model of the scenery using these other materials, suppose I used tinplate? I should be able to make a toy in tin (correctly called tinplate)—something of my own design.

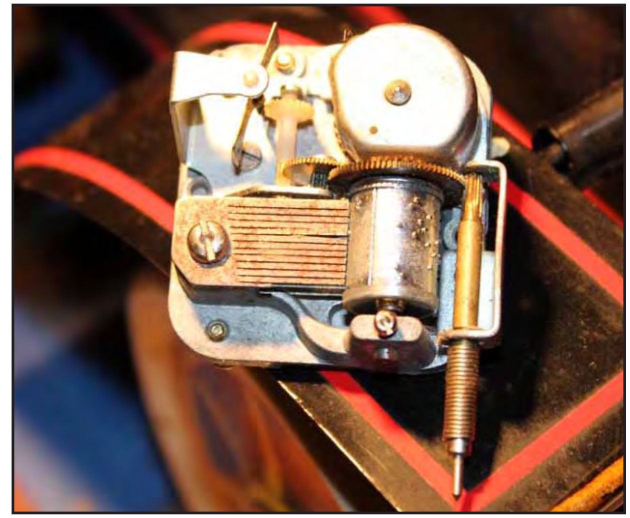
Building my own

Food cans are made from tinplate. I started rummaging for

LEFT: The author's first automaton. As the music box plays, the violinist bows and keeps time with his foot, while the dog dances below.

The face of the violinist. The author paints his automata in the same style, and using the same color palette, as toys from the Golden Age. The artistic treatment of the features brings the figure to life.

A black poodle dances at the musician's feet. The dog is attached to the same vertical shaft that controls the musician's bowing arm. The figure stands on a base made from an inverted food can.



A music-box mechanism similar to the one used in the violinist. The works are clearly visible in the photo. The power take-off shaft is at the lower right. The winder is on the side away from the camera.

empty cans—cleaning, cutting, and flattening them. Cutting the tinplate isn't difficult. Good strong scissors will do the job. That is the easy part. To make a toy or an automaton is another story. There is the designing, the making of a model, templates, and preparing the tinplate parts, besides determining the visual look, solving mechanical-movement problems, action, etc. Learning to solder well is also quite important.

Being self taught, I gradually became proficient in working with tinplate. I originally created single pieces for my wife and myself. However, seeing interest from other collectors, I also began making a few more for sale.

That's how an artist toy maker came to be. I enjoy working with tinplate. There are so many possibilities in creating wonderful toys and automata.

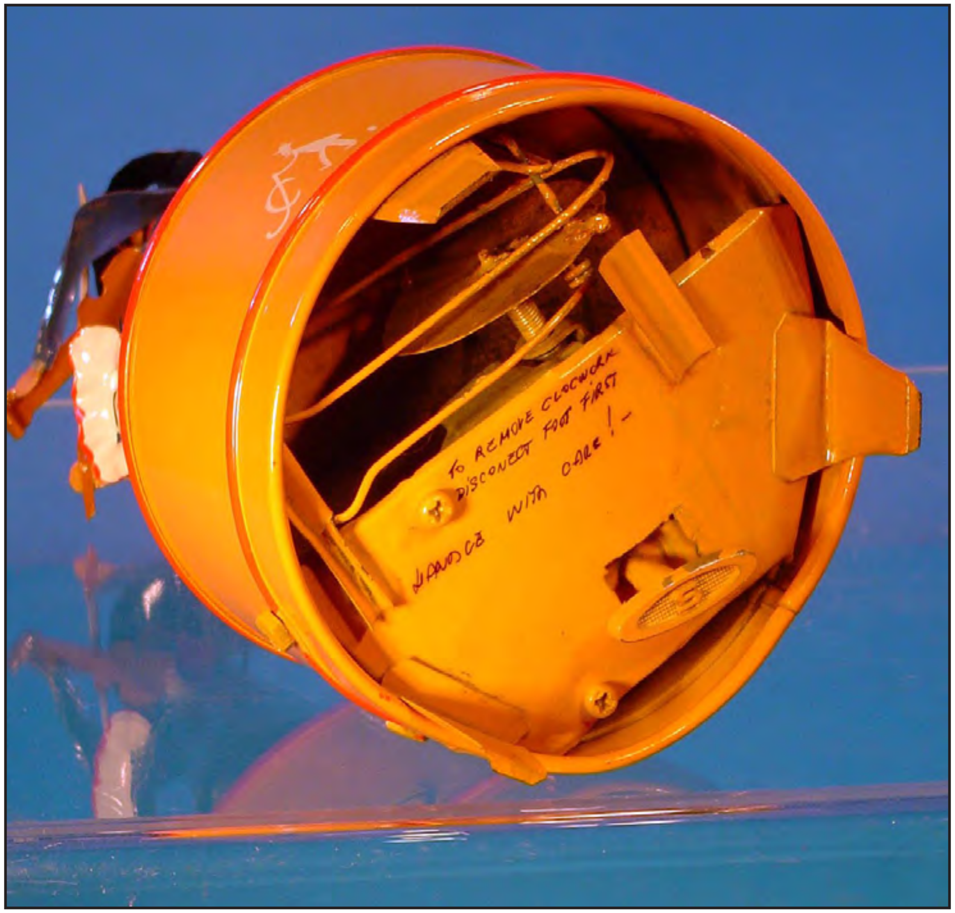
Automata

My first automaton toy was a street musician, which I made in 1984 in an edition of two. It is my design #44, sequence numbers 73, 74 (since 1980). The street musician is in an artist's attire from the belle epoque. He plays a violin and has a poodle dancing at his feet. The piece is musical, with three actions: the man plays the violin, he taps his foot to the music, and the dog dances. The automaton is powered by a wind-up cylinder music-box mechanism.

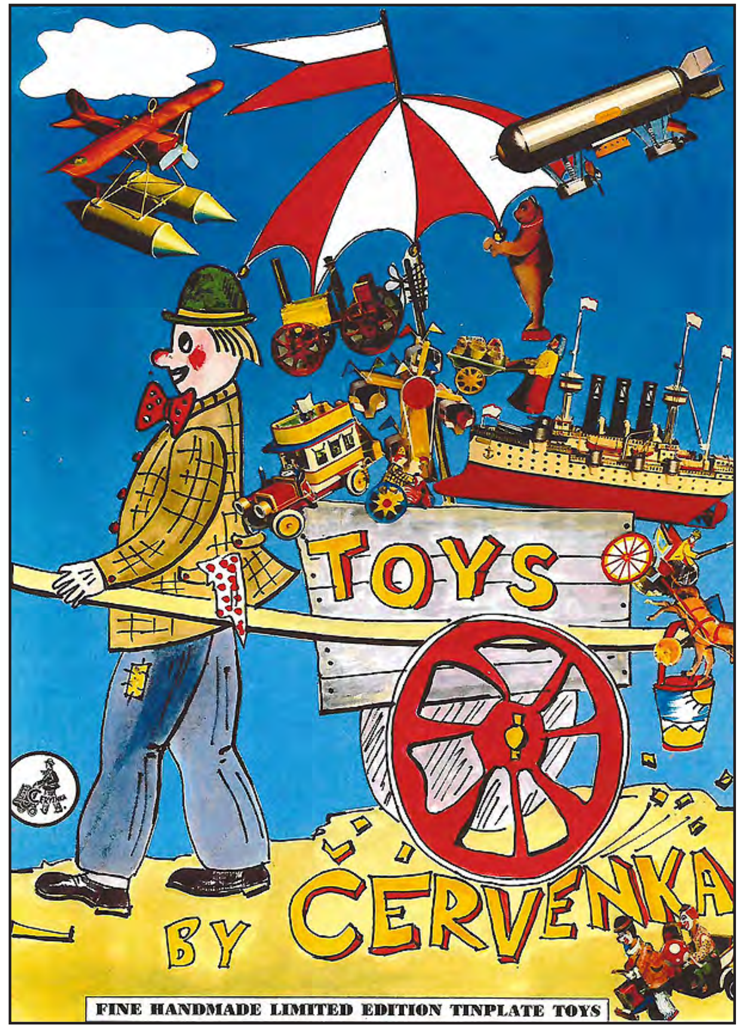
I can only attempt to describe the automaton's function. Once made, I cannot dismantle it to show its innards. Once it's done, it's done. If it goes, don't touch it—leave it alone.

How it works: A power disc is attached to the musical-cylinder axle. This disc is fitted with a pin that transmits movement to two levers and wires, one for horizontal rotating movement (violin playing, dancing dog), and the second for up-and-down motion (foot tapping in tempo).

As you can see in the photos, I used a food can, bottom-side up. The musical mechanism is attached to the underside of the can's bottom, with the winder on the lower side. Tinplate legs are soldered to the sides of the can so that the automaton stands a little off the table, while the figure is fixed to the top. In this



A view of the underside. The music box is wound from the bottom. A large disc has a peg that actuates the automaton's motion via two levers.



LEFT: A poster designed by the author to promote a gallery show of his toys and automata.

way, everything forms a self-contained unit and all of the mechanisms and levers are hidden safely from view.

I do not mind if the wires controlling the movement on the upper side are visible. That's just part of the fun. The simplicity of the action adds to the charm. The golden rule in automata design is that mechanical simplicity is always the best approach.

Of course, when bringing your dream automaton to visual and mechanical reality, there are necessarily many problems to be solved in its construction: how to blend the mechanical elements with the visual, making the actions work as planned, and finally seeing the automaton fully assembled and working. The creation of an automaton gives one immense pleasure in the achievement, before disassembling it (again) for painting and final finishing.

But wait—there's more!

- A video of the author's violinist in action can be found *here*.
- John Cervenka's website is *www.toysbycervenka.com*
- To learn more about working with tinplate, visit Tinplate Girl: *www.tinplategirl.com*

Galloping Horse

by Marek Jeczalik
Norwich, UK
Photo by the author

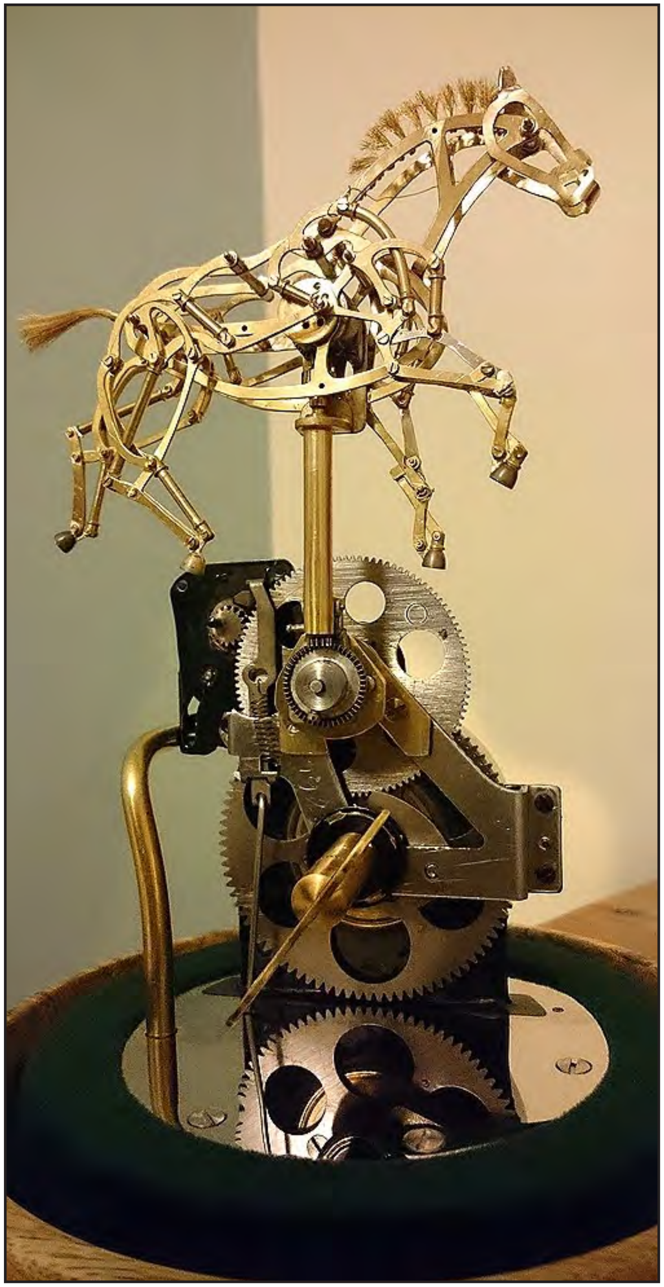
I was asked to make an equestrian-themed automaton for a surprise forthcoming 30th birthday present. I'd always wanted to make a galloping-horse automaton, so I immediately set about finding a clockwork drive I could gear down for this purpose.

The horse is made from hand-cut brass, with extremely fine gold-plated wire for the mane and tail. The whole project was finished with a glass cloche for protection.

I love to make one-off projects in my spare time, using more traditional materials, and hope they will eventually become heirlooms.

mjfineautomata@hotmail.com

Video: *https://www.youtube.com/watch?v=MmrUlAVKj7E*



Birds

by Neal Aronson • Santa Cruz, California, USA
Photos by the author

This automaton depicts two proud and anxious parents watching their toddler. The gear ratio makes the adult birds open their mouths and flap their wings more slowly than the baby, which moves about three times faster.

I tried several different methods of providing vertical motion to animate the adults, finally settling on the crank-and-lever arrangement to minimize lateral movement. The baby bird spins back and forth while hopping up and down frenetically. I glued suede on the head and wings of the adult birds as hinges and to provide contrast.

See the birds in action: *http://automatamagazine.com/videos/birds/*

Cabaret Mechanical Theatre—a history

Part 2: Covent Garden

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

JUSTIN LYCETT

Cabaret Mechanical Theatre in Covent Garden, London.

1. The foyer and entrance to CMT was dark and cavelike, with walls painted black.

2. Part of the Covent Garden exhibit. Automata are actuated by pressing the red buttons.

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RIGHT: 3. *Gambolling Dog* by Matt Smith.

Five years after opening her small Cornwall crafts shop, called simply Cabaret, Sue Jackson moved the business to London's Covent Garden, calling it Cabaret Mechanical Theatre or CMT. (See the first part of CMT's history in the Jan-Feb 2019 issue of *AM*.) The new location was in the vaults of the former fruit-and-vegetable market, and the interior was dark and cavelike (**photo 1**). Sue painted all the walls black, which worked well with the brightly lit automata.

The small retail area of the new venue opened in December 1984 and, by March 1985, the relocated permanent exhibition was ready to receive its first intrigued visitors. There were 52 motorized automata, examples of which are shown in **photos 2-6**. Cabaret Mechanical Theatre would remain in Covent Garden until 2000.

4. *Sue Jackson and Paul Spooner* by Paul Spooner.

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6. *New Guinea Proechidna* by Paul Spooner.

During CMT's first years, it became a cult destination for those in the know. It was always difficult to explain exactly what it was without seeing it firsthand.

HEINI SCHNEEBELI

5. *Sheep Shearing Man* by Ron Fuller.

At the beginning, five coin-operated machines were positioned at the entrance to entice visitors. Paul Spooner's *Last Judgement* (see page 5) was placed outside, despite some initial misgivings on the subject matter by the Covent Garden Market management team. Paul had also completed *The Dream* (**photo 7**) in 1984. This piece is based on Fuseli's painting *The Nightmare*, and is operated by bellows and compressed air. Once the coin is dropped into the slot, the bellows start pumping, the window opens, and the "night mare," or white horse, looks through the

7. *The Dream* by Paul Spooner.

window. A snake-like monster then appears from the wardrobe and the woman, who was sleeping in her bed, wakes up and looks around but the monster and the horse have disappeared. *The Dream* is still on exhibit and can currently be seen at Tim Hunkin's arcade, Novelty Automation, in London (*http://www.novelty-automation.com/*).

Tim Hunkin had written to Sue while Cabaret was still in Falmouth, suggesting that she might like to house some of his handmade machines. Sue was delighted to welcome Tim onboard. He brought along some of his existing machines, including *The Oracle*, a fortune-telling machine that delivered its answer in sand (Y, N, or ?) onto the back of your hand, and *The Barman*, which was placed inside the CMT exhibition and was operated by a coin.

The barman appeared to pour a glass of whisky. Then, after a pregnant pause, he delivered it at full pelt along the shiny bar top, which was usually a great surprise to the visitors. The glasses had to be wrapped in sticky tape, as they periodically fell off the bar and smashed. Peter Markey painted the background of the bar to complete the scene (**photo 8**). Tim went on to create more coin-operated arcade machines especially for Cabaret; those included *The Doctor* (**photo 9**), which apparently listened to your heart via a stethoscope, then wrote and dispensed a paper prescription.

ABOVE: 8. Tim Hunkin's *Barman*, inside CMT.

RIGHT: 9. Tim Hunkin's *Doctor* listens to your heart and writes an illegible prescription.

10. *Stirring Lady* by Lucy Casson.

11. *Beastie* by Michael Howard.

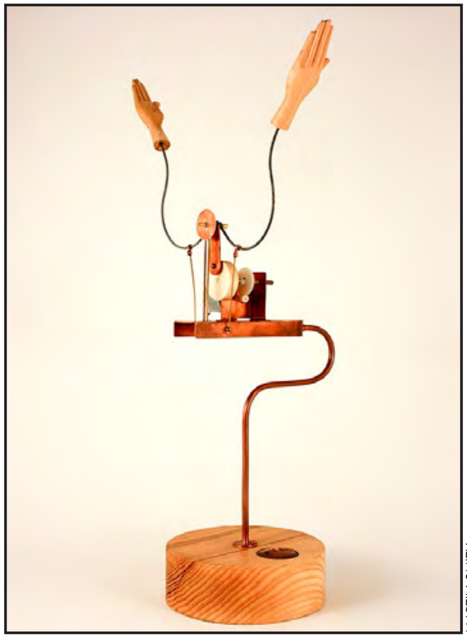
TIM HUNKIN

More artists

The move to London brought more artists and makers to CMT. Lucy Casson came in, with her clever tin-and-wire pieces in 1986, (**photo 10**). Other early contributors included Tony Mann, Jan Zalud, Michael Howard (**photo 11**), and later, Martin Smith brought in his first *Applause Machine* (**photo 12**) and other exquisite mechanical figures made from beautifully carved wood and wire.

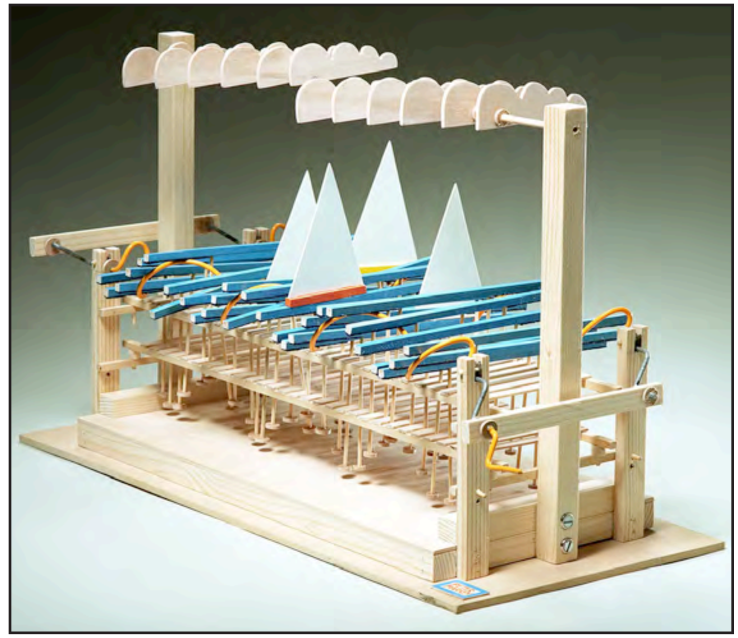
The number of automata collectors grew and the makers could barely keep up with the demand for smaller items for the shop. Peter Markey's *Wave Machine* was always popular (**photo 13**). Because of the demand for automata, The Fourteen Balls Toy Company was formed as a partnership between Matt Smith and Paul Spooner, so that larger editions of Paul's work could be built by Matt and his wife Sarah.

CMT's mail-order catalogs kept tourists in touch after they went home, and many collectors keenly awaited news of the latest designs by post. Several editions were created each year. *The Mill Girl and the Toff* (**photo 14**), designed by Paul Spooner, with an edition made by Matt Smith, was among the favorites. In this piece, a young man offers his girlfriend a diamond ring on bended knee, whilst their ancestors turn in their coffins below—one being made of fine wood with a crown, the other of a cheaper material. The caption is typically witty, with a hint of sarcasm:



MARTIN SMITH

12. Martin Smith's *Self-Applauding Machine.*



HEINI SCHNEEBELI

13. *Sailing Boats Wave Machine* by Peter Markey was part of CMT's effort to keep up with the demand from automata collectors.

HEINI SCHNEEBELI

14. *The Mill Girl and the Toff.* Design by Paul Spooner, built by the Fourteen Balls Toy Co.

STEVE TANNER

15. *Junkas Giles Agriplane* by Keith Newstead.

> "The English working class, jealous of its unique cultural identity, avoid marriages outside its own communities. English aristocrats, believing thick ankles to be a trait exclusive to working-class girls, prefer to breed from their own stock, too. Of course, neither of the above groups has anything to do with the middle class, with their Rover cars, pork-pie hats, and collections of automata."

Keith Newstead started creating automata in the early 1990s Among his first pieces was *Junkas Giles Agriplane* (**photo 15**), inspired by Rowland Emett's household machines of the 1950s. In this, a farmer sets out in a clever flying machine, which transports his livestock and dries his socks.

Keith's coin-operated machine, *The Great Chophandoff,* joined *The Last Judgement* outside. Customers were invited to put their hand inside the machine and, after stern announcements from Chophandoff (recorded on a telephone-answering machine) and much whirring, a "blade" was brought down across the visitor's wrist and fake blood spurted out from the sides. This was an instant hit.

My brother Will Jackson started creating large-scale machines after making a replica of Tim Hunkin's *Test Your Nerve* machine (or *Rabid Dog*) for our first international touring exhibition in Japan in 1993. CMT then became home to many of Will's humanoid coin-operated creations, including *Crankenstein*, which was brought to life by the turn of a handle; the *Brain Wash Machine*, where your friends could witness the inside of your head being cleaned; and *Hotline to the King* (**photo 16**), an underwater Elvis who could be reached by telephone. Will went on to create the acting robot, *RoboThespian*. He now owns and

16. *Hotline to the King* by Will Jackson

runs Engineered Arts, a successful robotics company in the UK.

Despite the popularity of the arcade machines in the foyer, there was often still a reluctance on the part of visitors to pay to go into the exhibition. Ron Fuller's *Stamping Man*, which stamped your entrance ticket, helped, as did the addition of the noisy musical nickelodeon in the museum. Sue also devised another way of solving the problem. She would arrange for staff members to put

HEINI SCHNEEBELI

17. Winners of the Designing Automata schools competition.

their coats on and pretend to be customers, saying things like, "Ooh, that looks interesting—two adults please." Hesitant visitors in the foyer area would soon buy tickets and follow them into the exhibition.

Schools and education

Some of the first visitors to the exhibition were lecturers from the nearby St. Martin's School of Art, as well as numerous school teachers, who often brought their students to CMT on school visits. The teachers were keen to learn how to teach automata making in the classroom, as it was a perfect medium for learning basics for Craft Design and Technology (CDT). Schools' curriculums changed over the years and automata making became a firm favorite in both primary and secondary schools. The demand for teaching materials led to our book *Cabaret Mechanical Movement*, various automata-making design kits, and the *How to Make Automata* video with Keith Newstead. We also developed a small touring exhibition that we sent out to educational institutions and science fairs, and launched the national Designing Automata competition for schools and colleges (**photo 17**). We realized that learning how to make automata was as popular as collecting them.

Stephen Guy arrived at Cabaret in the early 1990s. He immediately started trying out cardboard and wooden automata designs for workshops, as well as mechanical paper cutouts for the shop. Stephen continues to develop and run popular automata workshops, inspiring further generations of makers and engineers.

18. Paul Spooner's Heaven from The Ride of Life was featured on the cover of the July-August 1990 issue of *Crafts* magazine.

MAX ALEXANDER

19. Ron Fuller's Adam and Eve Bar from the Ride of Life is the only surviving relic of the ride.

Large-scale projects

CMT was involved in two exciting large-scale projects during the Covent Garden years. Unfortunately, only one saw the light of day.

The Ride of Life (1988-1990) was an ambitious project commissioned for 25,000 square feet in a new shopping center—Meadowhall in Sheffield, UK. The idea behind this was a ride, in which you would set off, relaxed in your sofa, on a wild adventure through a series of animated scenes from everyday modern life created by 15 different artists. The ride would have lasted 15 minutes, starting in Tim Hunkin's Sitting Room, traveling through Andy Hazell and Lucy Casson's Tea Room, Paul Spooner's Airplane, and many more, ending up with the rider leaving the sofa and choosing to go through Hell or Paul Spooner's Heaven (**photo 18**). The Ride was nearly completed but was canceled by Meadowhall at the last moment. Ron Fuller's Adam and Eve Bar (**photo 19**) is the only surviving scene.

For the Louis Vuitton Centennial Project (1995-1996), Paul Spooner, Matt Smith, and Will Jackson created seven life-sized mechanical mannequins that showed off new Louis Vuitton handbags designed by Monolo Blahnik, Romeo Gigli, and Vivienne Westwood, among others (**photo 20**).

The exhibition was launched at a lavish party at the banqueting house of Whitehall Palace in London early in 1996. It then continued on a worldwide tour to celebrate the centenary of the famous LV Monogram.

CMT continued to develop touring exhibitions. These included shows that traveled to Scotland, France, several venues in Japan, the Experimentarium in Copenhagen, and Technorama in Zurich, Switzerland.

In the meantime, the rent, rates, and service charges in Covent Garden continued to rise, which meant that keeping the exhibition open was a constant challenge. Keith Newstead's response to the ongoing

20. The Louis Vuitton project involved the use of seven full-size mechanical mannequins.

HEINI SCHNEEBELI

21. Keith Newstead's *The Economic Cycle*.

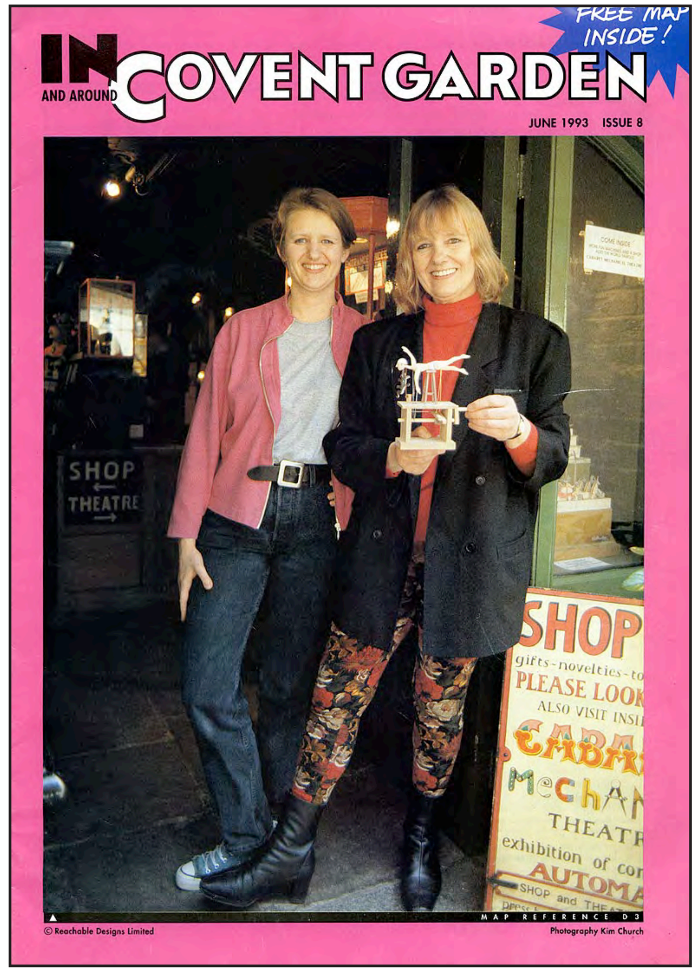
financial constraints of running a permanent exhibition in a prime London retail space was to create *The Economic Cycle* (**photo 21**) The politician and Chancellor of the Exchequer were the blind leading blind, whilst the bank manager dangled pound notes from a fishing rod, just out of reach of Sue and Keith traveling in the circus cart behind.

One of the last automata makers to arrive at CMT during the Covent Garden years was Colombian artist Carlos Zapata, who in 1998 brought some photographs of his work to show Sue. Sue fell in love with the pieces and Carlos began working in the shop in Covent Garden while creating small pieces at home in his spare time (**photo 22**).

Despite the continued popularity of CMT worldwide, visitor numbers to the Covent Garden exhibition had fallen. Toward the end of 1999 it became clear that CMT could no longer survive in London. In March 2000, Cabaret Mechanical Theatre left Covent Garden and set off for The Kursaal, Southend-on-Sea, UK. That story will be told in part 3, in the May-June issue of *Automata Magazine*. AI

HEINI SCHNEEBELI

22. Early work of Carlos Zapata.

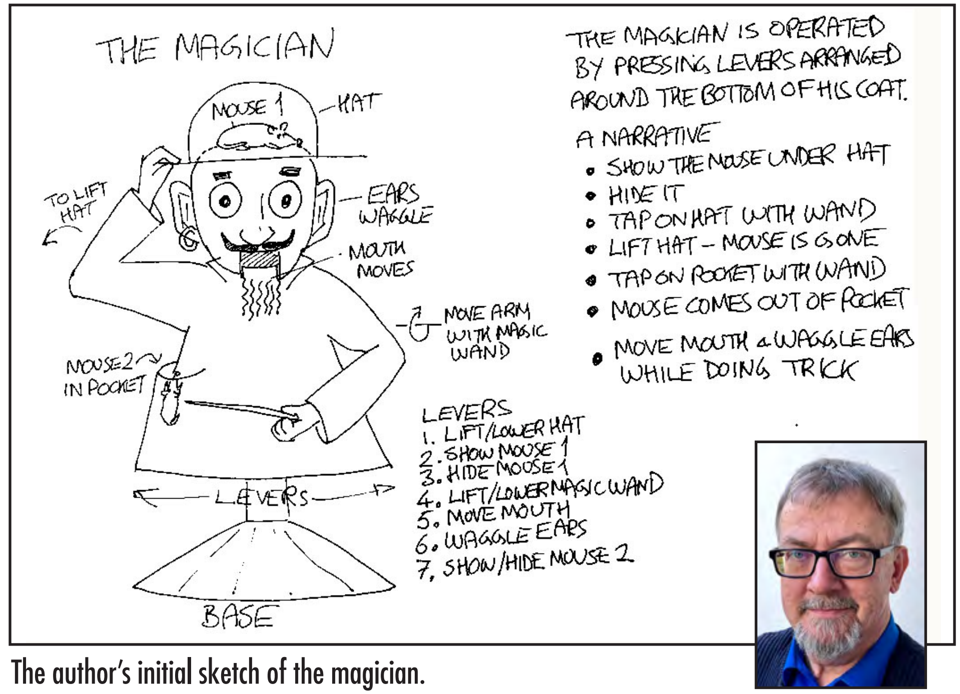


Sarah Alexander (L) and Sue Jackson on the cover of *In and Around Covent Garden*, June 1993.

Automata making in Prague

An account of the Mechanical Object Workshop

by Kim Booth
Berlin, Germany
Photos by the author except where noted



The author's initial sketch of the magician.

The Czech Republic and Prague are well known for puppetry. In the days of the Austro-Hungarian Empire, conventional theatres had to perform in German, so small traveling companies of puppeteers, who were allowed to perform in Czech, offered more than just entertainment for children. Even now, 100 years after the end of that empire, puppet shows for adults are still to be found and, from the couple that I saw, they seem to be much appreciated.

Modern Prague also has a well-regarded film-animation scene, resulting in a good supply of experts in puppet, armature, and model making. Master craftsman Miroslav Trejtnar and his team have also taught hundreds of students how to make puppets at his Puppets in Prague workshops (*http://www.puppetsinprague.eu*). When he announced a brand new Mechanical Object Workshop (November 5-11, 2018), I thought it was time to pay Prague a visit.

LEFT: The author's project, a magician, completed at home after the end of the workshop.

Preparations

To apply for a place, I sent a few details of things that I had made. Once I was accepted, Mirek asked for an idea of what sort of mechanical model I would like to build, so I sent him a drawing, with a rough outline of the movements I'd like to include. We exchanged a couple of emails and he said, yes, we can make that.

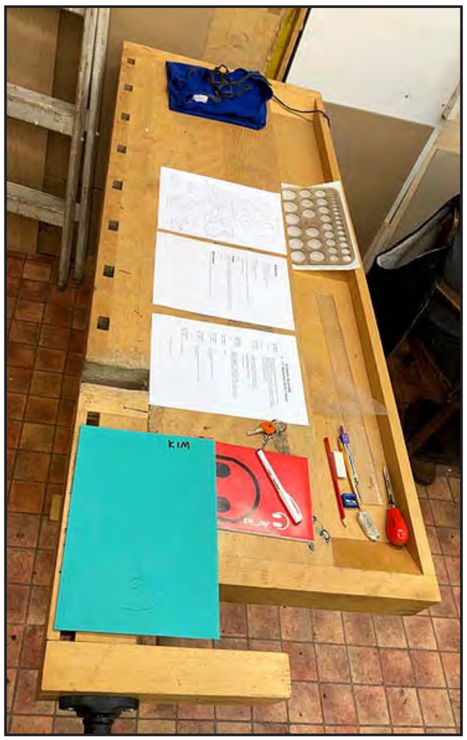
Mirek's American wife Leah Gaffen dealt with all of the organization—booked accommodation and a puppet show just before the course started, as well as an evening at the circus; sent a pocket map of Prague. She even included some tickets for Prague's public-transport system, which was great when I first arrived, confused by the unfamiliar surroundings. A schedule for the course and loads of tips about Prague were added, and we were all set.

Via the social-media page set up for the course, I was pleased to see that three of the five students were repeat offenders. That was a concrete statement about the quality of the previous workshops.

Fundamentals

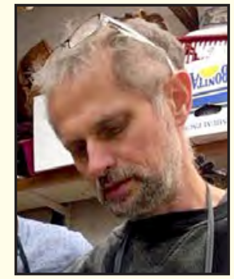
The six-day course, eight hours a day (with a day off in the middle), was basically in four parts:

- Workshop fundamentals about machines, tools, and materials
- Various mechanisms to make things move
- Maquettes to test the movements for your own project
- Building your project



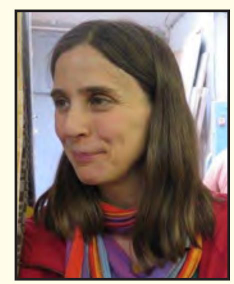
One tidy workbench for each student, ready to get started.

Some of the team



Miroslav (Mirek) Trejtnar graduated with high honors from the puppet-design department of the Prague Academy of Performing Arts. He has trained with Institut UNIMA in Charleville–Mezieres in France. In 1989 he started the KID Company, designing and producing wooden puppets, toys, and sculpture. Mirek's art has been exhibited around the world, including at several UNIMA festivals. He has designed puppets for numerous productions, including *The Baroque Opera* by the Forman Brothers. He has also produced puppets for the Jiri Trnka animated film studio in Prague. Mirek has taught hundreds of students at Puppets in Prague workshops. He has also taught for the Academy of Performing Arts in Prague, St. Martin's College of Design in London, New York University in Prague, Chapito Circus Academy in Lisbon, Portugal, and in Macao and Hong Kong.

Zdar Sorm worked for the Trnka animated-film studio at Barrandov studio in Prague for 20 years and is now a freelance puppet designer of film animation and theater, as well as a graphic- and furniture designer. He is a leading expert in the technological designs for animated films.



Leah Gaffen, an American who has lived in the Czech Republic for over 15 years, founded the Puppets in Prague workshops with Mirek Trejtnar and has worked with him as a producer for the course since then. She has also done production and translation work for the Prague Theatre Academy and numerous theater-education projects.

Types of material and their quality.

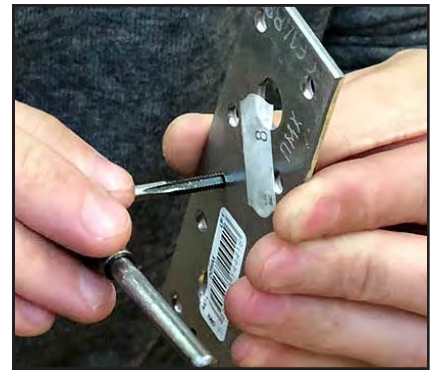
The lathe, ready to turn some wooden wheels.

How to properly use a bandsaw.

Chisels: sizes, shapes, and their care.

Using a chisel.

Basics of brazing.



Tapping a hole.

Cutting threads.

Mechanisms

There is nothing better to aid in understanding a mechanism than to pick it up, make it work, and inspect it from all angles. Mirek has a collection of mechanisms—some complete models from other artists and some basic mechanisms that he produced himself to illustrate how cams and levers can be used. These included Mirek's own push-along cyclist, one of which is now included in the collection of the prestigious Victoria & Albert Museum in London.

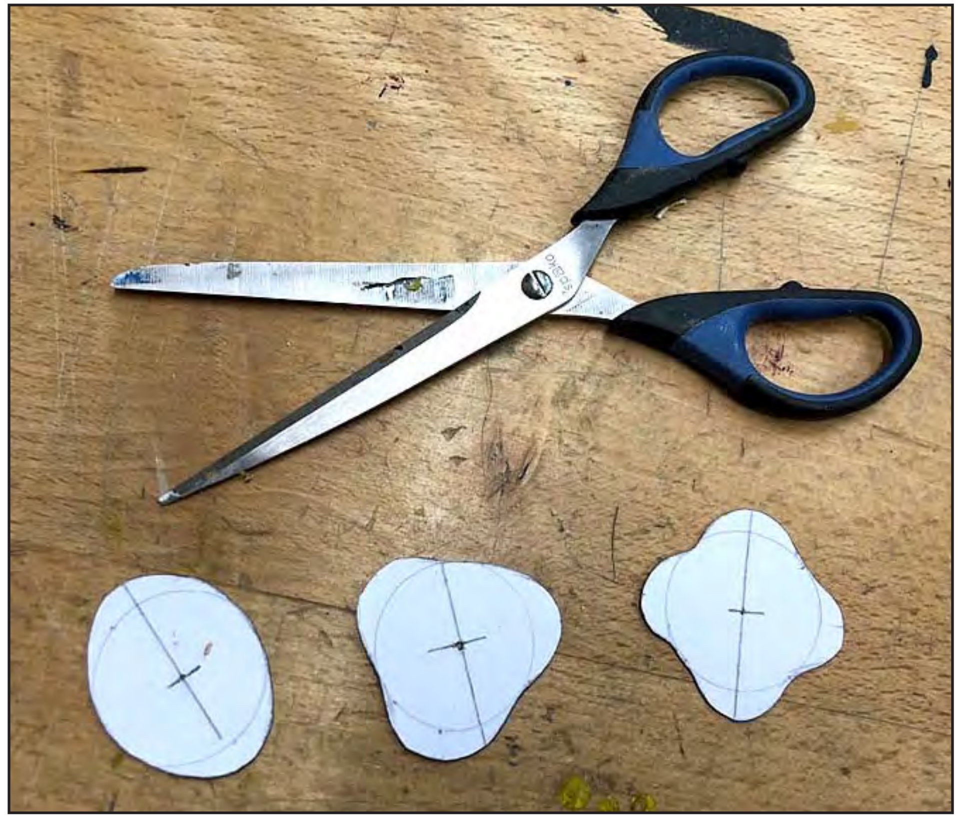
The *Horse* and the *Runner*, made by Peter Markey, use fascinating mechanisms. I spent quite a while handling them to see exactly how the movement is produced. *Man and Fly*, by Robert Race, uses a simple mechanism but is quite entertaining and shows that it doesn't have to be complicated to be successful. Mirek's own animated, carved face produces a really striking effect, just from a set of cams.

Examples for inspiration and understanding the basic mechanisms.

ABOVE: Mirek, with some small friends hanging around behind him and some online inspiration.

LEFT: Mechanisms—theory and practice.

Mirek made plenty of base kits so that we could try out the mechanisms ourselves.



Templates for three cams. Click here for a video of the three cams in action.

Making a maquette

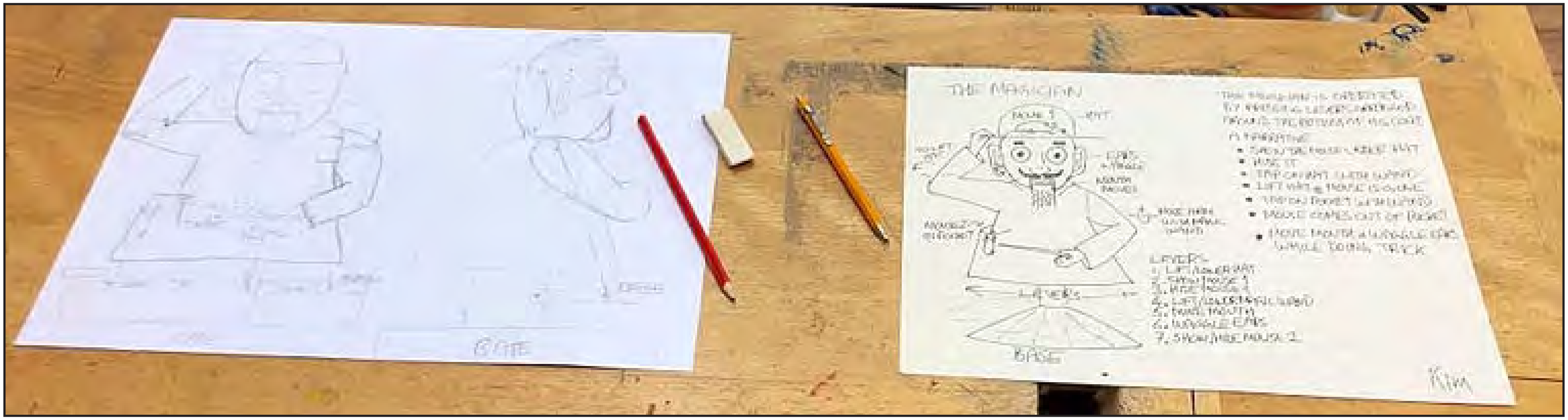
With an understanding of what mechanisms we could use in our own projects, we then moved on to trying out our ideas on a sort of working model or maquette. This meant drawing our ideas with enough detail that we could see how the working parts move together, which bits are hinged, or which parts sit on an axle or rest on a cam.

This is a fascinating intermediate stage of the process, which shows whether your great idea can work or not.

From this point on there was a flurry of activity, as Mirek, Zdar, and the team took our more-detailed drawings and conjured up just enough of a starting point for us to work on the movements. In my case, this meant a strange centimeter-wide outline of my magician figure standing on a box with seven levers, ready to do whatever I planned for the finished object.

Once I had screwed together the parts that Zdar made for me, I could start the process of adding movement. This first meant creating a full-size pencil drawing of something that moved, like one of my magician's arms. When I was satisfied with that, I cut out the cardstock arm and tried it on the maquette, to see if it worked. Is it the right size? Does it hinge in the right place?

With a sharp pair of scissors, this took no time at all, and a second or third attempt allowed me to get it just right. When I was happy with the paper version, I traced around it onto a piece of plywood and cut it out on the bandsaw.



A "technical" drawing of the project.

LEFT: The basic magician maquette, with seven levers and a simple outline of the figure.

ABOVE: Cut-out parts in card. If they were okay, they were then cut in plywood.

RIGHT: With its seven movements, the maquette is finished enough to get ready for the real thing.

Making the real thing

Having proved the principles on the maquette, I was now ready to start on the real thing. To make the most of the time available, I dismantled the maquette so that we could use the pieces as rough templates. It didn't take too long for the real craftsmen to cut limewood pieces roughly to shape, which I could then carve and prepare for assembly.

My magician also needed a hat. It was again wonderful to see how experienced model makers go about that. Once we had decided that it didn't need to be made of wood (I mean, who wears a wooden hat?), two layers of felt were soaked in diluted wood glue, then clamped into an improvised hat mold. After letting it dry over night, I used a flat iron to smooth the brim, then trimmed it to shape with a pair of scissors. I added a bit of wire reinforcement where the hand holds it, and ta-raaa…a hat!

Cutting the left arm on the bandsaw from the maquette.

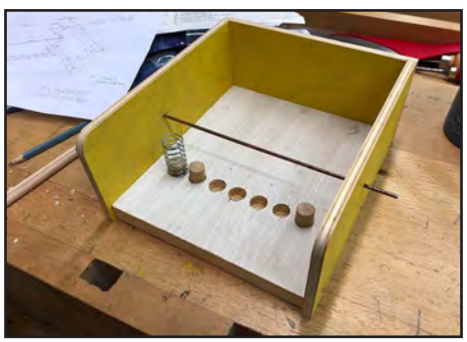
The left arm, as finished on the bandsaw.

Same treatment for the right arm.

The head's a bit more complicated….

The head after carving.

Zdar making a hat from two layers of felt soaked in glue.



A new base of the right size, with holes in the right places.

New levers made from nice wood.

The hat, removed from its mold and the rim ironed flat.

The glued-together, blocked-up body, which dried overnight, being trimmed roughly to shape.

The head has been joined to the body.

The magician's jaw has been added to the head.

The assembled base has been painted.

The head has been screwed to the body, which has been screwed to the base, and the mechanisms are starting to be fitted. Here, Zdar holds the author's automaton in its nearly complete state at the end of the course. The piece was finished by the author after returning home.

How did I like the course?

Although there wasn't enough time to completely finish him, my magician was finished enough, and I was confident of being able to complete him at home. I snaffled a few pieces of welding rod and some fishing line and set off for home, quite astonished at what we had achieved in one week. Once the magician was set up on my desk at home, I was quite proud of him!

The other participants in the course came from a diverse range of backgrounds and all were quite supportive. The atmosphere in the workshop was a happy and positive experience. The course was held in English, and sometimes some of the tutors struggled a bit to find just the right words. That didn't actually matter, as actions speak so much louder than words, and we all communicated just fine.

I also enjoyed seeing machines and tools, which I don't have at home, in action. More or less the first thing that I did on returning home was to order a set of chisels and a few other bits and pieces that I had found particularly useful, in order to maintain my momentum and enthusiasm. The deliberate process of making a maquette to quickly test out ideas really impressed me. In my days as a working engineer I would have called that "fast prototyping." Seeing it used for mechanical models was a surprise for me, although it shouldn't have been. That's why you go on courses, I suppose.

The accommodation was reasonably priced and close by. The local high street was full of places to grab a bite of lunch. Leah organized an amazing cultural program, which, for me, included a puppet show, a music show, a modern circus, a trip to see the biggest mechanical nativity scene on the planet, and a very special visit to see one of Mirek's old tutors. Fortunately, I arrived in Prague a little early and had a chance to do some conventional sightseeing in advance of the course.

All in all I had a great time, learned a lot, and now I understand why three out of the five students had returned to Puppets in Prague, having attended a previous course.

This Turk plays noughts and crosses

A new twist on an old automaton

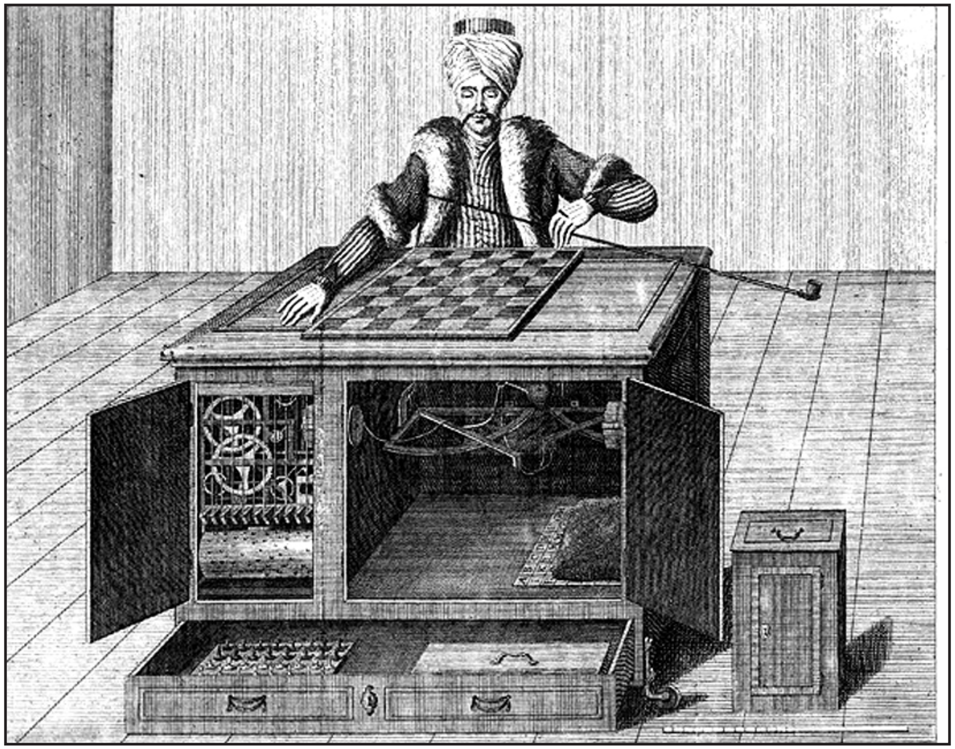
by Martin Edwards • London, UK
Photos by the author

In the spring of 1770, Austrian Empress Maria Theresa witnessed a new sensation. Before the empress and her astonished court, Wolfgang von Kempelen, a Hungarian nobleman, unveiled a life-size wooden mannequin dressed as an ancient Turkish magician. He was seated behind a cabinet that bore a chessboard. One side of the cabinet was occupied by clockwork machinery, including a music-box-type pin cylinder. The other was hidden by doors, which von Kempelen opened to demonstrate that the space behind was empty, save for a few brass discs and wires (**photo 1**).

The author's game-playing Turk is based on a legendary automaton from the 18th century.

Responding to von Kempelen's call for a volunteer, one Count von Cobenzl stepped forward and moved a chess piece to begin the game. To gasps from the audience, the contraption whirred into life, the Turk moved its eyes and head to survey the board, reached for a piece, and made his move. The Turk proved to be a strong player and quickly demolished his opponent.

Known as *The Chess-Playing Turk*, *The Mechanical Turk*, or simply *The Turk*, the machine became a sensation, traveling across Europe and America, challenging—and usually defeating—the strongest players. Hundreds of articles and pamphlets suggested how it might work; speculation ranged from a trained monkey or a Prussian



1. This old engraving illustrates the famous *Chess-Playing Turk*, originally shown in 1770 by Wolfgang von Kempelen.

2. The author's Turk plays noughts and crosses (tic-tac-toe). Playing pieces are bits of curtain rod with brass X's or O's glued on top. The board is a picture frame with a plywood insert, trimmed in brass.

cavalry officer who had lost his legs in combat concealed inside the cabinet, to von Kempelen influencing the machine himself with magnets or invisible wires. Others considered that the machine was, indeed, autonomously playing chess, a concept that apparently inspired the mathematician, inventor, and computer pioneer Charles Babbage to consider the possibilities of thinking machines.

The Turk met its end in 1854 when the Philadelphia museum in which it then resided caught fire. One of its syndicate of owners rushed into the burning building in an attempt to rescue the machine but was driven back by the flames. A later modification had given *The Turk* the ability to croak "Echec" (check) when it placed its opponent in check, and the failed rescuer, Dr. Silas Weir Mitchell, claimed that he had heard the Turk pathetically wheeze "Echec! Echec!" as if calling for help as it succumbed to the fire. Mitchell subsequently published a couple of articles explaining the secret of the chess-playing Turk's operation; it was a conjuring trick that involved a false drawer, a sliding seat, and sliding machinery that enabled the cabinet—contrary to appearances—to conceal a full-size operator.

The modern Turk

The story of von Kempelen's creation is probably familiar to most readers of this magazine, and there have been numerous replicas, homages, and references to *The Turk* in the work of modern automaton builders, but I couldn't resist building another! I wanted my machine to play a real game, but chess—quite apart from the challenge to my mechanical and programming skills—would take far too long to play. What if von Kempelen had built a prototype, though—a noughts-and-crosses (tic-tac-toe) playing Turk? Well, he didn't, but we can imagine… (**photo 2**).

Spoiler alert: if you haven't watched the video (*https://youtu.be/4mVtcGDpuy8*), you might like to do so, as I am about to describe the operation of my noughts-and-crosses Turk, and there's a reveal that I am about to ruin!

The human player triggers the game by placing an O counter (human plays O, Turk plays X) on the empty board. The mechanism starts to rotate and clank, the Turk raises his head, moves his eyes from side to side, looks at the board, then at his playing piece. He then reaches for a piece with his right hand, picks it up, and places it in position on the board.

As the game continues, the Turk's movement is interrupted on his second move by a sneeze (on one occasion, a player challenging the original Turk did claim to have heard a sneeze from inside the cabinet, something of a potential giveaway) and, on the third move, by a clang and a "malfunction," when the cabinet doors fly open to reveal a diminutive operator watching the action through a periscope, and turning a handle to operate the machinery. This operator stops, turns his head to look at the human player, takes a couple of drags on his cigarette, then continues. On the final turn, during the Turk's move, the machine stops with a clanking, grinding sound. The little operator shakes his head, then kicks the control panel with a resounding series of clangs, which eventually frees the mechanism and play resumes.

Design considerations

Readers will be familiar with the design constraints imposed by using what's cheap/lying around in the garage/dumped

3. The impressive-looking mechanical works do absolutely nothing.

on the street outside. My cabinet appeared on the pavement outside my house—tatty, crudely painted, missing its doors, unloved, and abandoned. It's smaller than the original Turk's cabinet but well proportioned, and it responded well to a few sessions with paint stripper, wood stain, and varnish.

4. A commercial mannequin head became the Turk's noggin.

I added a vertical divider, a drawer, and a pair of doors for the right-hand section (see the **lead photo**).

Like von Kempelen's original, my brass moving mechanics are purely for show and don't actually do anything at all. A music-box cylinder was a must. This I made from a sheet of 0.3mm-thick brass and used 3mm brass bolts for the pins (**photo 3**). The rotation is driven by a continuous-rotation servo concealed inside the cylinder. Yes, the entire construction is electronic and electromechanical; von Kempelen would weep.

If you're unfamiliar with continuous-rotation servos, they're an easy way of controlling the rotation of a small, geared motor. Like a conventional digital R/C (radio control) servo, they're controlled by timed pulses, in this case from an Arduino processor board. The servo will rotate forward or backward with variable speed, or stop, depending on the pulse width. Additional continuous-rotation servos drive gears and wheels behind the cylinder. Some spectators have commented that the mechanism is noisy; of course it is—that's deliberate! The original Turk must have sounded like a box of nails falling down stairs!

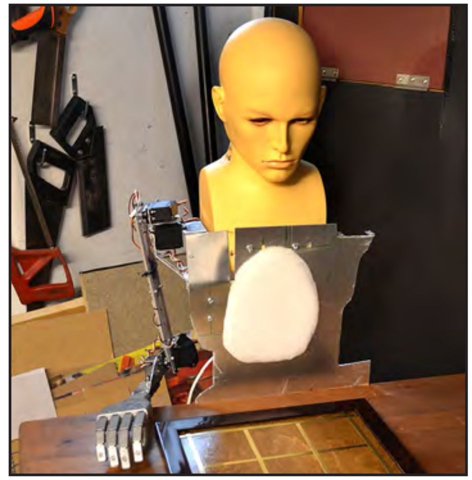
The Turk

I am no sculptor and, although I have cheerfully attempted rather crude papier-mache heads for creations in the past, I wanted my Turk to look as handsome and inscrutable as the original. To this end, I bought a mannequin head (**photo 4**) from the ever-reliable (well, usually) eBay. It's a bald, plastic head intended for modeling hats and scarves in a shop, and its rather effeminate features have led some spectasome spectators to insist that my Turk is a woman. He isn't, and the addition of a long party mustache does help provide some masculine credibility (**photo 5**).

Unfortunately, his head was filled with expanded polystyrene, which took half a day to chisel out. I cut out his eyes and mounted eyeballs on miniature servos inside. (It's possible to buy spookily realistic dolls' eyeballs. It took me a while to find just the right color, so I now have a fine, if macabre, collection.) I sawed through the neck, just below the jaw, and attached the head section to a vertically-mounted servo so that he could nod forward and back. Then I mounted this whole assembly on another servo, horizontally mounted, to provide rotation.

The Turk's body is rather basic. It's made from sheet aluminium and plastic, bolted onto the cabinet (**photo 6**). The fancy-dress costume I used to clothe him just about manages to disguise this. His arms are made from lengths of Perspex (Plexiglas) covered by flexible plastic tubing to give them shape (**photo 7**). Again, the costume covers a multitude of sins here. Only his right arm moves, thanks to three servos—

5. Fully dressed and moustached, the Turk looks omniscient and inscrutable.



6. The "body" is little more than an aluminum plate and a mechanical arm.

7. Flexible wire-reinforced plastic tubing gives the Turk's arm shape and form.

8. Shoulder and elbow servos provide motion. The second elbow servo works the hand.

two in his shoulder for up/down movement and rotation, the other in his elbow (**photo 8**).

I did experiment with making a functioning hand to grasp the playing pieces. This was a design aspect that apparently also caused von Kempelen some difficulty. I decided it was easier to cut my losses and use a child's toy—a plastic robot hand (**photo 9**). Squeezing the handle on the toy pulls a wire that closes the fingers. It was a straightforward procedure to cut away the hand section, mount it to the end of the forearm, and arrange another servo at the elbow to pull the wire and close the fingers. This is why the Turk uses his right hand (von Kempelen's played with his left)—it appears they only make right-handed robot-hand toys!

The robot hand, covered by a glove, also dictated the size of the playing pieces. These I cut from sections of curtain pole and glued a brass X or O to the top of each. The playing board I made from a picture frame, a stained-and-varnished piece of ply, and four strips of thin brass, which look good and are quite cheap, as they are sold as off-cuts (**photo 2**).

Nine reed switches glued onto the underside of the board, one under each small square, act as sensors. The reed will switch when the human player places a piece, as these have magnets set into their bases. This is actually similar to von Kempelen's system. Magnets in his chess pieces triggered the movement of flags underneath the board, allowing the hidden player to see which square a piece had moved from and to, and to replicate this on his own board.

The cabinet doors I made from interior grade tongue-and-groove timber. The doors are mounted on servos that enable them to fly open when the mechanism "malfunctions." For the little chap underneath, I searched for a realistic doll of the right size, and up popped just the thing on eBay—a secondhand Mr. Bean doll. I built a new skeleton from aluminium, mounted his head and left arm on servos, and dressed him in his original clothes. Nothing could go wrong, until it transpired that children all immediately shrieked "Mr. Bean!!" as soon as the reveal happened. I had no idea Mr. Bean's recognition factor was so high amongst under-twelves—Rowan Atkinson should be proud. Hence, the little chap's woolly hat (a baby's knitted cap), which effectively disguises him. His cigarette is an e-cigarette with the nicotine nonsense removed and the LED at the tip wired to the Arduino so that it appears to glow when he draws on it.

9. A plastic, toy, robotic hand grasps the game pieces. It is disguised with a glove.

10. The "secret" behind the action. A repurposed Mr. Bean doll keeps the show running.

11. An inexpensive Arduino, along with the author's programming, provides the brains behind the Turk's motions. All wiring and electromechanical devices are concealed.

The electronics

A single Arduino mega-microprocessor board handles all of the control (**photo 11**), with a piggybacked sound card providing sound effects, which include the sneeze during the second turn and the clangs when the mechanism "malfunctions" or the little operator mannequin kicks his control panel. I programmed the logic for playing noughts-and-crosses myself, reasoning that it's a simple and logical game—how hard could it be to devise an effective algorithm?

This turned out to be hubris, when I confidently offered a young challenger a thousand pounds if he could beat the Turk when it was nearing completion. He immediately did. A stern talking-to for my Turk and a couple of lines of code to anticipate the corner trap, rendered the Turk (I think) invulnerable. To my shame, though, I didn't cough up but merely offered the challenger double or quits. He hasn't taken up the offer yet.

Automata in the Classroom

9th graders learn mechanics

by Colleen McGuire • Berlin, Maryland, USA • Photos by the author

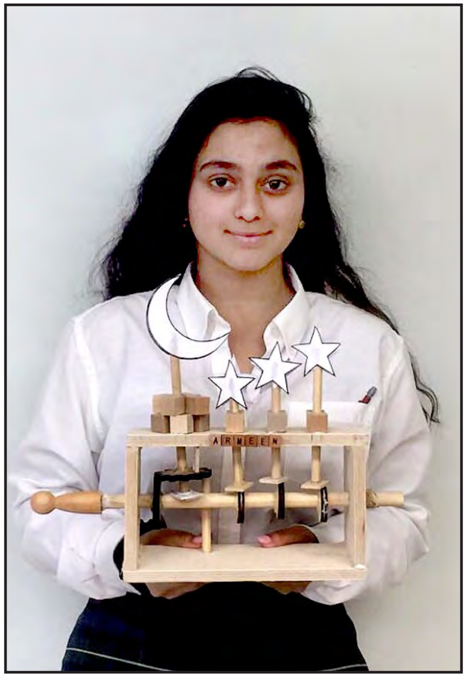
The author put together a sample project with which the kids (ages 14-15) could interact before making their own automata in this innovative class.

I told them they needed to use tools—maybe even power tools. Some nodded in glee; some mumbled, "Please don't make me use tools." Others were still stuck on, "What the heck *is* an automaton?" It may have been a shock to their systems, but my 9th-grade physical science classes have risen to the challenge of building automata.

Please bear in mind that I've only learned to "tinker" myself within the past few years. I have degrees in chemistry and English, and have been teaching chemistry and physical science for 20+ years at Worcester Preparatory School in Berlin, Maryland. In the last few years, I've begun teaching a computer-science programming class and have been using Arduinos and Raspberry Pi's to build robots and other devices. Over the same time period, I started to play in the workshop at home, where my husband had left a table saw, a miter saw, and a drill press to gather dust. Between starting to use small microprocessors and robotics in class, and messing with small woodworking projects on my own, I became enamored of the idea of allowing the kids to experience the same joys and frustrations I was having in these new pursuits.

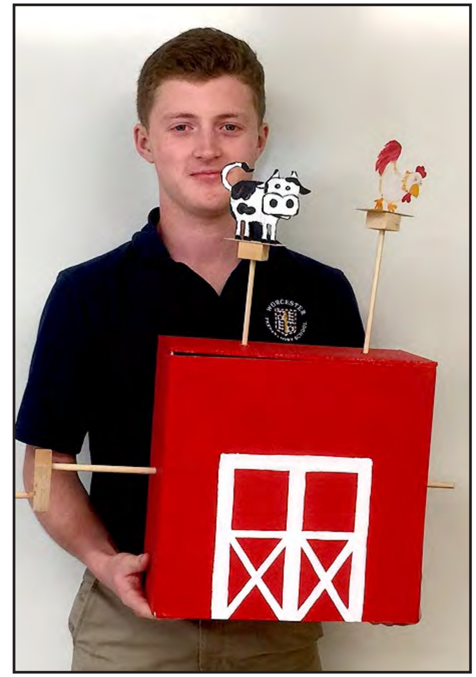
Background

I've always taught a unit on simple machines and mechanisms, as part of the physical-science curriculum. We love to do hands-on projects, and kids have built mousetrap cars and Rube Goldberg machines in the past. For the last two years, however, I have let the kids get a little more creative and try to build their own automata. The rules specified that there had to be at least three mechanisms



Armeen learned about the challenges of getting all the cams drilled and the followers lined up on her automaton.

Ava and Meredith couldn't let pass the opportunity to add bling!



Graham had fun laser cutting some of his barnyard characters.

and two objects needed to have different types of motion (up-down vs. rotation vs. sliding, etc.).

Because my students have little mechanical experience, I first had groups work with cardstock with pre-printed parts to build simple mechanisms to see how they worked. We also watched some fun examples on YouTube, and I showed them a few samples of my own. Afterward, I had each student draw up a plan for his/her own device and include a parts list.

Although recycled materials such as cardboard and cartons would work, I wanted the students to get a little shop experience, so they scrounged around for recycled wood or old toy parts from which to construct their projects. I'm fortunate to now run a small makerspace in our school, and we have a small laser cutter and CNC machine. These come in handy when trying to build cams and gears as needed. I try to have a selection of precut cams and gears available for the kids to use, and they typically build around these, which help to determine the size of their devices. It might be worth mentioning that local makerspaces are always looking for community-outreach opportunities and would probably be happy to help make some of these preshaped pieces, if asked.

The experience

When we finally settled down to work, it may have looked like chaos in my classroom, but students were earnest in their efforts and honest about their frustrations. My classes typically have 16 to 20 students. Because I have a limited number of tools and I required a majority of the


Waverly made a "tea-rrific" automaton, with a spinning cup and pouring teapot.


Chipper decided to add 3D-printed parts to his automaton.


Hanna incorporated sound and light in her detailed backyard scene.


Joseph found that LEGO gears worked well.

project to be done in the classroom (so that I could be sure it was hands-on for the student, not the parent), there was usually wait time, as students vied for access to the drills or laser cutter. This was not always a bad thing, I found, since it caused students to stop and watch what their classmates were doing, and they could learn from the mistakes of others.

The most popular tool by far has been the drill. Most students have not used any type of power tool so this is always exciting. They learn the difference between forward and reverse on the drill—literally *everyone* makes this mistake at least once. They also learn the importance of clamping a workpiece in place, especially if it's a small cam they are drilling! Additionally, they learn that a waste board, or spoil board, is a good thing to put under their work so that we don't drill holes into the bench tops! (Um…I do have a few new holes in the workbenches—oops!)

The designs the students selected for their automata were often similar to images found on the internet, like the barking dog or the cat and mouse. However, it's always fun to see some of their original thoughts, like the golfer and the dog or a Christmas scene in April.

As the final activity in the assignment, students had to show and explain their mechanisms and talk about the struggles they encountered and overcame while creating them. All the automata were then placed on display in the dining hall for the younger students to interact with, under the supervision of my 9th graders. After this, the pieces were on a one-month display in the school library.

For this year's classes, I'd like to build a set of demo mechanisms that can be disassembled

Carly, Caroline, and Maddy definitely "rocked the boat."

and explored by the students. The paper models were a bit tedious and small to really illustrate the concepts to them. I like the idea of disassembly so that the kids can get a better sense of the order of operations when building their devices. For example, let's not glue the cam in place on the axle, build the box, and then try to put them together! This will also allow the kids to select the right mechanism for their designs and vision.

The outcome

The students were all intimidated, frustrated, and disappointed at times, throughout the project. Some were disappointed with their results but assured us that, with more time, they could have fixed their machines. Most were pleasantly surprised at their success and how cool it is to make something that "works." I think they were impressed with their projects and proud of what they had accomplished.

Lessons learned

In no particular order, these are some of the lessons learned by the kids while building their automata. We discuss the concepts at the outset, but they have to be lived to be appreciated.

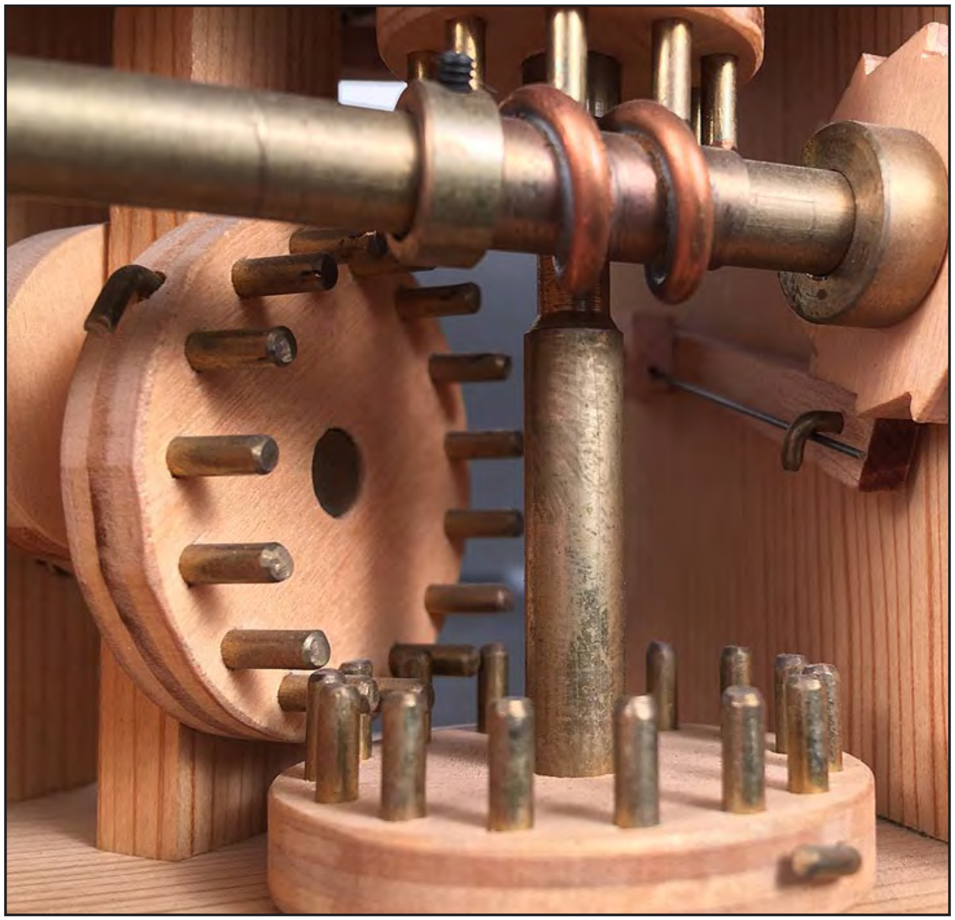
- Drills work better when set on "forward."
- Driver bits are not the same as drill bits.
- Goggles count.
- The bandsaw is teacher territory unless you are anointed by the teacher for its use.
- Spoil boards are important.
- Clamping your work is necessary, especially for drilling small cams.
- Gorilla glue is the devil—hot glue is an angel.
- Wood glue requires clamps.
- Short push rods are better than long ones.
- Friction is both your friend and your enemy.
- Energy is conserved but not always in the way you expect.
- Small wood blocks are handy when attaching two thin surfaces at right angles.
- The artwork matters but not as much as the functioning parts.
- Wait your turn; offer and accept help.
- 3D printing is slow but Thingiverse has tons of stuff ready to print.
- Laser cutting is fun but it's better when you know how to use Adobe Illustrator.
- Mistakes will be made…make time to adjust and modify.
- Measure, measure, measure.
- Documenting your work is not nearly as much fun as creating it but, when you get selected as a highlighted "Instructable," it can be awesome!

I'm so glad to have the resources and the support to be able to bring these lessons and experiences to my students. I don't know how many of them will be inspired to continue learning about mechanical things but at least we have demystified and gained an appreciation for all the great engineering we experience in our everyday lives.

MAKING PINWHEEL GEARS

Different methods for successful gearing: part 2

by Marc Horovitz • Denver, Colorado, USA • Photos by the author



With some tooling that you can make yourself, pinwheel gears can be fabricated both quickly and accurately.

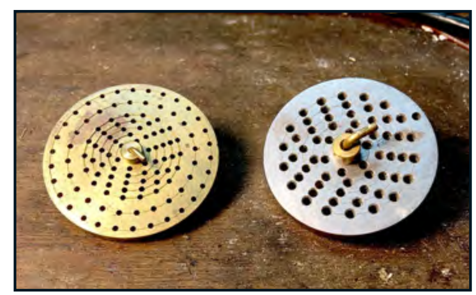
In the first part of this series, I discussed how to make pinwheel gears of wood. In this part I'll talk about using metal pins and a way to make the gears relatively quickly.

Wooden gears, while perfectly functional, must necessarily be made of larger components due to the relative weakness of wood when compared to metal, either steel or brass. Metal pins offer a couple of advantages. Because they are stronger, the gears can be made to smaller pitches, which means they'll take up less space. Often, the whole mechanism can be scaled down somewhat. Also, in my experience, gears with metal pins tend to work more smoothly.

Planning gears with metal pins follows the same procedure as outlined in part 1 for planning wooden-pin gears. The smaller the pin, though, the more accuracy in construction is required. I use a gear pitch of $1/4$" (6mm) or $3/16$" (4.8mm) in my automata, with $3/32$" (2.4mm) or $1/16$" (1.6mm) pins, respectively. Both look good (to my eye) but if I want more strength, I'll use the larger combination.

The tool

Since I expected to be making automata for the foreseeable future, I wanted to find a way that would speed up wheel production. What I came up with were the tools seen in **photo 21**. These look like dividing plates and, indeed, they function in a similar manner. The brass plate



21. Tools like these can make drilling holes in pinwheels painless, quick, and accurate.

(on the left in the photo) is for the 1⁄16" pins, while the steel one is for 3⁄32" pins. The brass one will yield wheels with 6, 9, 12, 18, 24, and 30 pins. The steel plate offers 6, 9, 12, 15, and 18 pins. Thus, from either of the tools, a wide variety of gear reductions is available.

To make the wheels, I first calculated the pitch diameters of the circles for the number of holes in each, making a little chart of the results. I then cut the blank on my lathe and mounted it on a rotary table on my milling machine. From there I was able to drill the holes quite accurately. The holes are the same size as the pins in the wheels the plates will make. The center hole is the same size as the shaft on which the wheel will be mounted.

An alternative

I know that most people don't have lathes, milling machines, and rotary tables. However, most people reading this will have a computer and access to a laser cutter (your local library?) or someone who has one. Worst case, there are companies online who offer laser cutting commercially.

You can do the drawing in any of the numerous free CAD (computer-aided design) programs online, then export the drawing in a file that is compatible with a laser cutter. I suggest that you make all of the holes slightly undersize, then drill them out yourself when you get them back from the cutter. That way you know they will be the correct diameter. Also, include the actual circles on which the pins lie in your drawing, and have them etched into the surface of the wood. This will avoid confusion when drilling your wheels, as you can just follow the circle.

Most lower-end laser cutters will not cut steel. The go-to material seems to be Baltic birch or furniture-grade plywood. This should be fine for a while. With care, you should be able to make many pinwheel bodies before your wooden tool starts to show wear (and becomes inaccurate). The simple solution to that is just to have several identical tools made at the same time, from the same drawing, and keep them on hand to replace the one that is wearing out.

The tool consists of three parts: the drilled plate, the pin, and the center plug (**photo 22**). The plate has already been discussed. The pin should be the same diameter as the pins in your finished pinwheels. One end is pointed, which can be easily done by twirling the pin while holding it against a belt or disc sander. Better yet, if you have a Dremel or other rotary hand tool, mount the pin in that, then turn it on while holding the pin against the sander to make the point. The other end of the pin is bent over 90°, mostly to keep it from falling through the plate when you don't want it to.

I turned the center plugs on my lathe. However, plugs could just as easily be built up from telescoping brass tubing, available at craft and hobby stores. The inside diameter of the smallest tube should be the same size as your pin diameter, while the outside diameter of the largest tube should be the same size as your shaft diameter (**figure 6**).

Solder or glue all of the pieces together, then trim it to length—about twice the thickness of the plate. Add an additional ring at one end to prevent the plug from falling through the plate.

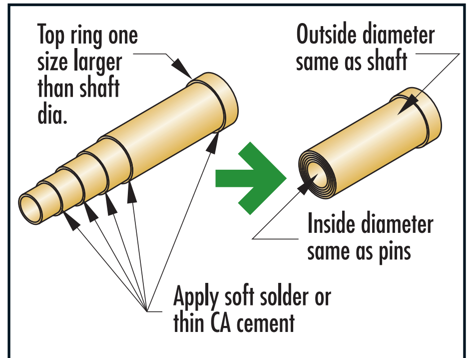


Figure 6—Center plug

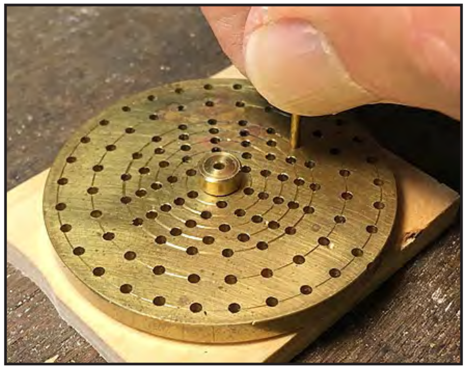
22. The three parts of the tool: the plate, the center plug, and the pointed pin.

Using the tool

Once you have the tool, using it is simple. Take a piece of plywood the thickness of a pinwheel and drill a hole in it (**photo 23**). The diameter of the hole should be the same as the shaft on which the wheel will be mounted (as well as that of the center plug). Put the plug through the plate, into the hole. This will hold the plate in position on the plywood.

Choose the ring of holes that will result in the desired pin-

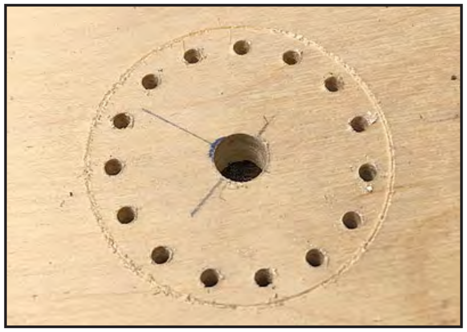
23. A hole the size of the center plug is drilled into the wood.



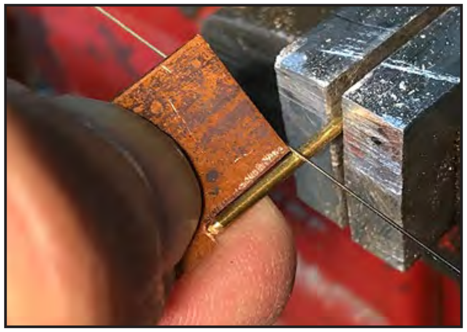
24. The plug is put into the hole and the plate is spun with the pin, scribing the wood.

25. The scribed line is the edge of the wheel.

26. After the first pin hole is drilled, the pin is placed in it and the rest are drilled.

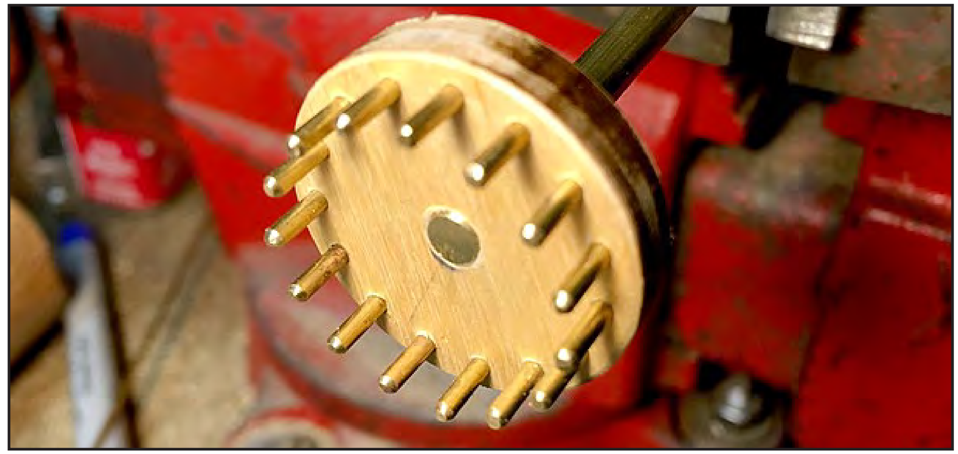


27. All of the holes are drilled and the wheel is ready to be cut out.



28. Cutting the pins with a pin gauge.

RIGHT: 29. The finished wheel.



wheel. Then put the sharpened pin in a hole of the *next larger* circle. Using the pin as a handle, spin the plate around the center plug, scratching the wood underneath with the pointed end of the pin (**photo 24**). This will indicate the outside-diameter of the finished wheel (**photo 25**).

Remove the pin and drill a pin hole through one of the holes in the chosen circle. Then place the pin through the plate into that hole. This will prevent the plate from rotating while you drill the remaining holes (**photo 26**). Then just go around the plate, drilling holes, until you've drilled all of the holes in the circle (**photo 27**). If you use a drill one size smaller than the pins, you should be able to just press the pins into place. Once all of the holes are drilled, cut the wheel out and finish it up.

I like to cut my pins with a jeweler's saw and a gauge similar to that mentioned in part 1 (**photo 28**). When all the pins have been cut, I chamfer their ends on the sander. The pins can then be pressed into the wheel. The finished wheel can be mounted on the shaft in the same way as described in part 1 (**photo 39**).

I hope that this will give you enough information to make some pinwheel gears of your own, if this is something you've been wanting to do. If you have any questions or comments, please send them to me at *automatamag@comcast.net*

Laudator Temporis Acti

Addressing the human condition

by Wade Warman
Raleigh, North Carolina, USA
Photos by the author

In 2015 I began researching the history and design of automata. As a point of origin for my research, the website of Cabaret Mechanical Theatre (CMT) allowed me to view works by many artists, including Tom Haney, Dug North, Keith Newstead, and Paul Spooner. Through this research I was able to see a broad range of aesthetics and mechanics in their automata. Taking my research and exploration further, I also looked into many types of mechanical functions, such as gears, cams, linkages, etc., to get a better idea of how certain kinds of movements could be created. (The book *Cabaret Mechanical Movement* proved to be an indispensable volume and quite the jump start for me!)

The result of my initial investigation was the automaton *Laudator Temporis Acti*. The piece itself is a rather simple design, with exposed mechanical components and a narrative performance. The viewer is presented with an old, cantankerous-looking man standing above a baby lying on top of an open-sided box. As the participant turns the crank, the man kicks and the baby goes flying. When the participant finishes turning the crank, the baby and man's leg return to their respective positions, ready for another kick.

Conceptually, *Laudator Temporis Acti* preceded many other works that more fully embrace my artistic inquiry of how automata and kinetic sculpture can use humor to examine aspects of the human condition. Technically, for a first automaton design, I felt that *Laudator Temporis Acti* was quite successful, since I had previously only fabricated one mechanical item—a simple cam-and-lever action. With this piece, I set out to incorporate specific traditional sculpting techniques and digital fabrication methods, including the manufacture of key components like the frame, figures, and pinwheel gears.

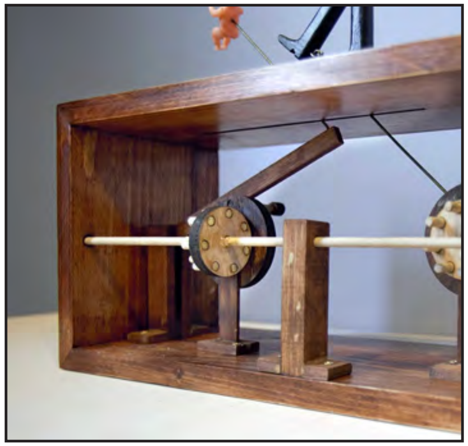
Construction

The frame is a simple wooden box made from poplar sourced at my local Home Depot. After determining the overall dimensions of the piece, I ripped the boards to width on a table saw, then cut 45° mitered angles for the corner joints. The frame is important from an aesthetic perspective; as with Paul Spooner's automata, the mechanical components are exposed to view. I wanted the viewers to see how the piece works and, by leaving the front and back exposed, this was achieved (**photo 1**).

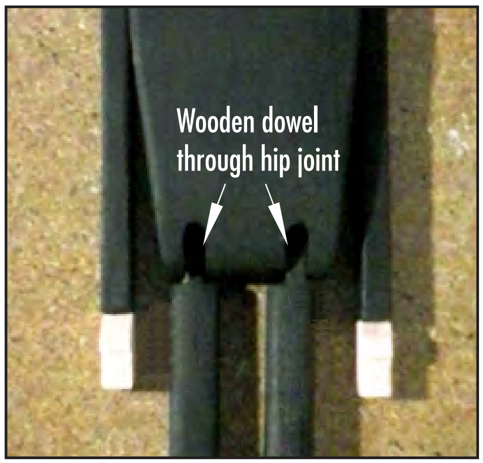
The two figures, man and baby, have different and appropriate origins, according to the roles that they perform. The baby is a plastic figure I found on eBay (**photo 2**) and decided was the right fit. The man figure was more of a challenge, due to his movement and the expression he needed to embody. It was at this point I decided to incorporate both emerging technologies (3D printing and laser cutting) and more traditional sculpting methods, so the man became a mixture of both.

For his body, I cut out the arms, torso, and legs with a standard bandsaw. From individual wooden pieces I was able to make some rudimentary curves that were representational of the body, and that were more complete when glued together.

To achieve the movement of



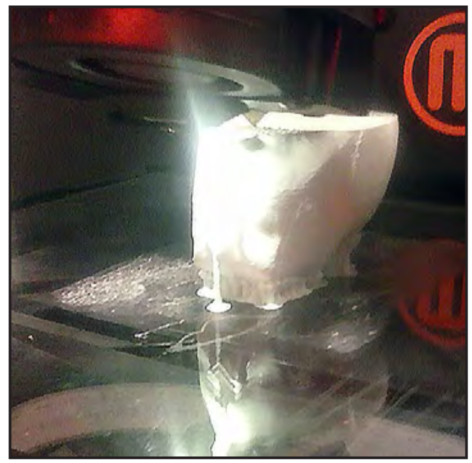
1. The frame is an open-sided box made of stained hardwood.



3. The man's kicking leg was hinged at the hip via a wooden dowel.

his kicking leg, I simply drilled a hole in his hip and used a wooden dowel as a joint (**photo 3**). His head, however, was not as straightforward. Initially, I thought I might carve it out of

2. Appropriate babies were procured online from eBay.



4. A head in the process of being 3D printed in plastic.

wood. This proved frustrating, due to my lack of wood-carving skills: I just could not get the expression of misanthropy right. Instead, I turned to 3D modeling. Using a free 3D-modeling program called Sculptris, I manipulated a default object (a sphere) as if it were a piece of digital clay. My work was aided by a few provided-example models that users could work with, one of them being a human head. The example head proved to be essential. I was able to digitally mold it to not only reshape it but also to create the facial expression I was looking for with the man figure.

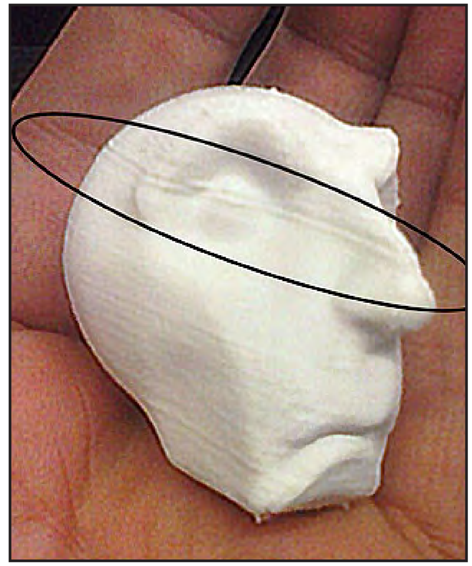
3D printing

When I was satisfied with the model, I saved it and sent the file to my 3D printer, a Makerbot, which is an extrusion-type printer. For those unfamiliar with this technology, imagine a high tech, hot-glue gun. It melts plastic (like hot glue), which it deposits in layers on the work surface in the shape of the object you designed (**photo 4**). After the first layer is done, it does another on top of that, over and over and over again, until you have a fully formed object (**photo 5**).

There are some serious drawbacks to this process, in my opinion. In particular, it takes a lot longer than one would imagine to print an object (10-, 20-, and even 30-hour prints are not uncommon) and the print often fails numerous times before a good one is produced. What's more, with extruder-based printers, the object has an unmistakable texture. It comes out with "tool marks," or ridges, where each layer of melted plastic was formed (**photo 6**). Some people don't mind this texture and look. I do.

Thus, the 3D print for me was merely a step in the overall process, allowing me to use the printed head as the "positive" for making a two-part mold. The mold itself was made from plaster (**photo 7**), for ridged texture. The head was cast in Flumo, a water based, slip-casting material that allows the artist to smooth out surface imperfections using a green scrubbing pad. The end result gave me exactly what I was looking for—the man's head was not only smooth and ready to paint but also had the expression of a curmudgeonly old man (**photos 8** and **9**).

5. The finished head still on the printer bed. The support pieces underneath will be trimmed away.



6. Visible tool marks left by the printing process are circled in this picture.

7. A two-part plaster mold was made to cast a smooth head.

8. Heads cast in Flumo.

9. The finished, painted head.

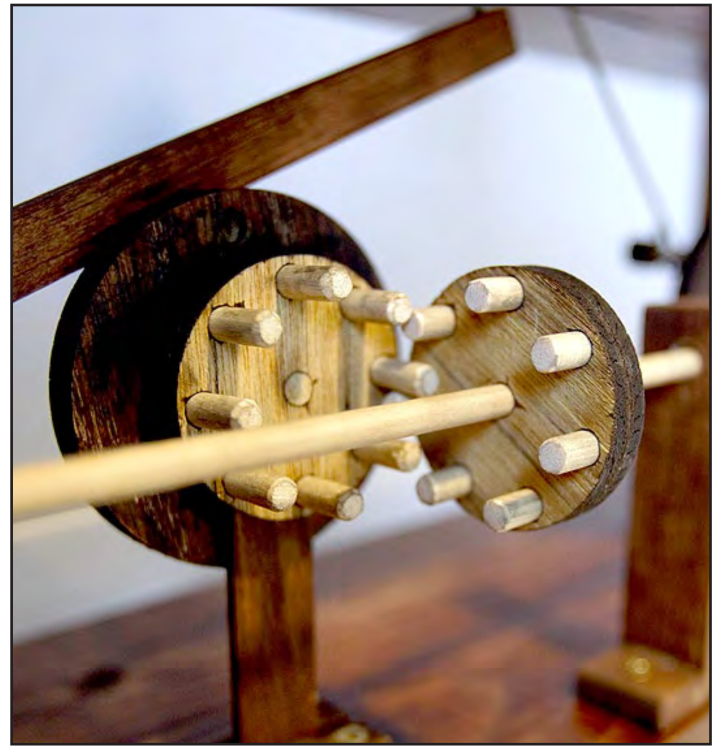
Laser cutting

To fabricate the pinwheel gears, I wanted to employ a rapid iterative process that would allow me to make and test gears quickly. Utilizing laser-cutter technology proved to be perfect for this. Simply, a laser cutter works by focusing an intense beam of light that can etch or cut through different materials, depending on the laser's programmed speed and intensity. An example of laser cutting, the crank handle for my automaton, can be seen in **photo 10**.

To operate the laser, a user must first create a design using a computer-aided-design (CAD) program. A CAD design works like a digital blueprint operator. I used a CAD program called Rhino to design my gears. Using this, I could quickly change the dimensions if the gears were too large or small, allowing the remaking of a gear in mere minutes (**photo 11**).

This rapid experimentation with gear size meant the timing of the automaton's motions were synced perfectly with each other: the man kicks and, as he does, the baby goes flying. For me, this was the most important technical aspect because, if the timing was off, malfunctioning mechanics would have led to an awkward performance. More importantly, if the timing of the components was off, the element of humor could have easily weakened the performance of the piece as a whole. For me, having the laser cutter as such a fast and iterative fabrication method meant the difference between success and failure.

10. Laser-cut crank handle. The dark, burned edges are characteristic of the process.



11. Pinwheel gears, precisely made on the laser cutter.

The humor element

Upon presenting the finished piece for feedback, one critique in particular stood out to me as quite interesting. My idea was to have perhaps added a spring to the baby to increase its movement. While I am not sure exactly how this might have been feasible on a technical level, it did provide much food for thought as to the humor element. Would the extra movement resulting from a spring create enough exaggeration to increase the humorous performance? Would it have changed the humor's dynamic, shifting it to a more blatant attempt at being funny and thus removing some of the subtlety? Of course, barring the creation of another iteration of the piece, I will never know the answer to these things. However, questions related to exaggerated movements have served me in subsequent inquiries as a way to add or increase humor to the performance.

Analysis

As mentioned above, *Laudator Temporis Acti* preceded my focused artistic research into how automata and kinetic sculpture might use humor as a way to examine the human condition. That said, I feel that an argument could be made that this piece shows signs of first inquiry in its initial stages and, as such, I think it is an informative and successful work.

The theme itself—kicking a baby—was the result of an expression often used by a person I once knew, who would say things like, "I'd kick a baby for a cup of coffee." I always thought this was an immensely dark and funny image and had wanted to use it in some way. In conversations with friends and colleagues, I noted that the vast majority felt that the idea of kicking a baby was not only humorous but also strangely cathartic.

This majority of opinion, however affirming toward the notion of humor it might have been, fell shy of speaking to the idea of the human condition. When asked why they felt the piece was humorous, people's responses varied. Looking at the broad reaction as a group, the majority noted that the piece seemed to work effectively by addressing the sense of frustration that all people experience at one point or another in their lives, and allowing them to figuratively kick a baby relieved some of this frustration.

There were, however, some dissenting views. Some responded by implying that they felt empowered, to an extent, to allow elements of misanthropic behavior to be released—that they could participate in negative behaviors without the worry of actually transgressing laws and social morals. Others were amused by the mechanical element and felt sympathy for the baby and disdain for the old man. It is because of these dissenting views that I cannot say that it speaks directly to the universality of the human condition or humor but it does reference some elements.

When asked if the piece was funny to them, as stated before, the vast majority responded affirmatively. In discussing the notion of humor, some of the follow-up questions were, "Have you ever kicked a baby?" and "Would you ever kick a baby?" As one might imagine, 100% of the answers to both questions were resounding no's.

Interestingly, this negative reaction to the follow-up questions did not diminish the humor for those who had found it funny. In fact, in asking them what made the piece humorous for them, it was the very idea of doing something so abhorrent that they found funny: they would never kick a baby in real life but to do so in a pretend, safe way was humorous. They enjoyed and found entertainment in this act of transgression as long as it remained comfortably safe and humorous through the actions of the automaton figures.

Despite these conceptual successes, especially when looked at as a precursor to my later and more focused artistic-research inquiry, I see weakness in the naming convention *Laudator Temporis Acti*, which translates to "in defense of the past." Though I personally felt good about this title, most of the questions I was asked pertained to its meaning. When I explained the title and the translation to people, they seemed to stare blankly at me, perhaps not understanding the meaning behind it.

This gave rise to some thoughts. If I have to explain the title, do I even need it? Will it add anything? Or will it (as it could be argued in this case) detract from the overall piece? So, as I have continued to move forward with my conceptual work, I contemplate and consider more carefully the naming conventions and relationships that occur between the participant, the automaton's performance, and the physical work. AM

Write an article!

Automata Magazine needs writers. Everyone has a unique story. Writing it down isn't as difficult as you might think. If you're shy, we've prepared some guidelines for you: *http://automatamagazine.com/write/* There's also a list there of the kinds of stories we would like to see.

You could write about your projects, visits to places of automata interest, your collection, problems you have solved, or what-have-you. This fascinating field of endeavor encompasses all skill levels, and you don't have to be an expert or fine craftsperson to write about your work. With automata, charm and concept are often as important as craftsmanship (sometimes more so!).

And don't forget our Gallery. Please send photos and descriptions of your projects to be included.

automatamag@comcast.net

AUTOMATA FOR BEGINNERS

I'm a bit biased about wood

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

This article is about decorating your automata. At Timberkits, we concern ourselves mainly with automata makers who are hobbyists, rather than those engaged in professional practices or aiming for gallery pieces, so our emphasis is very much on having fun with it. We also focus on characters and creatures, though not exclusively. Our aim is to give life to the piece, not polish (**photo 1**).

Timberkits, as the name suggests, are made of timber, so I make no apology about this material taking center stage. I am a bit biased about wood. It is a really great material to work with:

Watch "How To Decorate your Drummer" for a start-to-finish case study: *https://tinyurl.com/ybub327y*

1. *Happy Hands*, painted and decorated.

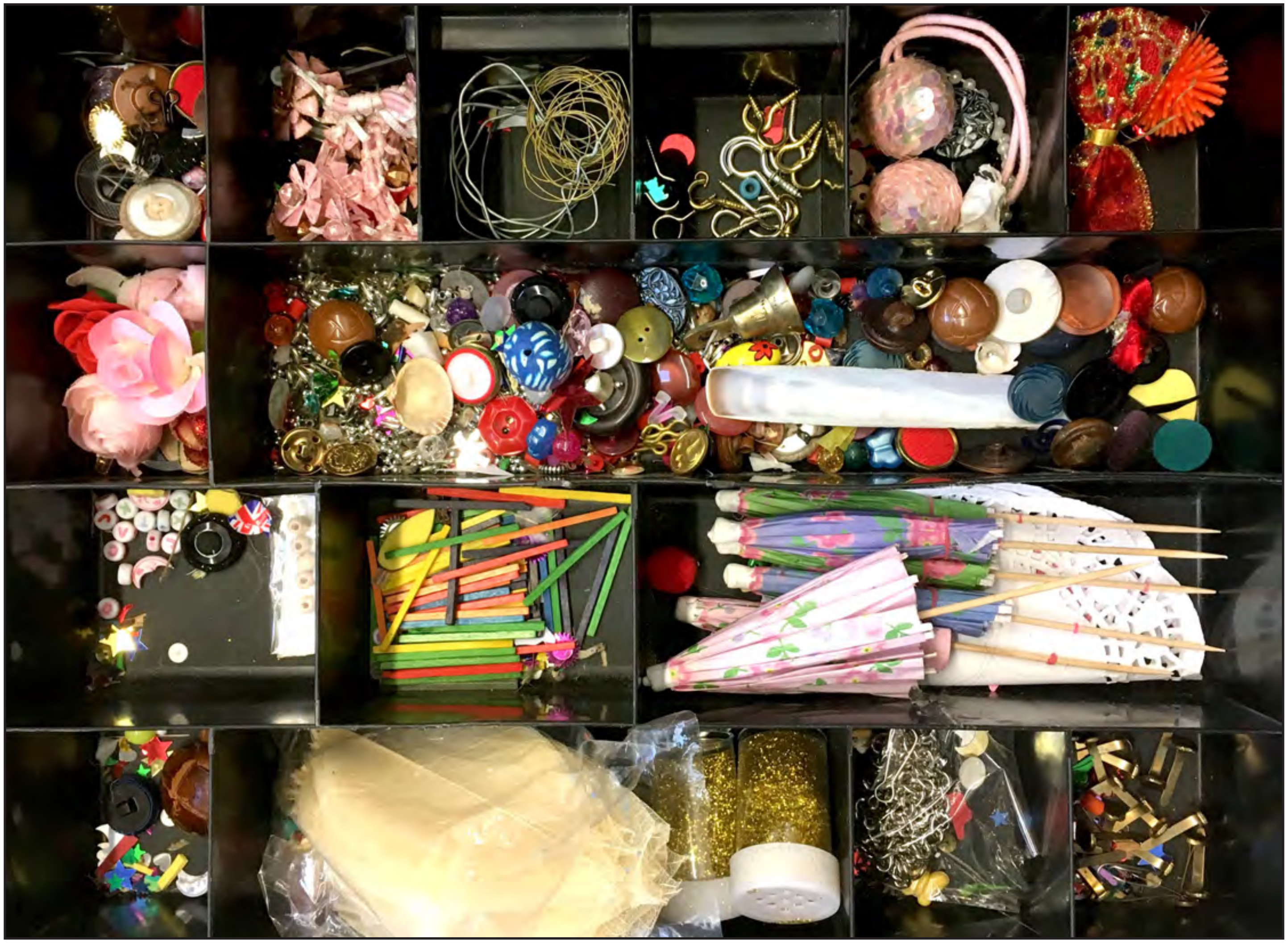
2. Harold the Drummer, of Cartoon Violence, in real life.

3. *Harold the Drummer*, immortalized as a Timberkits automaton.

warm, soft, fragrant, varied, full of character, and so on.

The best thing about wood in the context of automata is how easy it is to customize. With a small amount of knowledge, experience, a vast myriad of materials, and the right glue, there is no end of possibilities. Plastic and metal are harder to manipulate than wood, and tend to need painting or attaching with more noxious chemicals, but there are lots of ways to use them in applied detail. For the sake of simplicity, I am going to talk about decorating characters here but the principles can apply to any theme.

The most important tool is your own observational skills. The world is full of different textures and surface treatments, so take note. I often try to make models look like known people, either by request or out of devilment. I like to find defining details or features that are quintessentially them (**photos 2** and **3**).



4. Never throw away broken jewelry and make a habit of raiding other people's sewing boxes, shells from the beach, wire from old electrical gadgets, etc. Think magpie.

Your next most important tool is your ability to collect materials. You need a box of bits (**photo 4**)—or several boxes of bits. Or, as in my case, an office full of boxes of bits that drive my colleagues insane.

Marry these two tools and you will find yourself gazing at people on the underground or in the shops, musing along the lines of, Hmmmm, frizzy hair—wire wool; brand new tattoo—drawing pens; old faded tattoo—pencil crayons; sleek hair—embroidery thread; small dog—fluffy pom pom from bobble hat, trim to shape, add eyes…. I do this obsessively. I no longer see people as human beings, merely as assemblages of interesting material equivalents.

Here are some basic techniques and guidelines:

• If you are painting wooden components, do this before final assembly. Be aware, though, that your paint must not compromise surfaces that need to move smoothly against each other or surfaces that will need gluing together. Wood glues depend on the material being porous so won't work on sealed surfaces. Acrylics are the best paints to use but you can also try dyes. Enamel paints will only work on sealed wood. Painting wood tends to raise the grain; the fibers become plumped up and make the surface look rough or furry. To get the best finish, sand back after the first coat is dry, then apply a second coat.

5. Thin strips of paper made better piping than trying to paint neat lines.

• Once the paint is dry, you can always use other media to add surface decoration or marks. Felt-tip pens, drawing pens, pencils, little highlights of varnish—try anything (**photo 5**).

• Pre-painted tissue paper makes great fabric effects but requires gentle treatment to create drapes rather than crumples (**photo 6**).

6. Real fabric tends to be a bit springy and it can be difficult to make it behave. Paper is easier to manipulate at this scale. Here, silver cord has been applied for piping.

• I use PVA glue (white, water-based glue, wood strength) for wood, card, paper, and fibers, and UHU All Purpose Adhesive (spirit-based glue) for pretty much anything else, with an occasional spot of super glue (CA cement) for tricky materials. Double-sided sticky tape is useful for thin plastics or metal-shim detail, but bear in mind that it tends to come off over time.

• When it comes to texture, you are only limited by your willingness to experiment.

I generally find that things become more alive with a good mixture of different media and layers. If you just stick to paint, for example, the result will be a little flat. If you embellish with some fuzz, some twinkle, some bumpy bits, and some scrumply bits, your piece will take on a whole other dimension.

Finding the right material for the job is deeply satisfying, and finding the right detail to capture the essence of your character is a joy. Take your time, indulge, and enjoy. AM

Keep an eye on our Facebook and Instagram pages for regular submissions from our customers, who love to show off their fabulous creations, like the ones presented here, for instance.

Contacting Sarah

If you have questions or comments for Sarah Reast about this column, you may write to her in care of *Automata Magazine*: *automata-mag@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/*

REVIEWS

BOOK REVIEW
Figures in the Fourth Dimension
by Ellen S. Rixford
Published by the author :
https://tinyurl.com/rixford
11¼ x 8¾", hardbound
512 pp., profusely illustrated, all color
Price: $80US + s&h
ISBN 978-0-578-15865-5

This beautiful, large, self-published volume successfully embraces a vast amount of practical information, with beautiful photographs, and technical diagrams related to the design of puppets and automata.

No one publication has previously attempted to explain the mechanisms of animated works of art from basic to advanced levels. The mechanics of the hundreds of artworks that are featured in this volume are described by clear technical illustrations or photographs that rarely need written explanation.

Over the course of 512 pages, the reader is gently guided through principles of basic physics and necessary tools for simple movements, to in-depth explanations of some of the most famous 18th- and 19th-century works that are currently found in museums.

Quality was in the mind of the author from the outset in producing this masterpiece. It is a visual delight and a joy to read. The book weighs five pounds and is an inch-and-a-half thick.

Within its landscape format are more than 1,000 high quality, full-color illustrations and photographs that are filled with information on basics, principles, and mechanisms. These include linkages, cams, gears, shafts, pulleys, and many more, with descriptions and illustrations of how they are used. The book covers both puppets and automata, as these are closely related. They range from 17th- and 18th-century examples to more modern pieces.

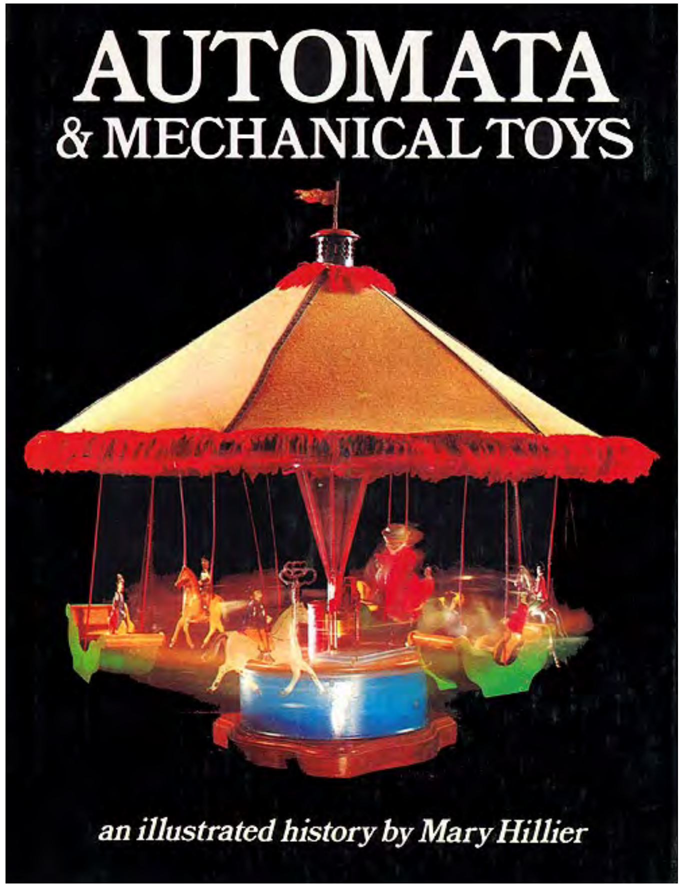
Author Ellen Rixford is an accomplished mechanic. She covers many detailed and intricate mechanisms, explaining the complexities. She peels back the layers of each object and dissects the mechanisms with great attention to detail, using exhaustive descriptions and careful explanations.

The book encompasses rich content, doesn't skimp on details, and uses generous visual aids. Ellen leads us through tools, materials, and a huge range of techniques, providing inspiration to the aspiring builder as well as eye candy for the appreciative viewer.

The content is a compilation of contributions provided by a wonderful assortment of some 30 noted artists, from the early masters to contemporary experimenters. Many of these artists have been generous in revealing their secrets, making the understanding of these mechanisms—from simple to more complex—much clearer.

This book is enriched by the beautiful presentation of these puppets and automata. It offers the enthusiast, amateur builder, student, and artist the scope to enjoy, utilize, and understand the content. —*W.T. Ware*

BOOK REVIEW
Automata & Mechanical Toys—an illustrated history
by Mary Hillier
Jupiter Books, 1976 (first ed., out of print)
Bloomsbury Books, 1988 (second ed., out of print)
7½ x 10"
200 pp., hardbound with color-printed dust jacket
ISBN 1-870630-27-0



Mary Hillier's *Automata & Mechanical Toys* is a comprehensive history of mechanical amusements, from jointed ancient-Egyptian dolls through a battery-powered NASA lunar-lander toy. Her writing is conversational, but extremely thorough. This is a history book with illustrations, rather than a how-to manual or project book.

The main focus is on clockwork automata, starting in the 14th century in Europe and the 16th century in Japan. For centuries, these were intricate, expensive entertainments for wealthy adults: for example, the writing or drawing human figures, singing birds, animated animals, and so forth. The goal was to emulate complex behavior with natural-looking movements.

Around the middle of the 1800s, the manufactured-toy industry began to flourish in Germany and England, giving rise to less sophisticated and less expensive clockwork toys, as well as steam-driven mechanisms. Transportation models (carriages, railways, automobiles), moving baby dolls, and the like became popular and widespread.

Those toys from the 1860s to the 1960s occupy the great majority of Hillier's book. It is heavily illustrated with (exterior) photos of automata—almost all in black-and-white—or line drawings. While there are some cutaway or mechanical drawings, they are mostly old patent illustrations and not very useful to the modern builder.

Published in 1976, Hillier's book predated the Cabaret Mechanical explosion of the early 1980s. (One suspects that the second edition, in 1988, may have been in response to Cabaret Mechanical Theatre's success.) Our current standard of hand-operated automata featuring visual puns was apparently completely unknown to her, and thus the world of automata represented in the book is considerably different than the one we know today.

Given the meticulous historical research and focus on clockwork, this is a book for those who have interest in the long, interesting history of moving, mechanical replicas of life. Collectors of automata should gain great knowledge from it but those looking for automata from the past 40 years, or for inspiration to build something themselves, may not find much here to help them. —*Vance Bass*

Many books about automata, and of interest to automatists, are now out of print. However, they are still valuable and most are available through the used-book market. Given that, we'll be reviewing more of these in upcoming issues of *AM*.

The End