AUTOMATA MAGAZINE

Mike Palmer's *Merlin*

1/6—Nov/Dec 2019

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DEPARTMENTS

Automata Magazine is published six times a year by Sidestreet Bannerworks, Denver, Colorado, USA.
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EDITORIAL

A year complete

by Marc Horovitz

I am amazed that this issue of *Automata Magazine* completes our first year of publication. I initially approached this project with a certain amount of trepidation. The time between the conception of this magazine and the publication of our first issue was fraught with uncertainty. Many obstacles had to be overcome.

We were unsure about how the magazine would be received. Would people be interested in it? Would they contribute material for it? Would there be enough subscribers to make the effort worthwhile?

The upsides to this venture have far outweighed the angst, mistakes, and bumps in the road. The response to *Automata Magazine* has been overwhelmingly positive. We now have subscribers from around the world. Automata seem to have universal appeal. It's delightful to correspond with folks from everywhere and to see their original, creative, and imaginative work.

It was our goal to make the magazine all-inclusive. We wanted to feature automata history, places of interest, the thought processes and work of individual artists, education topics, mechanics, how-to stories, collectors' insights, and much more. Our wonderful authors have made all of this possible. It has been easier to fill our pages with stimulating and thoughtful material than we'd have ever imagined.

We had hoped to initially produce a publication with around 30 pages each issue. As it has happened, no issue has had fewer than 50 pages, and this one has over 60! We offer our heartfelt thanks to every one of our authors and subscribers for making *Automata Magazine* possible.

One thing that I've realized over this year is how thin on the ground we automata enthusiasts are. Yes, there are thousands of us, but we are spread out so far that few of us have local support from other like-minded people. To my knowledge, there are no clubs or other organizations devoted to automata. We're essentially on our own. AutomataCon is the only gathering I know of especially for automata enthusiasts, but, sadly, it's only every other year.

Certainly, the internet can supply an abundance of information if you are willing to dig for it. Websites like Facebook, Instagram, Pinterest, and other social-media sites show lots of automata, as do YouTube and Vimeo. All of these are valuable and fill definite needs. They're good places to simply show off a new piece of work.

However, one thing that seems to be lacking on the internet is in-depth coverage of the specific things that intrigue us. This is where a magazine comes in. Our authors provide significant information that goes far deeper than most online sources post.

Articles, news, and reviews are organized in a single place. You always know where the information is and it is easily accessible. Comprehensive pieces can be read at leisure. And—best of all—over time, the information contained within becomes an encyclopedic resource covering everything concerning one basic subject—automata.

So, given all of that, we're looking forward to the upcoming year and what it may bring. We already have some great articles on file. We always need more, though, on every topic, so please keep us in mind. If you haven't written for us before, we'd love to hear from you. Those who have already been contributors, we hope that you'll continue writing fascinating stories for the magazine, and we'll be happy to continue to present your work to our readers. Thank you all!

NEWS

Forum report

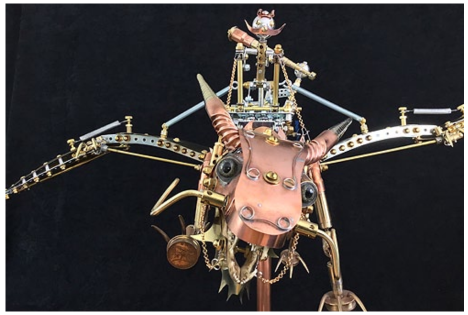
Automata Magazine's online forum is growing at a respectable pace. In the month of September, forum membership increased to 27 and we had 44 threads of conversation. Members shared questions, images, suppliers, ideas, and just plain good conversation.

Thanks to those who have joined and who are participating. I look forward to further forum growth. —*Jim Coffee, Moderator*

Automata for sale

Maurice Feely has several automata for sale by artists such as Lisa Slater, Matt Smith, Carlos Zapata, and Pablo Lavezzari. He can be reached at *automatakits@gmail.com* for more information. The automata may be viewed in action at this link: *https://www.youtube.com/user/maurice6591/videos?view_as=subscriber*.

EVENTS



Morris Museum presents The Adventures of Baron von Steubon and Cromwell: A Kinetic Tale by David Bowman. A series of 18 mechanical vignettes tell the story of two automata and their journey on land, sea, air, and into the past, as they encounter fantastic mechanized beasts, in their quest for long-lost family and treasure. November 14, 2019-March 1, 2020.

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

The Mechanical Circus is a collaboration between CMT and Rijksmuseum Boerhaave, the Netherlands. Puke Ariki Museum, New Plymouth, New Zealand. November 2019-April 2020.

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

More info: *https://cabaret.co.uk/exhibitions/current/*

AutomataCon

Hosted by The Morris Museum: May 29-31, 2020. More info: *http://www.automatacon.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. A 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*.

LETTERS

Tips

I thought the following tips could be useful to other *AM* readers. To stick patterns onto wood, I use a Pritt glue stick (that's what it is called in the UK). It sticks paper to wood, peels off pretty well, and awkward bits can be removed by damping the paper.

If you need gears, try the gear program on this site: *https://woodgears.ca* It's quite useful.

Finally, the book *507 Mechanical Movements* has been animated for the internet: *http://507movements.com/* —*Keith Martin, Leeds UK, keithmart19@gmail.com*

Woodworking forum

I am an automata maker in Sydney, Australia and would like to let you know how much I look forward to your magazine. Your new forum will be a very good source too.

There is another forum I would like to bring to your attention. Woodwork Forums (*https://www.woodworkforums.com/*) is a large forum with many many sub-forums, one of which concerns itself with automata. I recommend it to your readership. —*Gustav Klekner, Sydney, Australia*

PHOTO COURTESY OF THE MUSEUM OF NATIVITY SCENES

Proboštʼs mechanical Christmas crib

An automated nativity scene in the Czech Republic

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

Nativity scenes are an inseparable part of Christmas in the Czech Republic, and as the festive season approaches, you will find them at almost every Christmas market. Nearly every Czech city or town has a Christmas tree in the main square, with a nativity scene beneath the tree. Each nativity scene is original and unique. The story of baby Jesus, with a manger for a crib, is shown in many ways by the artists. One artist in particular, Josef Probošt, was responsible for perhaps the most elaborate nativity automaton in Europe .

The elaborate scene above, begun in 1885, was carved primarily by Josef Probošt, over a span of 40 years. Collaborator Josef Friml created the complex system of mechanisms that put the vignettes into motion.

Probošt's Christmas crib

Josef Probošt was a Czech farmer and carpenter who lived in a small village called Třebechovice pod Orebem (current population, 5,700), about 120 kilometers east of Prague. In 1999 his automata were declared a Czech national cultural monument, but his work actually started in 1885, while Queen Victoria was still on the British throne.

It is thought that Probošt initially made the scene for his wife, following the death of their infant son. She liked her gift, and Probošt decided to enlarge it. He brought in another carver, Josef Kapucián, and also Josef Friml, a mill carpenter and specialist in the making of cog wheels and other wooden mechanical parts. Probošt was a deeply religious man who intended his work for an altar. His original, modest concept was of a religiously based nativity scene, with the infant Christ, angels, stars, wise men, and so on.

As the piece grew, year by year, the concept grew with it, to show all aspects of rural life in Bohemia at the beginning of the twentieth century. These aspects included mining, carpentry, weaving, and farming, plus blacksmithing and music making. Local residents who visited Probošt to admire the nativity scene during its construction served as models for many of the characters depicted. Probošt himself can be seen as a carpenter and Kapucián as a wise man. Probošt worked on the scene for 40 years, leaving farm work to be done by his wife and daughter. He died in 1926.

There is plenty of visible mechanism in evidence. The machinery in front appears to power a loom in the background.

Men endlessly turn the wheels underground, as if they are providing the motive power for the display.

Two rams perpetually butt heads.

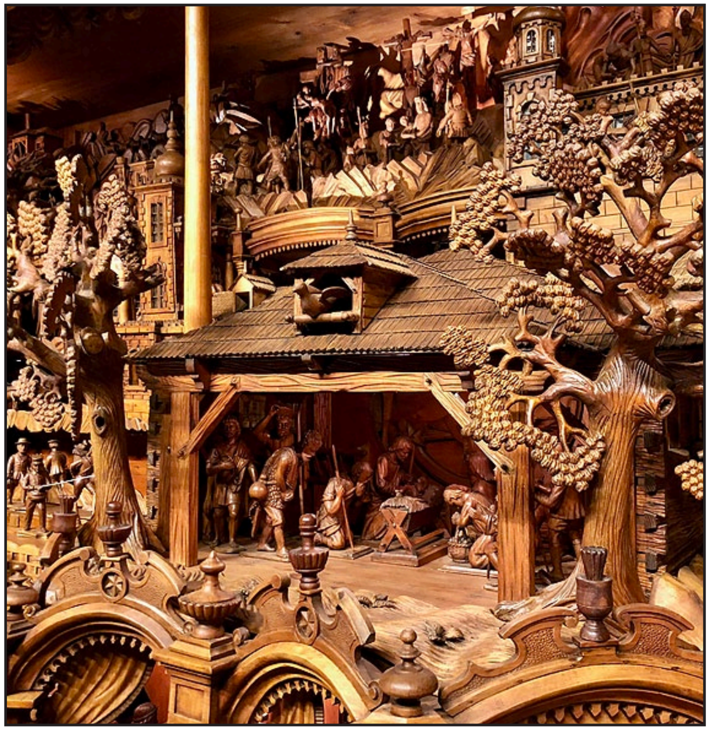
This is a portrait of Josef Probošt, working at his bench.

How does it work?

In the back of the scene, a

large wooden wheel, which was originally turned by hand, activates the belt drives, shafts, cogs, cams, wooden chains, etc., bringing all of the vignettes to life. A motor was installed in 1935, and now, since the crib's extensive restoration a few years ago, an electronically controlled electric motor does the work, with laser beams monitoring its smooth operation.

The entire display is 23 feet long and is made up of about 2,000 carved parts, including 373 individual figures. They illustrate 51 crafts in the community, with 120 figures that move in a procession around the scene on simple, but obviously effective, wooden conveyors.



Highly detailed, stylized trees bracket the central scene, with Jesus in his crib.

A team of experts spent more than 18,000 hours on the crib's meticulous restoration, completed in 2016. Here, a band gives a concert.

Where can you see it?

The nativity scene was first exhibited in 1906, at the Provincial Artisan Union in Chrast, where it won a diploma and a gold medal. After Probošt's death, it was occasionally exhibited in various places in Central Europe and was even shown at Expo 67 in Montreal, where more than eight million visitors (including Queen Elizabeth II) saw it. In 1970, it was shown in London, at the Ideal Home Show.

Since 1972, it has been displayed in the small village of Třebechovice pod Orebem, in the town's Museum of Nativity Scenes. You can drive there, or from Prague, you can take a train to a town called Hradec Králové. There you can change trains to cover the last 14 kilometers to Třebechovice. It's a short walk from the station to the Museum of Nativity Scenes. The village has one small restaurant, Restaurace Na Roli, which serves traditional Czech meals.

I was fascinated to see this vast automaton, built by a man with a passion and helped by a couple of friends, using rudimentary but effective technology, over half a century before the Cabaret Mechanical Theatre in Covent Garden launched the new wave of automata building. Equally fascinating to me is to think about the trades and activities shown, and to consider what their contemporary equivalents might look like, carved in limewood, of course. A

More information and videos

- Museum website
  http://www.betlem.cz/en/
- Official 20-minute video
  https://www.youtube.com/watch?v=P_jkJnFwn2M
- Author's one-minute video
  https://www.youtube.com/watch?v=F36UkBBySm8
- Wooden conveyor mechanism
  https://www.youtube.com/watch?v=s4F3INnuzLk

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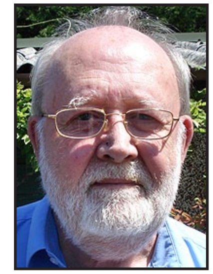
Merlin's story



Part 1: How this automaton came to be

by Mike Palmer • Tarleton, West Lancashire, UK • Photos by the author

Merlin was begun in 2009 and finished in 2013. During this four-year period, the automaton absorbed all of my spare time—I can only guess at about 3,000 hours. I am a clock and watch repairer in my main occupation. I mention this because the experience gained in repairing clocks greatly helped in my ability to understand small mechanisms, and I already possessed all of the tools necessary for the construction of this automaton.

The magician Merlin stands in a cabinet within a cabinet. The outer structure can be seen in **photo 1**. The inner part, which contains the scene and mechanism, is approximately an 18" (46cm) cube, which is removable as a whole from the outer cabinet.

The automaton is powered by a 6V DC, 5A adapter. Six volts were required by the cam-driving motor, so the voltage had to be reduced from there for the other electrical components, including some LEDs and small, 3V motors.

1. Merlin, in his workshop, performs a variety of magic for the onlooker.

As soon as the power supply is connected, the automaton lights up. However, the action only begins once a push-to-make switch is operated for a couple of seconds. This allows time for a cam to engage a microswitch that maintains the power supply until the other cams have completed their cycle.

The action

Action begins when the manic broom sweeps the floor and Merlin lifts his head. He turns to the crystal ball and mutters a spell. He waves his hand over the ball, but it doesn't light until he does it a second time, when he corrects the spell (**photo 2**). Satisfied that it is now working, he turns to light the fire. His wand glows bright red, but the fire also doesn't light the first time, because he again gets the spell wrong (**photo 3**).

Eventually there is a bright flash of light and the fire bursts into life. After more pokes of the wand, spells, curses, and hand gestures, the cauldron makes its way over the fire, where it begins to glow and wobble as it boils (**photo 4**).

Merlin then lifts his head and points his wand at the dragons (**photo 5**), who twist and writhe in their attempts to get free, while their eyes glow green.

Having demonstrated his power, Merlin then proceeds to turn everything off.

ABOVE LEFT: 2. Merlin again waves his hand over the crystal ball, which then lights up.

ABOVE: 3. Wand aglow, Merlin lights the fire for the cauldron.

FAR LEFT: 4. The cauldron, having moved itself over the fire, simmers.

LEFT: 5. Dragons writhe in an attempt to escape, while their eyes glow.

The process

I find that the most difficult aspect of designing and building automata is coming up with the idea. Deciding on a suitable subject and figuring out if and how it could be made is *by far* the most difficult part of my self-inflicted torment. I have worked with small mechanisms all of my working life, so that part of the construction process comes more or less naturally. It also helps that I am a hoarder of tools and materials. I never part with anything that could possibly be of use, however remote that possibility might be.

I started this automaton in what some people might regard as a back-to-front way. I first decided that it would fit into a wooden cabinet, which I would make. This would be in the form of a castle (**photo 6**). This idea sprang from my admiration of the old Black Forest clocks in wooden architectural cases. I also decided the following: under no circumstances must the viewer be allowed to see how any of the actions are performed; the entire piece (including the inner scene) must come apart for repair or maintenance; and there must be a detailed record of its construction for the benefit of anyone attempting future repairs. It is impossible to discern how to even open the cabinet without referring to that record.

6. The castle-like cabinet that houses Merlin predetermined the space in which the automaton must be housed.

Perhaps automata makers are already familiar with the feeling that they are making life difficult for themselves just by the very nature of what they try to achieve. By adding the above conditions to the task, "difficult" takes on a new meaning. Time was greedily devoured by the ravenous beast I was trying to create, especially considering that the figure of Merlin alone contains about 70 separate, removable parts.

The automaton is made up of separate units, each with its own purpose. These units comprise the cams and followers, the broom-operating mechanism, the dragon-operating mechanism, and the figure of Merlin. That last one could be regarded as part of the cam mechanism, since the figure is attached to it. The sum of the units might be considered complex, but as individual elements, the only one that I would describe as a bit complicated is the figure of Merlin. However, when that is compared to a watch that was made, say, 200 years ago, it wouldn't measure up to that description!

I regard it as my job to fit the mechanics to the scene, not vice versa. The scene must look right to me. If it doesn't, no amount of mechanical jiggery-pokery will make it so. The ultimate piece has to resemble the original concept—morphing is forbidden in my workshop.

In this case, I first made the floor of the scene, marking the positions of the various items in the room. From this I was able to determine where Merlin should stand, and therefore where the cam assembly should be sited. The scene is made almost entirely from scratch. As far as I can remember, the only bought parts were the dragons (Harry Potter game), some small glass jars (local art shop), the knight in armor, and some odd bits of glassware from doll's-house furnishings. The cupboard where Merlin keeps his potions can be seen in **photo 7**.

I don't normally do drawings. Apparently, I am fortunate in being able to think in three dimensions. Various people have asked how I am able to do this, and I don't know—any more than I know why they can't. I make no claim to any special ability here. For *Merlin*, apart from my making a very rough sketch of the scene inside (with the object of forming ideas, rather than any formal layout or mechanical information), the only essential drawing I did was the scale drawing I made of the cam assembly/geometry (**Fig. 1**).

Most of the actions are obtained via the bank of cams (**photo 8**). Additional motors power the dragons, cauldron, and broom. These are switched by

ABOVE: 7. Merlin's cupboard. Books are carved wood. Potions are on the shelves, herbs are in the boxes.

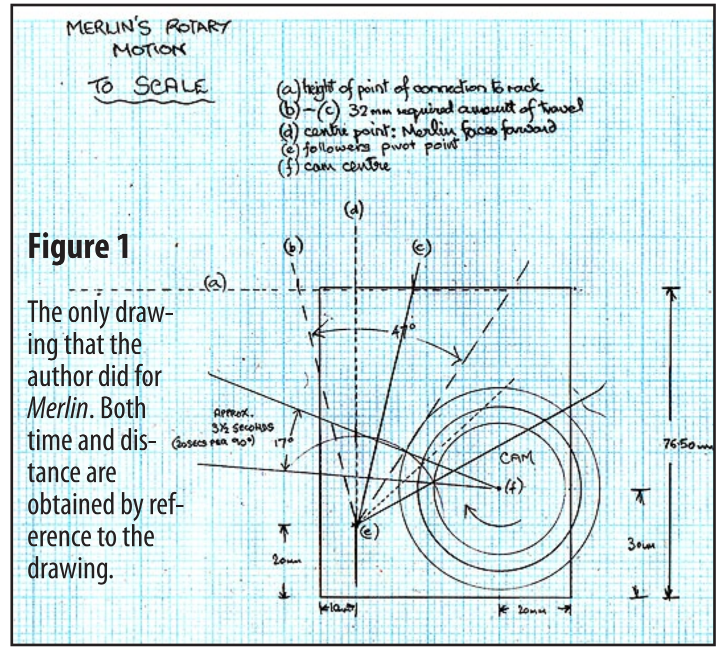
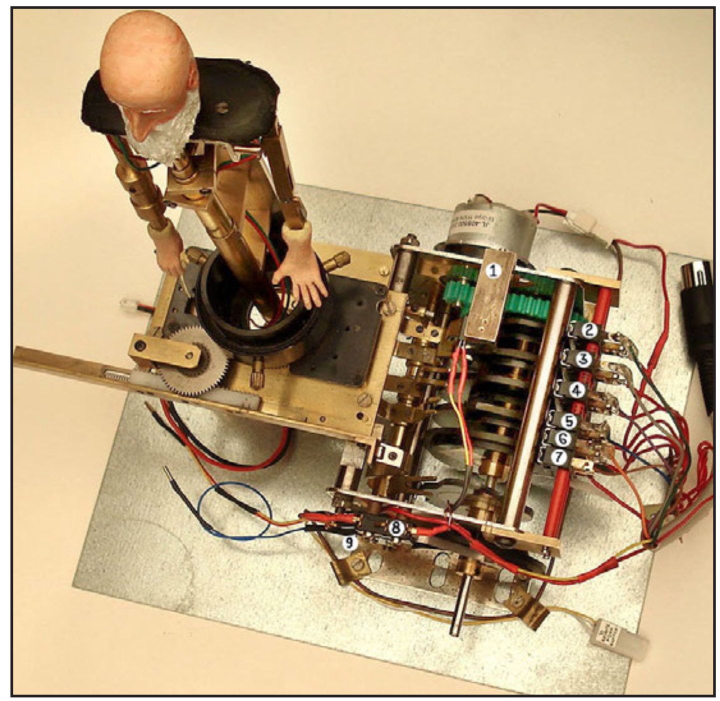


Figure 1

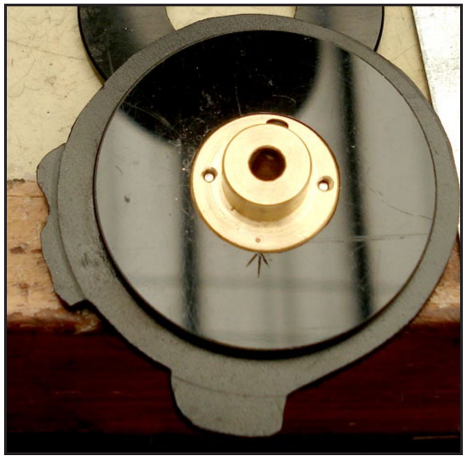
The only drawing that the author did for *Merlin*. Both time and distance are obtained by reference to the drawing.



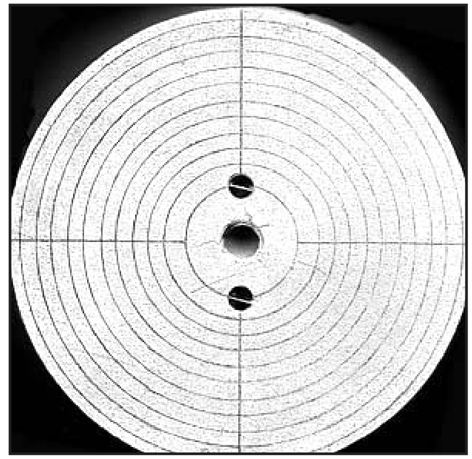
RIGHT: 8. The cam assembly can be removed as a whole. All actions are controlled by this unit, but the writhing dragons and the broom have separate motors, controlled by microswitches on this assembly.

additional cams fastened to the sides of the primary cams.

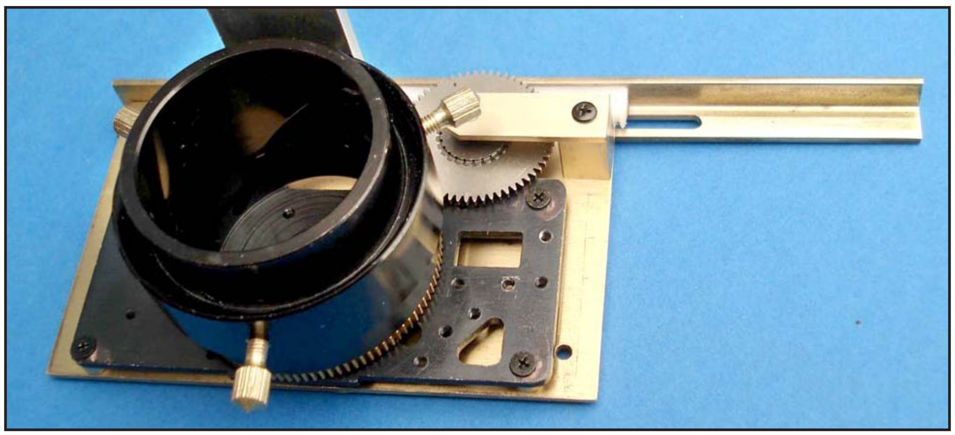
Motors are actuated by micro-switches. These have long, bendable arms and can be wired “push to make” or “push to break.” They are activated by secondary cams that are attached to the sides of the primary cams and can be just seen in **photo 8**. The switches use a common positive voltage and distribute the power supply to the various elements of the automaton via a DIN plug and socket (a standard multi-pin connector), which permits the cam assembly to be disconnected if and when it must be removed.



9. A black ABS plastic cam, held in place by a brass collar.



10. A cam-blank drawing. A scan of the finished drawing will be temporarily mounted to each cam so that the design can be worked out.



11. The cam-actuated rack-and-pinion assembly. Merlin is mounted to the black tube.

Working with cams

I make my cams from black ABS plastic (**photo 9**), and I keep my patterns, just in case. The thing that bothers me about plastic is the question of its long-term stability. A concentric piece of brass, for whatever purpose, will stay concentric, but will plastic or wood? And steel rusts.

The period of time that it takes the cams to make one revolution in *Merlin*, for example, is approximately one minute and 20 seconds. The maximum diameter of the cams that could be used in this setup was determined by the space available. Consequently, two dimensions were established immediately: diameter and timing.

I began the cam-making process by making blank cams from black ABS plastic, as mentioned above. I made a drawing of the outside diameter, together with a series of diminishing circles, so that the area to be later removed could be clearly marked. I then divided the cam drawing into four equal segments, each representing 20 seconds of running time (**photo 10**). A scan of the drawing for each of the cams was made. These were later temporarily glued to the cam blanks. I made flanged collars for the cams, which could be screwed to the cam blanks. These were fitted with grub screws for fastening them to the camshaft. I milled a flat on the camshaft to ensure that the cams maintained their correct position and that the burr created by the grub screw didn’t interfere with removal.

The most difficult action to achieve was Merlin’s turning motion. This required the cam follower to act on a rack and pinion. It pushes a sliding rack along a path, where it meshes with a pinion to which a gear is attached. This gear, in turn, drives the toothed tube to which Merlin is attached (**photo 11**). This is asking a lot of effort from the motor, and without doubt, it takes considerable mechanical liberties. A better arrangement might have been designed, but at the time, this is how I did it.

I was never certain that it would work or, if it did work, for how long it would work. On testing it by hand, it didn’t seem to offer undue resistance. This was the first action to be tested. Despite my misgivings about the mechanical liberties, the assembly worked the first time and has worked ever since (three-plus years now), with no evidence of the motor straining.

The design of this particular cam was dictated by the maximum amount of travel required to push the rack to create the extreme of Merlin's turn and, of course, the timing of the movement. This was the only element of *Merlin's* design where I was forced to produce a technical drawing, as mentioned above (**figure 1**). I made a scale drawing of the cam, including the cam center, follower center, and the amount of travel required of the follower-to-rack extremes. An additional cam on the outer end of the camshaft exists only to maintain, then switch off, the supply to the cam motor when the cycle is complete.

In the next issue of *Automata Magazine*, I'll talk about some of the specific mechanics involved in the construction of *Merlin*.

To see Mike's *Merlin* in action, visit *https://tinyurl.com/mikesmerlin*

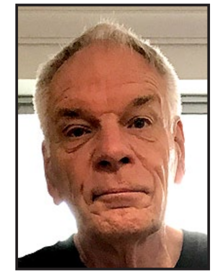
GALLERY

Tau Tau

by Pat Keck • Andover, Massachusetts, USA • Photos by Ricardo Barros
Submitted by Jim Ramsay
Visit Pat's website: *http://patkeck.com/*

The *Tau Tau* is a burial figure, commissioned by Jim Ramsay. If anyone approaches, the figure looks up. When Jim dies, the watch will be stopped, Jim's ashes will be locked in the chest, and the Tau Tau will be repositioned to sit upright and guard his remains, looking up if anyone comes too near.

Through the looking glass and glimpses of MADness



A visit to automata museums in Normandy and Stratford-upon-Avon

by David Soulsby • Billingshurst, Great Britain • Photos by the author

While the eyes of the world were on Normandy for the 75th anniversary of the D-Day landings last June, I traveled to the south of the province to the city of Falaise, to visit Automates Avenue. This is a museum that traces the history of the famous animated Parisian store-window displays that were popular between 1920 and 1960.

Having paid my €8 entrance money, I went inside to discover the streets of Paris from an earlier period, faithfully recreated. Included are a number of shop windows from the era's large department stores, such as Galeries Lafayette and Au Printemps, each with an animated scene from a former display (**photos 1** and **2**).

1. Recreation of an old Parisian street in Automates Avenue. The museum has 14 window displays and 300 automata exhibited.

Automates Avenue

Before strolling around the atmospheric streets, I sat down to watch a video presentation on the history of the museum. It was created in 1994 to house automata donated to the city by Cosette Decamps-Bellancourt, the great-granddaughter of Jean Roullet.

Roullet's automata workshop, established in 1866, expanded and was eventually renamed Roullet-Decamps (R&D), in 1889. This family firm became one of the most versatile and creative of all Parisian toy and automata manufacturers. Its remarkable accomplishments included the creation of mechanical toys, musical automata, and later, electrically operated animated displays for store windows. The company was in business for more than 120 years.

Just as early automata had depicted the culture of the time of their creation, window displays illustrated popular customs and events from the early years of the 20th century. In 1909, explorer Commander Robert Peary reached the North Pole. This milestone was celebrated in a tableau in the window of Bon Marché. The display featured R&D automata, with icebergs and the aurora borealis. This was the store's first animated Christmas showcase.

2. Window display for Galeries Lafayette, 1953.

3. Representation of Roullet-Decamps workshop.

With the development of plate glass, shop windows of the major department stores increased in size. Animated scenes were designed to attract and entertain visitors. Each year, in early December, the pavements were so crowded that it was almost impossible to move past the major stores in Paris.

Over the years, the automata lost much of their originators' design genius and the figures took on a simpler, more comical, and less realistic persona. The displays that were chosen were often based on the styles of famous French cartoonists, such as Raymond Peynet, Jean Effel, and Albert Dubout. I must admit that Peynet was the only one that I'd heard of.

Moving into the museum, I entered an area set up to resemble the actual R&D workshops, where all of the original automata in the museum had been built. This display demonstrates the whole process of sculpting, molding, mechanics, decoration, and costuming, with a number of completed automata in operation (**photo 3**).

The window displays are arranged around the museum in chronological order. An early example shows one of the builders positioned beneath the floor of the shop window, completing the Bon Marché scene entitled *The City by the Lakeside* (**photo 4**).

One panorama, created in 1936 for Grands Magasins du Louvre, was apparently based on an actual incident. This occurred when a drunkard moved the direction marker for the Tour de France, and the cyclists crashed into a drove of pigs (**photo 5**). Another display, created for Galeries Lafayette in 1947, shows the participants in a dance marathon, popular in America between the wars. This display, mirroring a Dubout drawing, comprises 19 figures in a tableau of spinning dancers, some collapsing on the floor in front of the judges, as the jazz band plays on (**photo 6**).

I found the museum interesting, and it gave insight into how automata from the famous House of Decamps had expanded from toys into shop-window displays in the early 20th century.

The MAD Museum

On my return to the UK, I traveled to Stratford-upon-Avon, to the so-called MAD (Mechanical Art & Design) Museum (**photo 7**), which was a complete contrast to Automates Avenue.

4. *The City by the Lakeside*, created for Bon Marché.

5. *Le Tour de France*, made in 1936 for Grands Magasins du Louvre.

6. *Dance Marathon*, shown at the Galeries Lafayette in 1947.

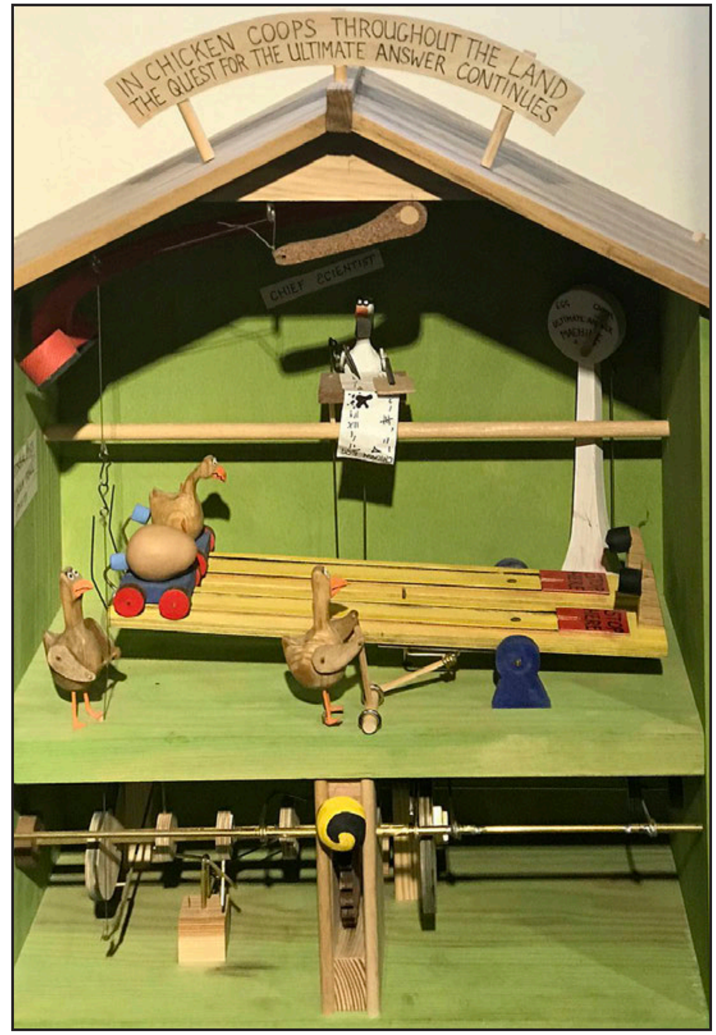
7. The MAD Museum, Stratford-upon-Avon.

The differences between the two museums were striking, not only because of the distinct periods in which the automata were built, but also in the themes that they depict.

Here, the models are made of simple materials—wood, iron, and even pieces scavenged from everyday items. They are handcrafted, generally hand cranked or operated by small electric motors, and have no electronics. Their mechanisms aren't hidden but are usually on show, so that you can see wheels, cogs, and cams all interacting. These provide extra interest in the automata.

The exhibits in this museum display the hallmark of a large number of present-day automata—a sense of the ridiculous. One of these, by Chris and Angela Margret, shows three demons, with paint pots and brushes, swarming over and defacing a portrait of Shakespeare. This is simply entitled *Gremlins Vandalise Shakespeare* (**photo 8**).

ABOVE: 8. *Gremlins Vandalise Shakespeare* by Chris and Angela Margret.



RIGHT: 9. Neil Hardy's *The Chicken and The Egg.*

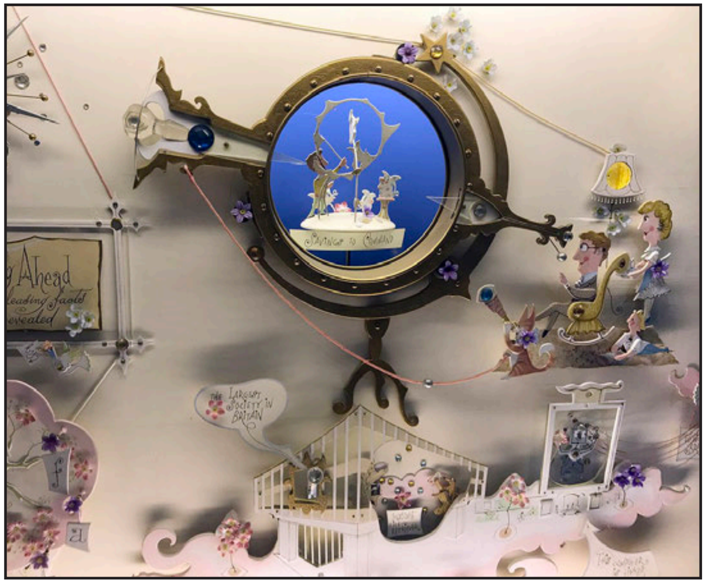
The descriptions on the roof of Neil Hardy's *The Chicken and The Egg* (**photo 9**) state, "In chicken coops throughout the land, the quest for the ultimate answer continues" and " Chicken or the egg?" One each of chicken and egg is placed on its own trolley, at the top of a wooden ramp. At the push of a button, the ramp is raised and one of the chickens, designated as Chief Scientist, waves a sign saying "Release Hammer." The hammer falls, striking the two trolleys simultaneously, and the racers are propelled down the slope. The answer, however, appears inconclusive, as the result is a dead heat.

Not all of the exhibits are in this vein, of course. An unusual exhibit is *Halifax Tableau*, a piece commissioned by the Halifax Building Society. This is a moving representation of one of Rowland Emett's cartoons (**photo 10**). Emett is well known for his design and construction of fanciful machines, especially those he built for the 1968 film *Chitty Chitty Bang Bang*.

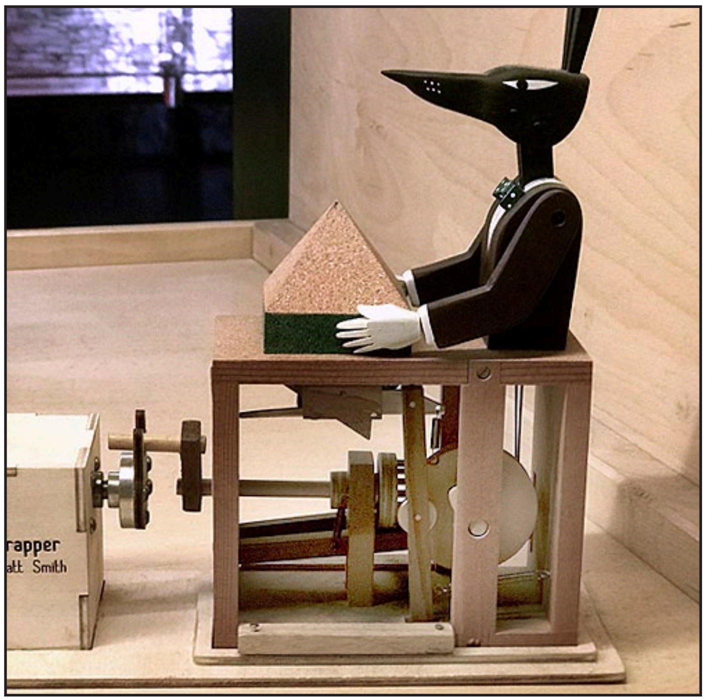
There are also a number of kinetic art and rolling-marble machines in the exhibition, but the automata by some of the modern artists were the highlights for me. Many artists exhibit (and sell) their work at The MAD Museum. Several pieces on display are by Paul Spooner (**photo 11**), who was part of the renowned Cabaret Mechanical Theatre and is the artist who built the fantastic *Last Judgement* (on the cover of the March-April 2019 issue of *Automata Magazine*).

Both museums I visited were entertaining in different ways. The Normandy museum had several automata that made me smile; The MAD Museum had many that made me laugh.

It seems that modern-day automata still have the same pulling power to attract passersby as the vintage ones displayed in the Normandy museum. After all, as with most automata, what goes around comes around.



10. *Halifax Tableau* by Rowland Emett. This was built in the 1950s.



11. Paul Spooner and Matt Smith's *Scarab Wrapper*.

A brief history of The MAD Museum

by Katie Wilson, Director of Marketing

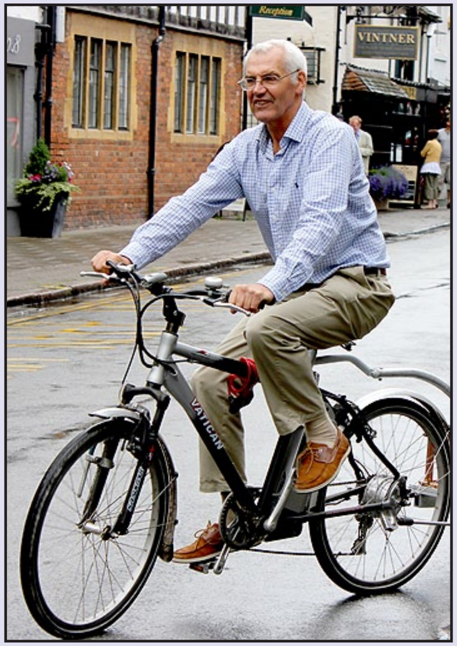
Photos by The MAD Museum

Visitors to The MAD Museum are greeted at a friendly and colorful front desk.

The MAD (Mechanical Art & Design) Museum exhibits around 70 pieces of kinetic art and automata. These moving sculptures have been created by inventors, artists, technicians, and engineers from all around the world.

Kinetic art and automata are well-respected art forms, but for the general public, not so well known. MAD can best be described as a mixture of Wallace and Gromit, Heath Robinson, and Scrapheap Challenge.

These types of artwork are tricky to describe, but generally speaking, "kinetic art" most commonly refers to 3-D sculptures that move naturally (e.g., wind powered) or are operated by a motor or the viewer. "Automata" have similar principals, but are commonly moving, mechanical human or animal figures, typically made from wood. You can read more about kinetic art and automata on our website: https://themadmuseum.co.uk/kinetic-art-and-automata/.



Founder Richard Simmons.

The MAD Museum was first brought to life by a local entrepreneur, Richard Simmons. Having an eye for weird and wonderful machines, and a passion for creative engineering, Richard decided to set up the UK's first mechanical-art venue in the tourist town of Stratford-upon-Avon in Warwickshire. He wanted to provide a permanent venue to display exhibits for those who would otherwise not come across such works.

Richard recruited his son Iain and nephew Mike Abbotts to head up the museum. With the help of a small, passionate team, The MAD Museum unbolted its doors for the first time on Friday, 23 March, 2012. Based on Sheep Street in Stratford-upon-Avon, the team spent the first year working hard to develop a sound reputation, while also building relationships with the local community and the mechanical-art world.

Inside The MAD Museum.

Keith Newstead's *Brassy Mermaid*.

Landing Surprise by Alan Westby.

Eighteen months after opening, The MAD Museum made the decision to relocate from Sheep Street to Henley Street, just around the corner. This move gave the museum a larger, more accessible premises and a more central location in the heart of the town, near Shakespeare's birthplace. On Saturday, 26 October, 2013, the new museum opened.

Since then, The MAD Museum has continued to display a steady rotation of new exhibits and artists. Richard Simmons has even built an exhibit that is currently on display in the museum. *The Kitchenator* is a rolling-ball sculpture made entirely out of things you would find in your kitchen. Richard found it a lot harder to make than he originally thought it would be, but he's not deterred and intends to someday make another creation to display at MAD.

RIGHT: *Recycled Rover* by Alan Oram.

In 2015 The MAD Museum hosted its first temporary exhibition, *The Inventions of Heath Robinson*, which displayed an exclusive collection of original prints by the prolific cartoonist and illustrator. The space that held this temporary exhibit then went on to become The MAD Zone, an interactive area in the museum in which visitors can build their own marble runs and creations.

In 2016 The MAD Museum invested in two laser-cutting machines and began producing marble-run construction kits and a small range of laser-cut products. This initiative has grown in size and demand, and now functions under a subsidiary company called MAD Factory.

Over the last three years, the company has continued to make improvements to the museum, run events, win awards, and work with local and national businesses. In a world full of computer screens and Do Not Touch signs, The MAD Museum continues to encourage visitors to press buttons and interact with machines, in the hope of encouraging imaginative thinking while engaging learning.

Neil Hardy's *Circus Piece*.

The MAD Museum crew. Left to right: Vicky Barrow, Mike Greenfield, Mike Abbotts, Iain Simmons, Morgan Amed, and Katie Wilson.

DEAD MEN DON'T WATERSKI

An automaton featuring the Pepper's Ghost illusion

by Peter Hurney • Berkeley, California, USA
Photos by the author

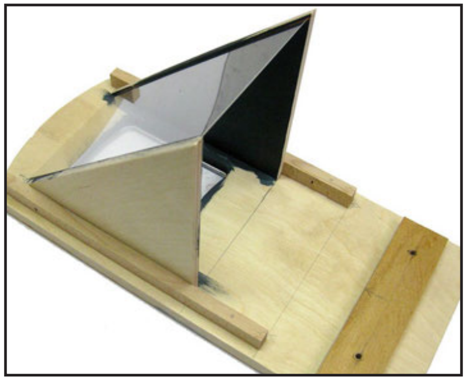
This project started out as part of a diptych of whimsical, yet random, automata. This one was intended to be part two of *Don't Drink and Row* and *Dead Men Don't Waterski*. The *Don't Drink and Row* automaton got off to a good start but got sidetracked and stalled. *Dead Men Don't Waterski* was started later but was completed first. I look forward to sharing the wisdom of not drinking and rowing in a later issue of this magazine.

The main thing I wanted to play with in this piece was the Pepper's Ghost illusion. The best-known use of this technique is the ghosts having a dinner party in Disneyland's Haunted Mansion, but the illusion has long been used in the theater and predates Disneyland by over a century.

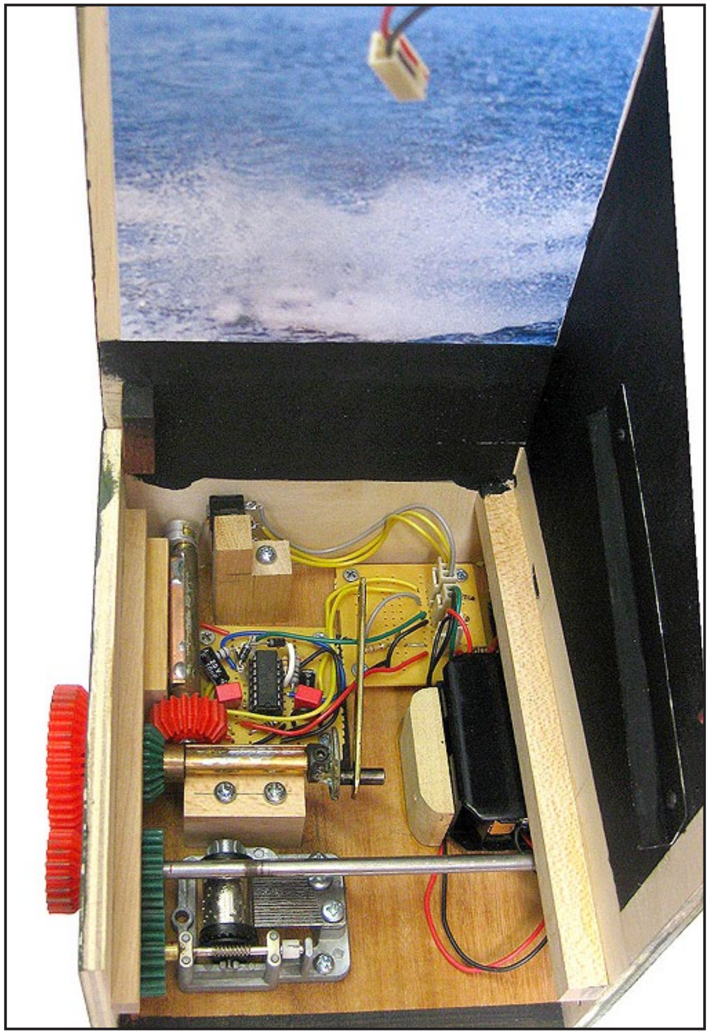
The illusion works via a sheet of glass that operates as a beam splitter (**photos 1-3**). In this project, the ghostly image of the water-skiing skeleton is reflected toward the viewer in the angled glass, while the lake background is seen transmitted directly through the glass.

Correct and balanced lighting is necessary to make the illusion work properly. In my box, the lake background is illuminated passively by ambient light coming in through a vacuum-formed, translucent, white Plexiglas roof, while multiple battery-powered LEDs illuminate the skeleton.

I find that sound makes automata more fun. While many of my projects rely on modern electronics for sound, I sometimes use simple, hand-cranked Swiss music boxes. Some of them lend themselves better than others to having gears added onto their shafts. Generally, older music boxes work better. With the musical mechanism I used for



1. The front panel, face down. The reflecting glass is angled in front of the viewing window.



2. The picture of a lake on the back wall is viewed directly through the front window. Mechanics are hidden when finished.

3. The ghost appears when the skeleton is lighted and its image is reflected in the angled glass. It can't be seen when the lights are out.

this particular automaton, I was able to solder a brass sleeve onto its shaft, then knurl the sleeve and press a plastic gear onto it. American Science & Surplus (*https://www.sciplus.com/*) regularly carries these little plastic gears, for which I keep finding good uses. Shafts should be knurled to lock the gears onto them (**photo 4**).

To enable the battery-operated LEDs to turn on and off without the use of a manual on/off switch, I used a cam-operated microswitch (**photo 5**). My co-conspirator, Isaac Snider, came up with a clever little circuit using a 556 timer chip, which is a dual version of the standard 555 timer (see the sidebar). In function, this circuit turns on with a change in the microswitch and shuts off shortly after the switch stops cycling. The power consumption at rest is low; a 9V, 600Ah battery lasts three months or so.

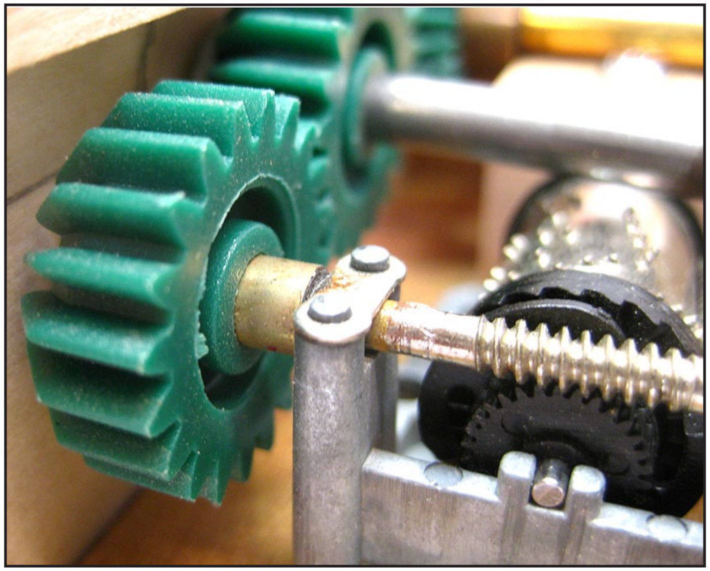
The cam on the shaft cycles the microswitch (**photo 5**). You may think it odd that the cam is driven by an extra shaft when it could have been placed onto the cranking shaft. I had initially wanted the illusion of splashing water in front of the water-skiing skeleton, so the cam was originally put there to jiggle a plate of glass onto which "splashing water" was painted. This illusion proved to be visually disappointing.

An animator friend suggested that to make it more convincing, two pieces of glass would be required, with the splashing water painted on each. The two pieces, moving separately, would create a kind of a moiré effect. For what it would add to the visuals, as compared with the added complexity of the mechanism, I scrapped the idea and just used the cam for the micro-switch. I always let my pieces evolve as they are being built. If an idea doesn't work out well, or if a better idea presents itself, I will change, even if it sometimes means backing up and creating more work. I usually prototype my automata to work out ideas and concepts and to see how they will work mechanically and visually (**photo 6**).

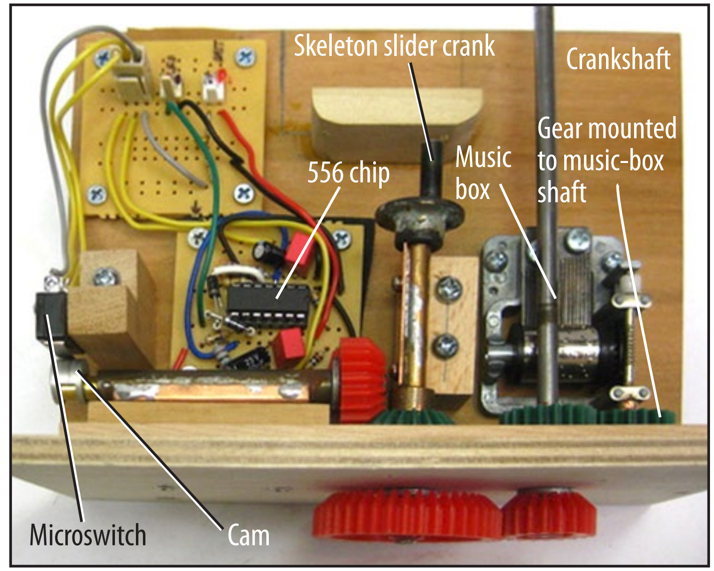
Another idea that changed while I was working was the motion of the water skier. He was originally mounted on a see-saw type of rocking platform. The motion didn't look right so I changed the mechanism. He got moved onto a sliding platform. A simple crank arm moves the platform back and forth (**photo 7**).

I wanted a little hesitation in the skeleton's up-and-down movement so he would appear to travel up, pause, travel down, pause, and so on. I achieved this by simply placing a second platform on top of the crank-driven platform. This second platform is friction driven, just by sitting on top of the moving platform. The upper platform is longer than the lower one, so it reaches its end stop sooner. Then it pauses while the lower platform completes its movement. It's a subtle difference but it makes the motion look better.

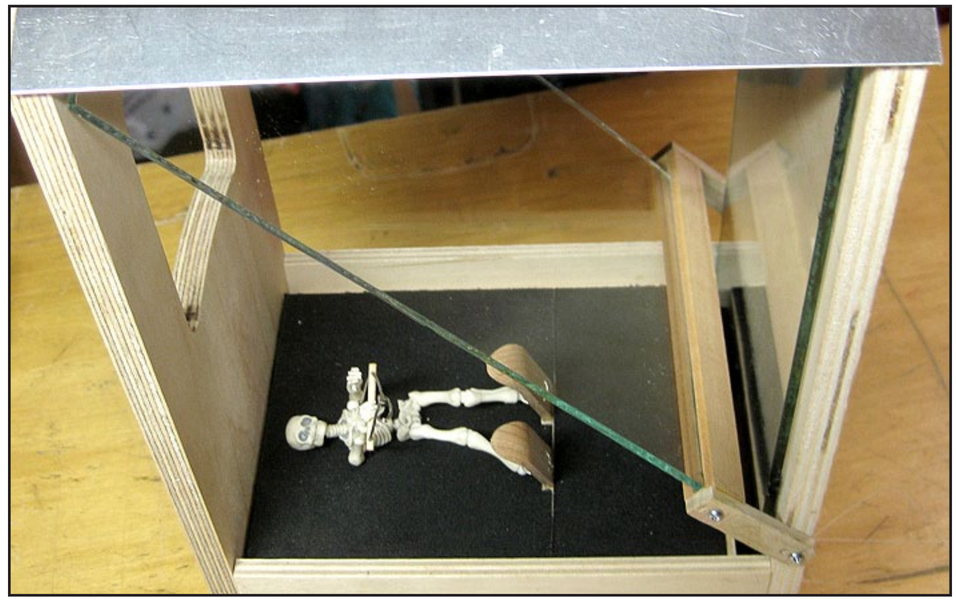
LED lights illuminate the figure. I found that the little LEDs are quite directional—they act like tiny spotlights. I had to use a line of seven of them, aimed head-to-ski along the full motion path (**photo 8**). There are



4. A knurled brass tube was soldered to the shaft of the music box and a plastic gear was pressed onto it.



5. The interior of the automaton. The only thing missing from this photo is the battery power supply.



6. The author's automaton in the prototype phase. The ultimate positions of the skeleton and the reflecting glass were determined through experimentation.

two additional LEDs that point in from the other side of the box, to help the lighting. No more than three LEDs can be in series on a 9V circuit, so I split them up into groups of two (using a 220-ohm resistor), and a single LED (with a 560-ohm resistor). The 9V battery box is made by Gotoh for guitars and ukuleles, for when one wants to add active electronics to an acoustic instrument.

The automaton's box is painted with acrylics. The "Dead Men Don't Waterski" lettering, the frame around the viewing window, and the skull and crossbones were laser cut out of thin wood, then glued to the face of the box. The viewing window is clear acrylic. A short video of the finished automaton can be seen at *https://tinyurl.com/DeadMenDontWaterski*.

7. The bottom plate oscillates while the top plate, with the skeleton, slides with it. When the top plate hits the stops, its motion pauses.

8. LEDs, placed in the side wall of the unit, evenly illuminate the skeleton from skull to skis.

The timer circuit for the LED lighting in *Dead Men Don't Waterski*

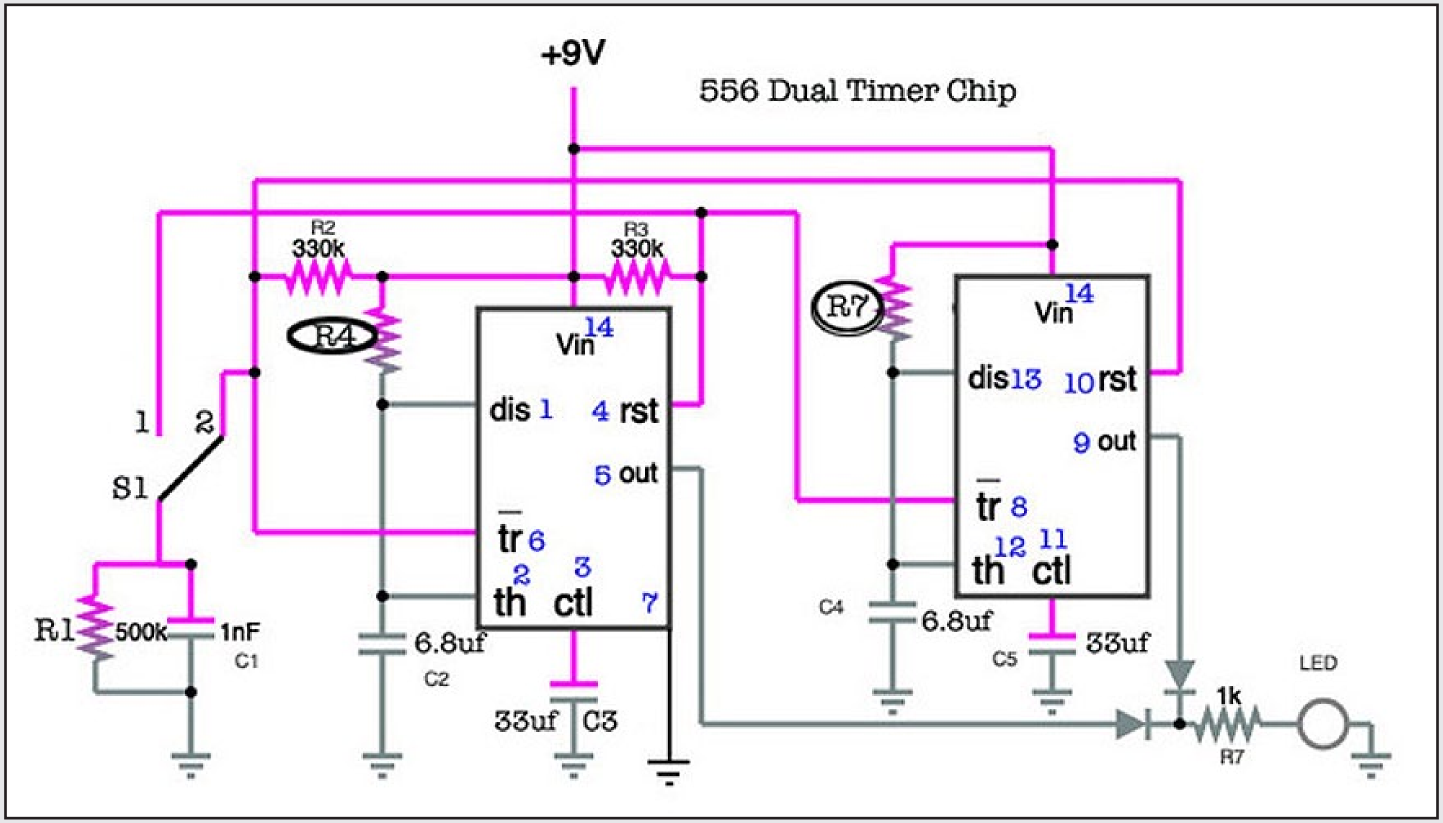
by Isaac Snider • San Francisco, California, USA • Photo by Peter Hurney, diagram by Isaac Snider

Over the years, I have built a few Arduino-powered automata projects. Arduino microcontrollers are great. They're easy to use, inexpensive, and versatile. This project was a bit different though. It is a simple, hand-cranked box. We wanted to turn on seven LEDs, leave them on for a few seconds after the cranking stops, and power them with a 9V battery.

The functionality would have been a simple task with a microcontroller. It would take just a few lines of code, a few resistors, and a transistor. The issue we'd run into is that, out of the box, an Arduino Nano draws about 15mA of power. At that rate, it would drain the battery in under three days. There are some hardware and software tricks that will drastically cut down this power consumption, to about 10µA (0.01mA), so the battery would last for years. However, this would get into more complex code, and for what we were doing, using an Arduino was a bit of overkill.

We settled on using a 556 timer. The 556 is just two 555 timers in one chip. The 555/556 timer is an amazing little chip—much more than just a timer. It can be an audio amplifier, a motor driver, a servo controller, a tone and signal generator, and lots more. (Search Google for 555 timer projects, and discover all the cool things you can do with them.)

The 556 timer is a good balance between power consumption and simplicity. It has three 5k-ohm resistors in series, so at 9V, it only draws about 0.6mA. It can also handle 200mA, so it can drive LEDs directly without the need for an additional transistor. For the purpose of this article I will refer to the 556 as two 555 timers.



The circuit. Before we start, you need to understand a little about how the 555 timer works. The main things we will focus on here are the discharge pin, the threshold pin, the trigger pin, and the reset pin.

The trigger input on the 555 timer needs to see a voltage of less than one-third of the source voltage in order to turn the output on. To turn off the output pin, we need to apply a voltage of less than 0.7V.

The threshold pin will also turn the output off when the applied voltage reaches two-thirds of the source voltage. The discharge pin is used to discharge a capacitor once the timer is reset.

This box has a hand crank driving a cam, which triggers a SPDT switch. Each throw of the switch is connected to the trigger pin of one of the 555 timers and the reset pin of the other 555 timer. They are also each tied to the input power through a 330k-ohm resistor. The common contact on the switch is tied to ground through a 500k-ohm resistor, and a 1nF capacitor is connected in parallel.

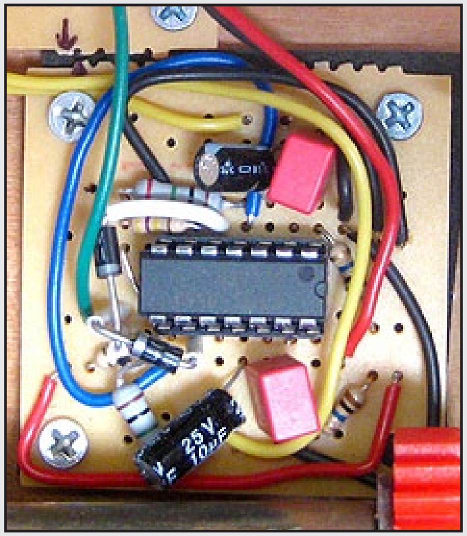
The resistor-capacitor circuit is the key to making this work. When the switch is in either position, the capacitor is charged and the series-connected 500k-ohm and 330k-ohm resistors form a simple voltage divider. The output voltage works out to about 5.4V when using a 9V battery. This is the voltage being applied to the trigger input on one timer IC and the reset input on the other. Remember from above that the trigger pin needs to see less than one-third of the input voltage to turn the output high, and the reset needs to see less than 0.7V to turn the output off.

When the cam rotates, the throw of the microswitch toggles back and forth, but it isn't always at one or the other throws. Each time the switch switches, there are a few milliseconds between the time the contact is broken on one throw and the time contact is made on the other throw. This is where the capacitor comes into play. In those few milliseconds there is no voltage being applied to the capacitor or resistor, which allows the resistor to discharge the capacitor.

Now the capacitor needs to draw power to charge back up. When the capacitor is fully discharged, it will draw a lot of current when voltage is applied. This causes the voltage across the 330k-ohm resistor to drop very low, below 0.7V. At this point, one of the 555 timers is reset by the reset pin and the output on the other is turned on by the trigger pin, which has been pulled below one-third of the source voltage.

The capacitor rapidly charges up to 5.4V. Once it has reached equilibrium with the voltage divider, it is almost as if it doesn't exist until the next cycle. This will keep happening, as long as the cam is being turned and the microswitch is being toggled.

This covers how the LED is switched on. Now we will cover how it is switched off, which is much less complicated, being just a standard 555 circuit. On the diagram, there are two resistors that are connected to power (R4 and R7). Their other



The 556 chip and its associated resistors and other electronics.

sides are connected to the discharge pin and the threshold pin. There are also capacitors that connect the resistors to ground.

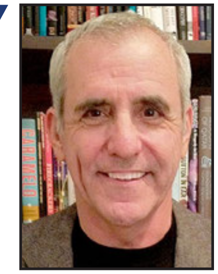
As current flows through the resistors, it charges the capacitors. As the capacitors charge, the voltage increases, as does the voltage being applied to the threshold pin. Once the voltage reaches two-thirds of the source voltage, it causes the output to be turned off. It also grounds the discharge pins and, as a result, discharges the capacitors. The discharge pins remain grounded until the trigger is pulled low again. By increasing the capacitor or resistor size, you can make it stay on longer; by decreasing both you can make the interval shorter. For durations up to about ten seconds, you can simply adjust the resistor size based on the table below.

Value of R4 & R7	Approx. time in seconds the light will remain on
150k	1.3 seconds
220k	2 seconds
330k	3 seconds
470k	4 seconds
560k	5 seconds
680k	6 seconds
1 Meg	8.5 seconds

This was my first attempt at building a 555 timer circuit that did anything more than make a light blink. I came away with a new appreciation for the little chip. There is an elegance to the way these chips work that I had not understood until now. It was nice to get my head out of the world of "for loops" and "if/then statements" and work with what some consider to be the greatest chip ever made.

This chip is nearly 50 years old and about a billion of them a year are still being built, which is a good run for anything. In researching this project I was shocked at what this chip can do. I can't wait to try it out with another project. If you've never worked with 555 timers before, I encourage you to check them out. AL

GALLERY



The Cheater

by Randall Rudd

San Antonio, Texas, USA

Photo by the artist

One youth writes confidently. The other doodles aimlessly, as his gaze subtly shifts to his more-studious classmate's paper in a grim attempt to procure knowledge. Unbearable suspense ensues, until a surprising chain of events takes place.

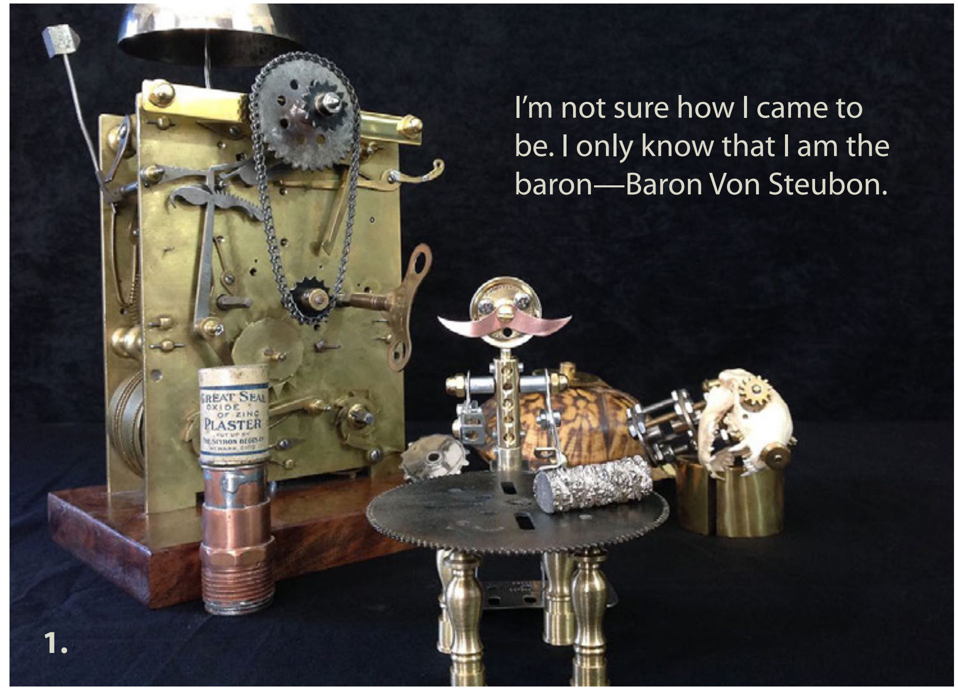
To see a video of the cheater's mischief, click **here**.

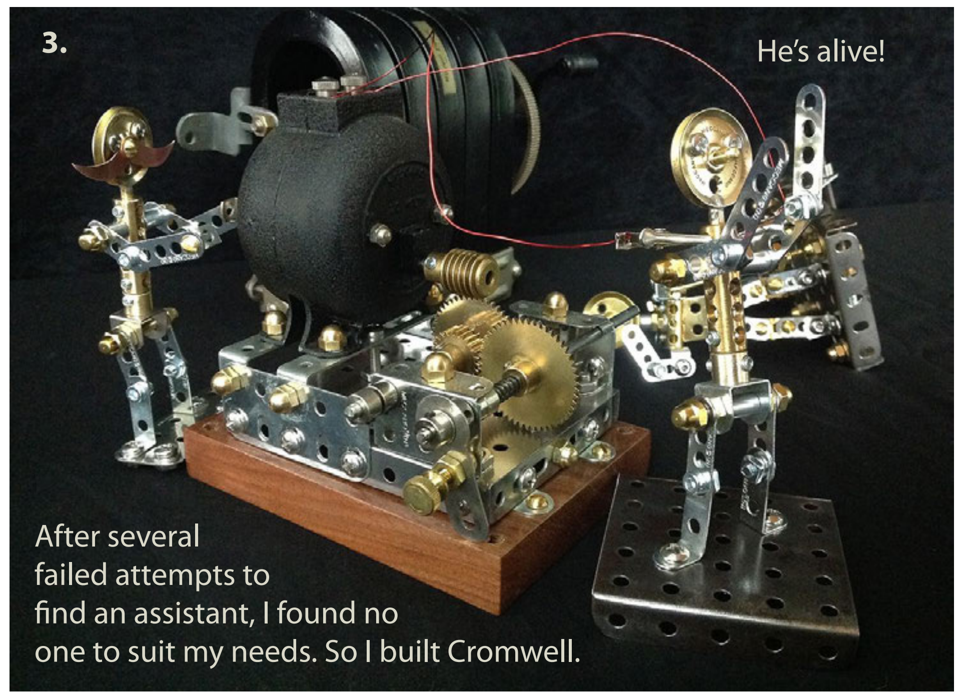
THE ADVENTURES OF

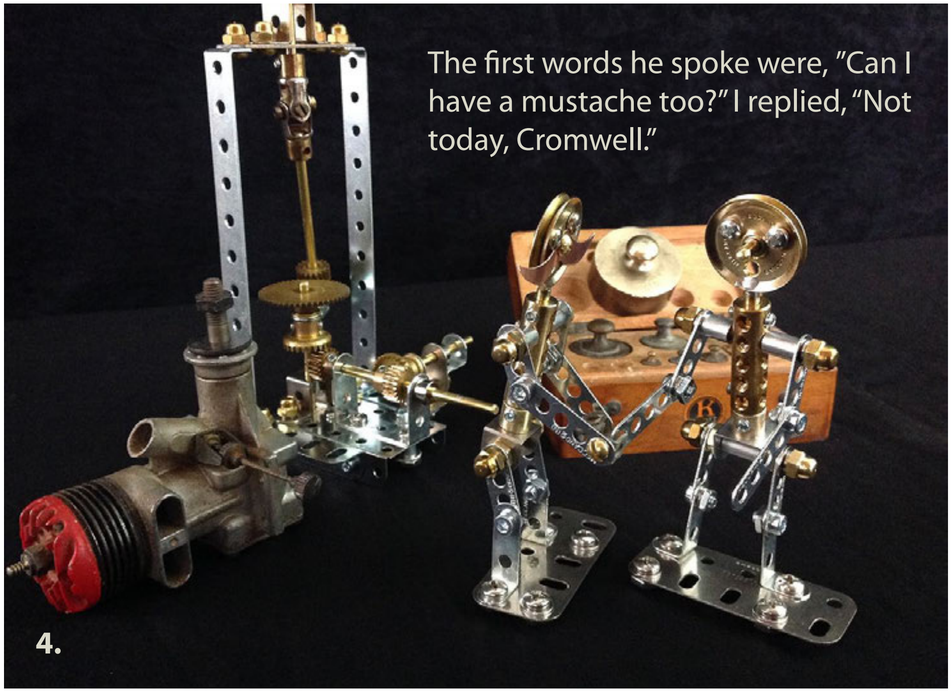
BARON VON STEUBON AND CROMWELL

Episode 1: The adventures begin

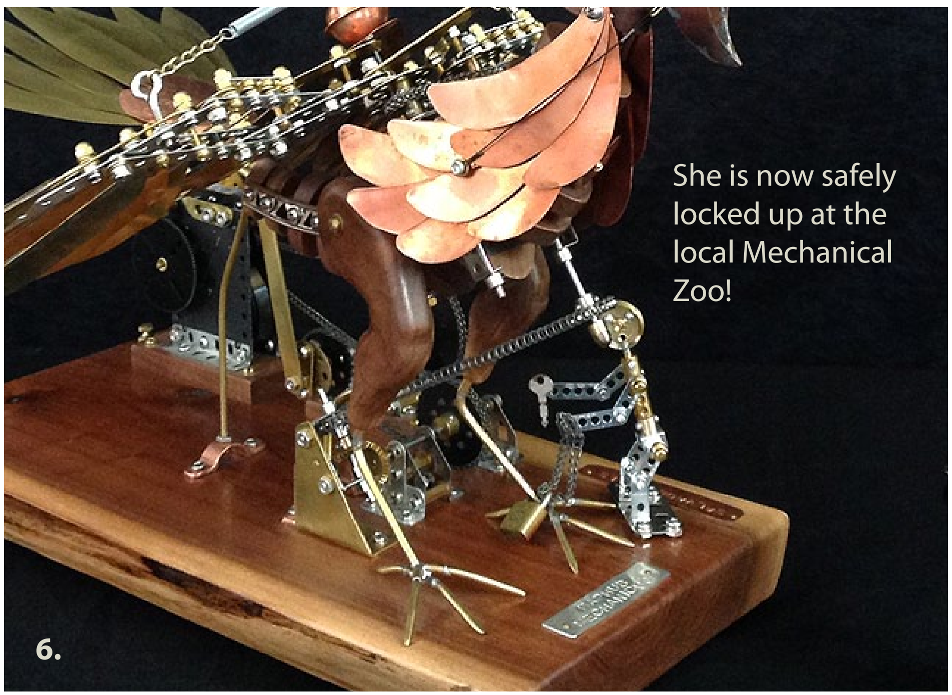
by David Bowman • Mechanicsburg, Pennsylvania, USA
Designs, constructions, and photos by the author






The first words he spoke were, "Can I have a mustache too?" I replied, "Not today, Cromwell."
4.


On Monday we had to save the village from a rampaging Dodo Bird.
https://youtu.be/-Sd4FPX_tbo
5.

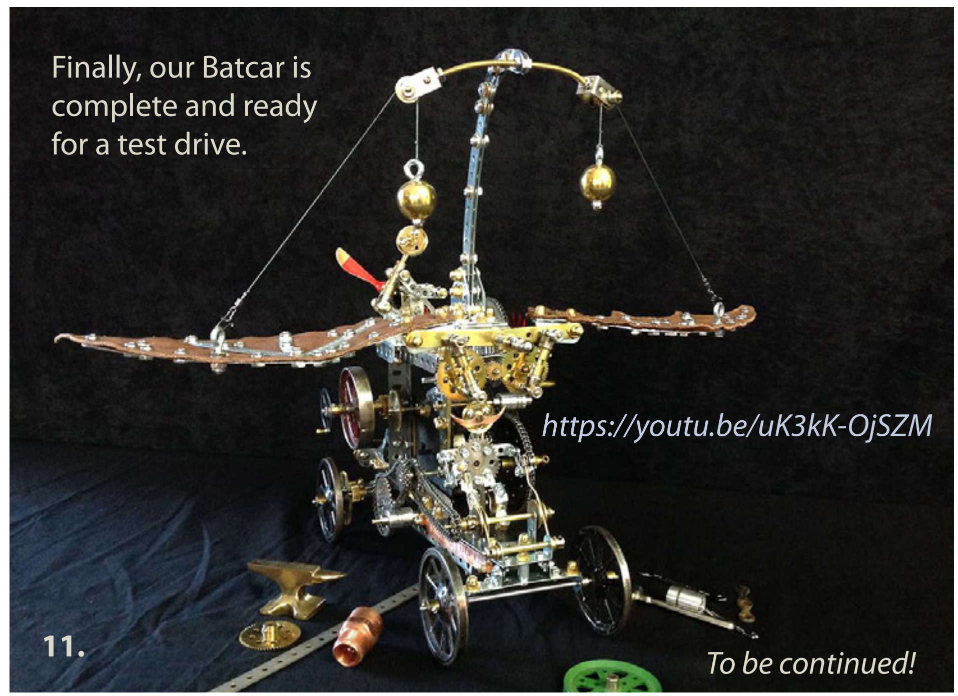

She is now safely locked up at the local Mechanical Zoo!
6.


On Tuesday, we had to barter keys with the Giant Bear Skull, who had taken our friend captive.
https://youtu.be/H6h3p5rh_cY
7.

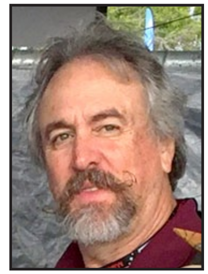

After many offerings,
the giant key did the
trick. Bernard is now
safely home, working at his restaurant.
8.


As more calls for
assistance came in, I
decided we needed
some vehicles to
allow us to travel
quickly to remote
destinations.
9.


"Put your back into it,
Cromwell!"
10.


Finally, our Batcar is
complete and ready
for a test drive.
https://youtu.be/uK3kK-OjSZM
11.
To be continued!

Exhibiting at the Maker Faire Bay Area



A hands-on display brings automata to thousands

by Matthew Pomerico
Paso Robles, California, USA
Photos by the author, unless noted

Adults playing with the author's automata at the 2019 Maker Faire Bay Area, in San Mateo, California.

I am a wood carver of 20 years. In the past few years, my focus has shifted to making carved-wood automata. I have made a few dozen in that time and even teach automata making to other wood carvers who are interested in making their pieces move. I've also made working wooden models of paper automata by Keith Newstead and Rob Ives, as well as some of my own design. My last automaton used Dr. Seuss's book *Hop on Pop*, which I made move. When the handle is cranked, the kids hop on Pop.

I love seeing all of the different ways people make their own automata. Carving is still my main focus and I like to see how much I can make just from wood. However, I understand the flexibility necessary for using other materials to accomplish smooth movement.

This past year, I was able to participate once again in the Maker Faire Bay Area, in San Mateo, California, as an exhibitor. I went there, along with my good friend Ken Morgan, to represent the California Carvers Guild. Last year was my first opportunity to present my wooden automata at the Faire. What I noticed then was that people who were carrying things had a hard time turning the handles on some of the lighter-weight pieces.

With that in mind, I built a display unit that was heavy enough to anchor the pieces to it. This accomplished two things. The first was that only one free hand was necessary to operate the automata. The second thing was that the pieces couldn't just walk away. As a bonus, I was able to make two levels on which to display my work.

We had a great time talking to people from all over about our

ABOVE: The author's display at the Maker Faire.

LEFT: Kids playing with the author's automata.

craft, and with my focus on my automata, it was great to see people light up when they saw how my work moved.

We set up on Friday, prepared for rain with tarps and warm clothes. Friday is the day that a lot of the schools attend and it was great fun to see the kids interact with my automata. We talked with hundreds of people, who ranged in age from 5 to 85, plus lots of makers and craftspeople from all over the country. I answered numerous questions on what I was making and why I like to carve them.

Most of the kids just wanted to crank the automata to see what happened, but a lot of them wanted to know how I got the pieces to perform the way they did. These kids spent as much time looking at the mechanical parts as they did at the figures themselves. For me, the best part is the look on people's faces when they see the figures come to life: from the delight of a six-year-old girl, giggling when the kids on *Hop on Pop* start bouncing up and down, to the sly smile of the 75-year-old man following his wife around, when he made the *Surfing Dog* ride the wave.

The author's display being test run on his garage bench.

If you have never been to a Maker Faire, I strongly suggest you look for one in your part of the world. These have been going for about 13 years so far and are great places to learn about all sorts of new things. At ours, we saw glass blowing, forging, spoon making, and every electronic development you can think of. Laser cutters, CNC routers, and 3D printers were well represented, and information was available everywhere. The Faire provided an opportunity to learn new skills for advancing your automata designs.

Many of the booths had participatory demonstrations so you could try your hand at different things. You could assemble a simple, blinking-LED kit and learn to solder. At another booth, they were teaching the use of an electronic breadboarding kit. You could talk to the 3D-printer people to get ideas on just what those machines were truly capable of, or you could compare them to the practicality of a laser cutter for making gears for your automata. I picked up a paper robot, powered by fan, that walks across the table, and a cardboard, winged unicorn to assemble.

The highlight for me came on Sunday, when, after talking with a lady about what I was doing and showing her the workings of one of the models, she thanked me and stepped back so I could talk to another person. She then came back and said she had something for me—a blue ribbon that was the Maker Faire Editor's Choice award. They took my picture and left me feeling very grateful. It was a good day.

CAROL EAVES

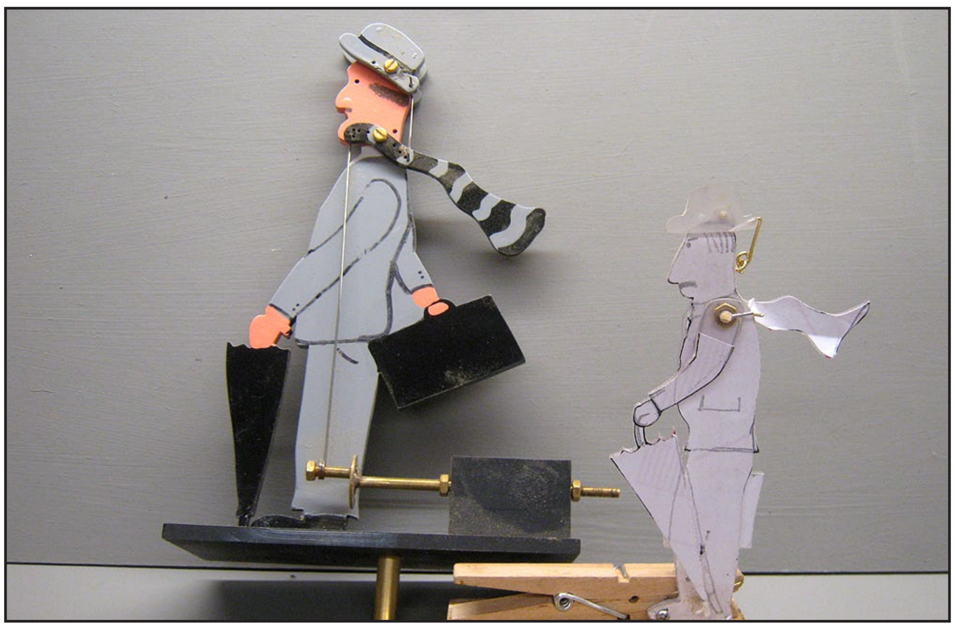
Left to right: Gary Eaves, Ken Morgan, and author Matt Pomerico.

A man battles the wind

A clothes-peg automaton you can build

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

I'd been playing around with this idea for a while, first as a whirligig (**photo 1**). I thought it was great that the man was fighting against the wind, which was the very thing that made him work as a whirligig! However, at the time, I really couldn't make the device



1. The first incarnation of the windblown man was a whirligig, seen here in the background. In the foreground is the author's prototype clothes-peg automaton.

Weather Man is annoyed at having to battle the wind gusts.

work well enough. The man's hat was clumsy and unreliable.

The figure went through various incarnations since its inception and had been put back on the shelf several times. Now he's made a reappearance, in my flurry of clothes-peg-automata making.

Doodling one day, I came up with a character I was happy with. He had just the right shade of pomp, self importance, and impotent fury— how dare the wind interfere in this person's important day?

I wanted his scarf and hat to move with the wind gusts. His briefcase needed to move, too, and he should lean into the prevailing wind. As I am always happy to get as much movement for free as possible, I linked his arms on a single rod through his

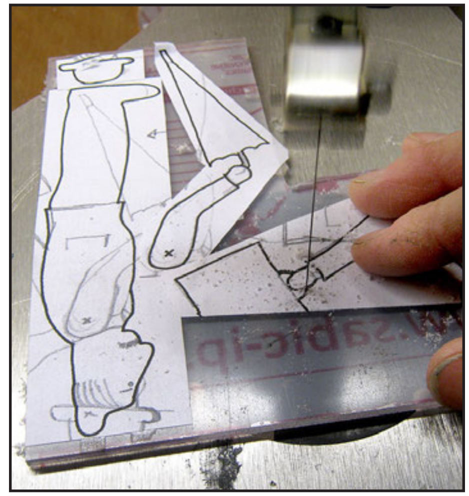
2. Several copies of the drawing were made. Parts are individually highlighted on each drawing.

body and made his scarf part of the rear-arm assembly. His hat was a little trickier. It's still a little clumsy but getting closer to what I'm looking for.

I started with the drawing. I wanted an archetypal 1950s businessman who looked silly and self important. I got lucky in that the drawing came out pretty much as I wanted. I then photocopied him several times. On each sheet, I outlined the bit I needed to cut out to make the whole (**photo 2**). Notice the knob on his head where the hat attaches.

After sticking the various pieces to 3mm (1/8") Perspex (Plexiglas), I cut them out on the scrollsaw (**photos 3** and **4**). Often, if I'm making several of the same piece, I'll stick three sheets of Perspex together, getting three for the effort of one. This technique can also be useful at this early stage—if the first goes wrong, you still have a couple of extra pieces to play with before having to cut again.

I drilled 3mm holes in the arms and 3.2mm holes in the body. M4 nuts were used as spacers between the parts. I tried gluing



3. Parts are cut out on the scrollsaw. The author made his man out of acrylic sheet.

the arms to their rod but failed. Instead, I drilled through the arm's edges, into the rod, with a 1mm (#61) drill, then pushed in a 1mm brass rod to fix the arms in place.

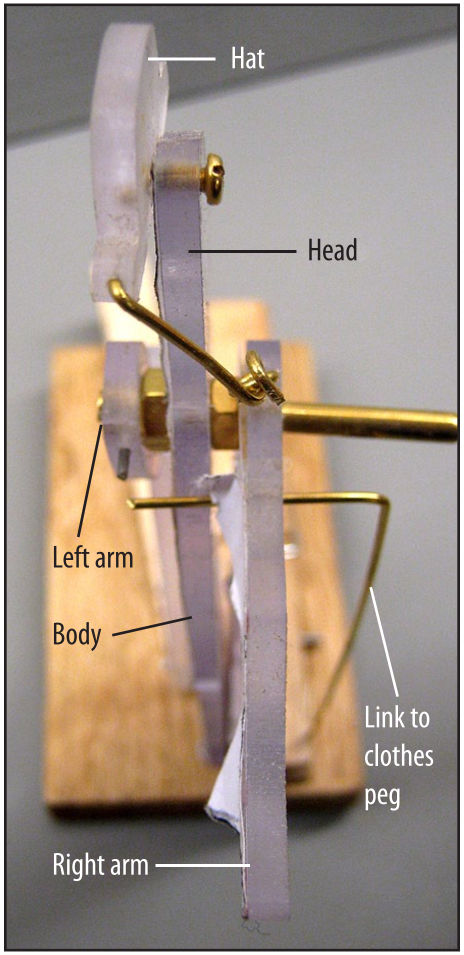
I drilled a blind hole, 1.5mm (#53) diameter, in the edge of the back of the hat. Through the knob on the top of his head, I drilled a 2mm-diameter (5/64") hole. This allowed me to screw in an M2 brass machine screw, fixing the hat to his head but keeping it loose enough to easily move. All of this can be seen in **photos 5** and **6**.

Connecting the arms to the clothes peg is more art than science. Often, several attempts are required to find just the right spot to attach the rod to the arm.

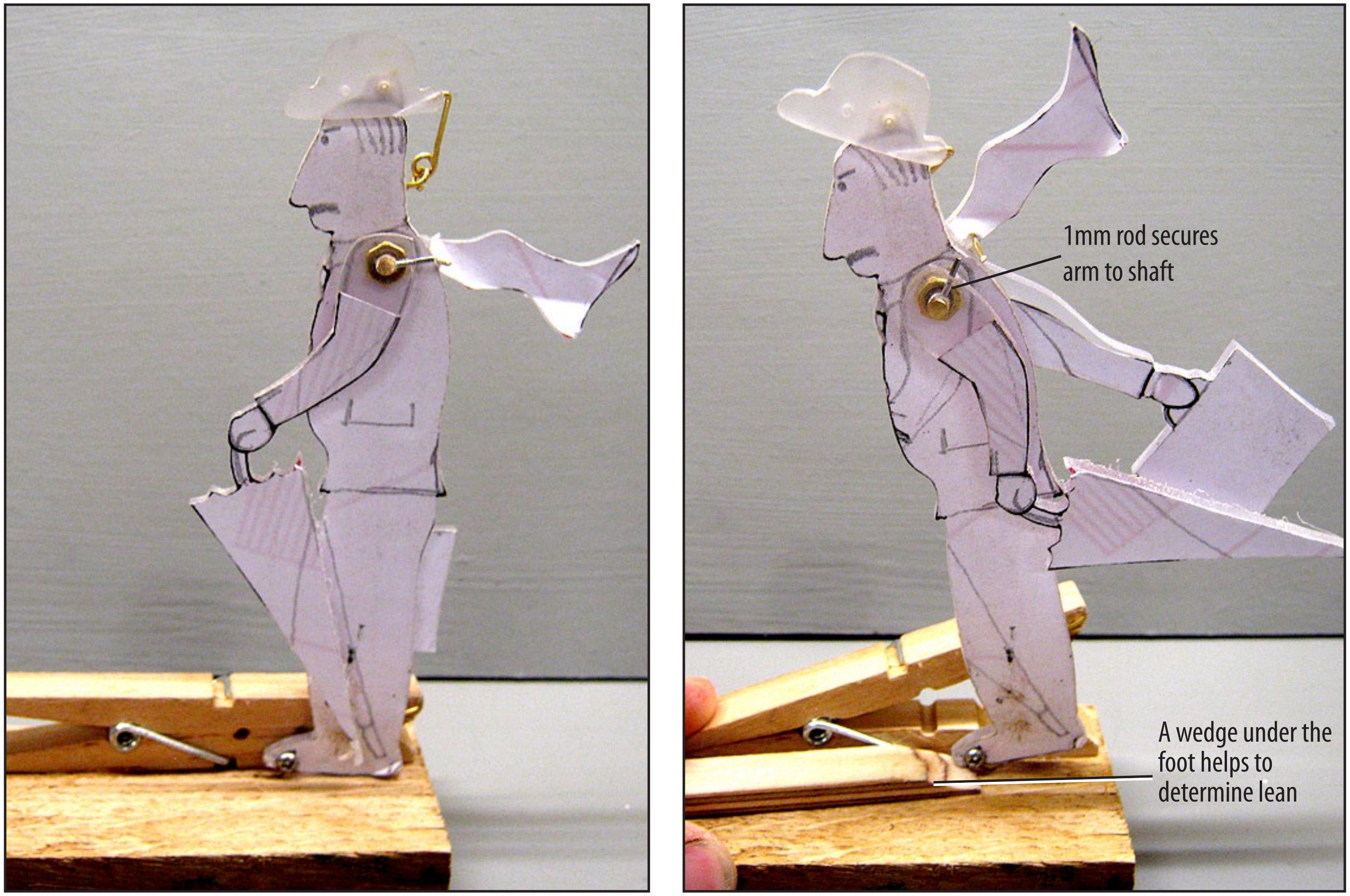
4. The plastic parts, cut out, with the drawings still stuck to them.

5. The automaton seen from the back side.

I drilled a 1.5mm-diameter hole in the moving part of the clothes peg. I then took a good guess where the arm needed drilling



6. The piece, edge on, showing the linkages.



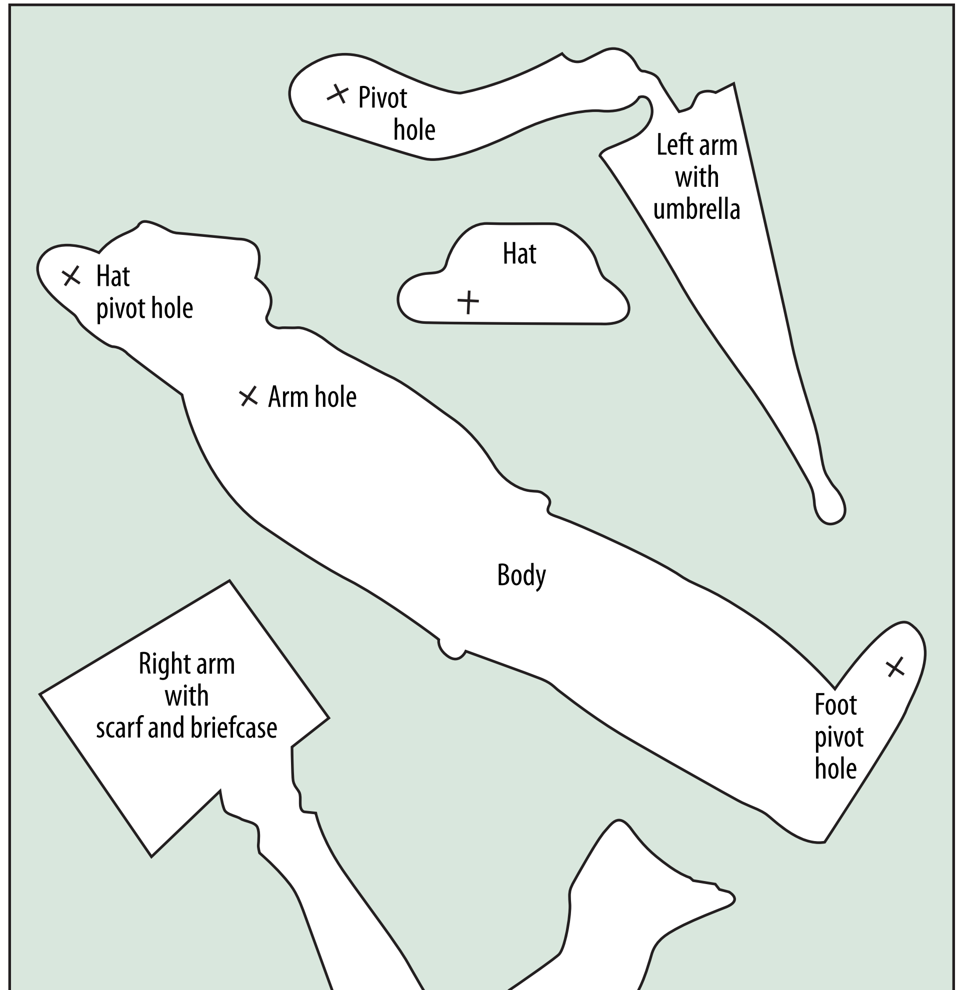
7. These two images show the action of the figure when the clothes peg is pressed.

and, with the same 1.5mm bit, drilled a hole there.

I bent a piece of 1mm brass rod to 90° and threaded it into the hole drilled in the peg. Then I eye-balled the point at which I needed to make the bend in the rod, to match up with the hole in the arm. I added a millimeter or two, then, holding the rod in pliers at that point, made the bend. It's better to make the rod a fraction too long, as you can always kink the wire to take up slack. If it's too short, you have to start again. Check the movement. Sometimes you have to drill several holes in the piece to find that sweet spot.

Getting the man's body to rock forward as everything else moves back was important. It meant that he had to be pivoted on his foot. I got lucky here, without much thought, as the figure did just what I wanted. Using a wedge under his shoe, I was able to manipulate how far forward he moved—too much, and the arm movement was lost; too little, and the lean was negligible. Sliding the wedge back and forth gave me options. **Photo 7** shows where I drilled and pushed in the 1mm rod to secure the arm. Also shown is the plywood wedge under his foot, limiting his lean.

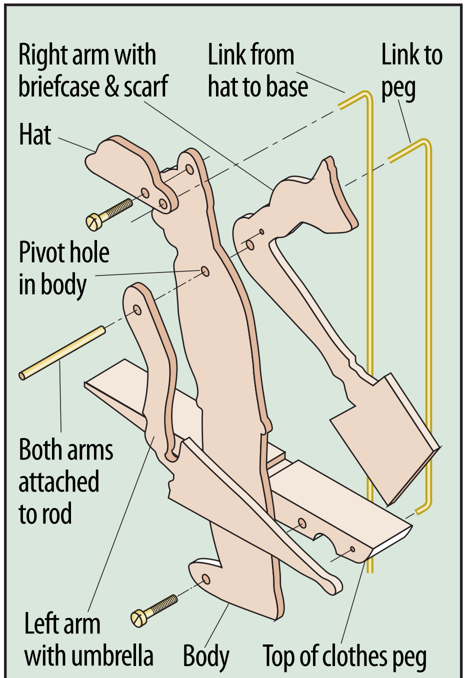
8. The finished piece, fully painted. This view of the back side cleary shows the linkages. Note that the rod connects the hat to the base, instead of to the shoulder.



Full-size parts to cut out
Use 3mm- (1/8") thick material

To get the man's hat to fly off in the wind, I originally linked it to his right shoulder. You can see this in **photos 5-7**. However, I wasn't satisfied with this arrangement, so in the final incarnation, I ran a 1mm rod from his hat to the base (**photo 8**). This arrangement makes his hat come off in the wind just fine, and it is less visually obtrusive.

I think—if Weather Man makes it beyond the peg stage to a pedestal, crank handle, and cam—I would like to try to include some other windy notions. These might

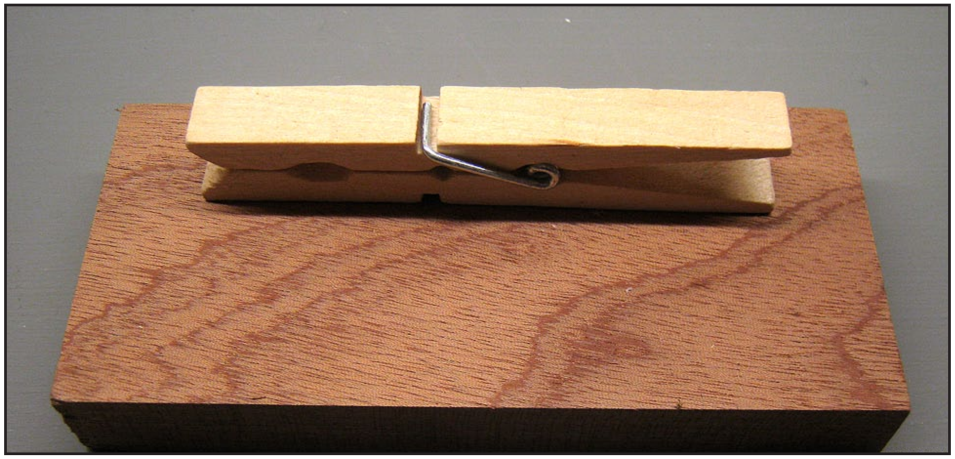


Schematic assembly drawing

include a newspaper flying past or a tumbling cat!

There was still the finish to consider. I chose matte black for the man's clothing and an acrylic flesh tone for his skin (**photo 8**). For details such as hair, eyes, etc., I used an India-ink marker pen. For a little dash of style, I painted a stripe of gloss black on his bowler hat, to give it a satin band. After all, he is a very, very important person.

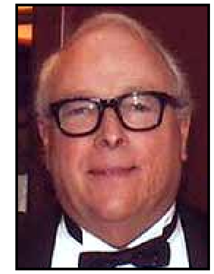
I found a handy piece of scrap wood for the base and glued the clothes peg to it (**photo 9**). I left it overnight to cure. For titling the piece, letter stamps are useful (**photo 10**). I colored in the letters with a fine-tipped pen after they were stamped into the wood. AM


9. A wooden base enables the figure to be free standing.

10. Metal letter stamps were used to stamp the title of the piece into the edge of the base.

The Musical Box Society

An organization with an interest in automata



by Terry Ware • Fareham, Hampshire, UK • Photos courtesy of the Musical Box Society of Great Britain

The Musical Box Society of Great Britain (MBSGB) is an international organization with members in Europe, North America, Asia, and Australasia, all who share an interest in mechanical musical instruments. Four times a year the MBSGB publishes its internationally acclaimed journal, *The Music Box*. Each full-color edition of 40–44 pages features a wide variety of topics, such as instruments of specific or novel interest, research, collecting tips, and restoration techniques and projects. Many of the articles are by world-recognized experts in their respective fields.

Formed in 1962, initially for lovers of musical boxes, the society now embraces all forms of self-playing instruments, including minute singing-bird automata, musical snuff boxes, various

Fairground-organ automata.

other automata, cylinder and disc musical boxes, organettes, barrel organs and pianos, self-playing pianos and pianolas, fair organs, and orchestrions.

I have been a member of the MBSGB for many years now. I joined the society because they have an interest in automata. Since many early automata were powered by a musical-box mechanism, the link was established. At the time I joined, it was hard to find many people or groups interested in automata.

The society is mostly about mechanical music. However, a number of members own automata. At the meetings, members are happy to demonstrate and talk about them. In more recent years, automata have become much more prominent in the public eye. This may be due to the increasing development of robotics technology available to the general public and schools.

The Music Box carries news about society current events (meetings, visits, auctions, etc.), international mechanical-music events, collections, museums, and other places of interest. It also provides news from other mechanical-music organizations, many of them overseas (Musical Box Society International USA, for instance), as well as quality articles, some which are related to automata. If you are interested in mechanical music and automata, I recommend visiting the website: https://www.mbsgb.org.uk/

Tortoiseshell singing-bird *tabatière* (snuff- or tobacco box).

Benefits of the Musical Box Society

The Musical Box Society of Great Britain offers the following:

- National and local events for socializing and for enjoyment of mechanical music
- Promotes research and publishes books on various aspects of mechanical music
- Publishes the quarterly journal, *The Music Box*
- Maintains a unique register of cylinder musical boxes
- Maintains a comprehensive archive
- Holds an annual auction

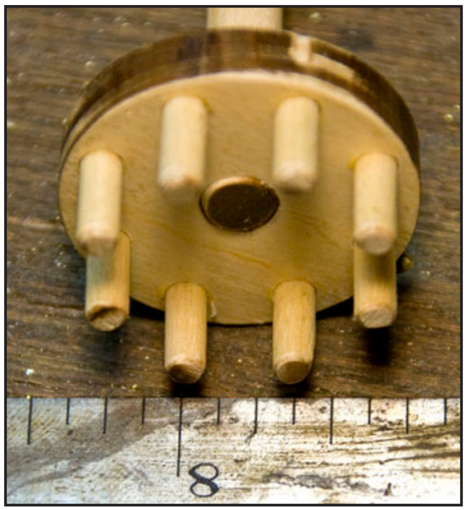
Make your own worm gears

Two methods for slowing down your automata: Part 2—the wire

by Marc Horovitz • Denver, Colorado, USA
Drawings and photos by the author

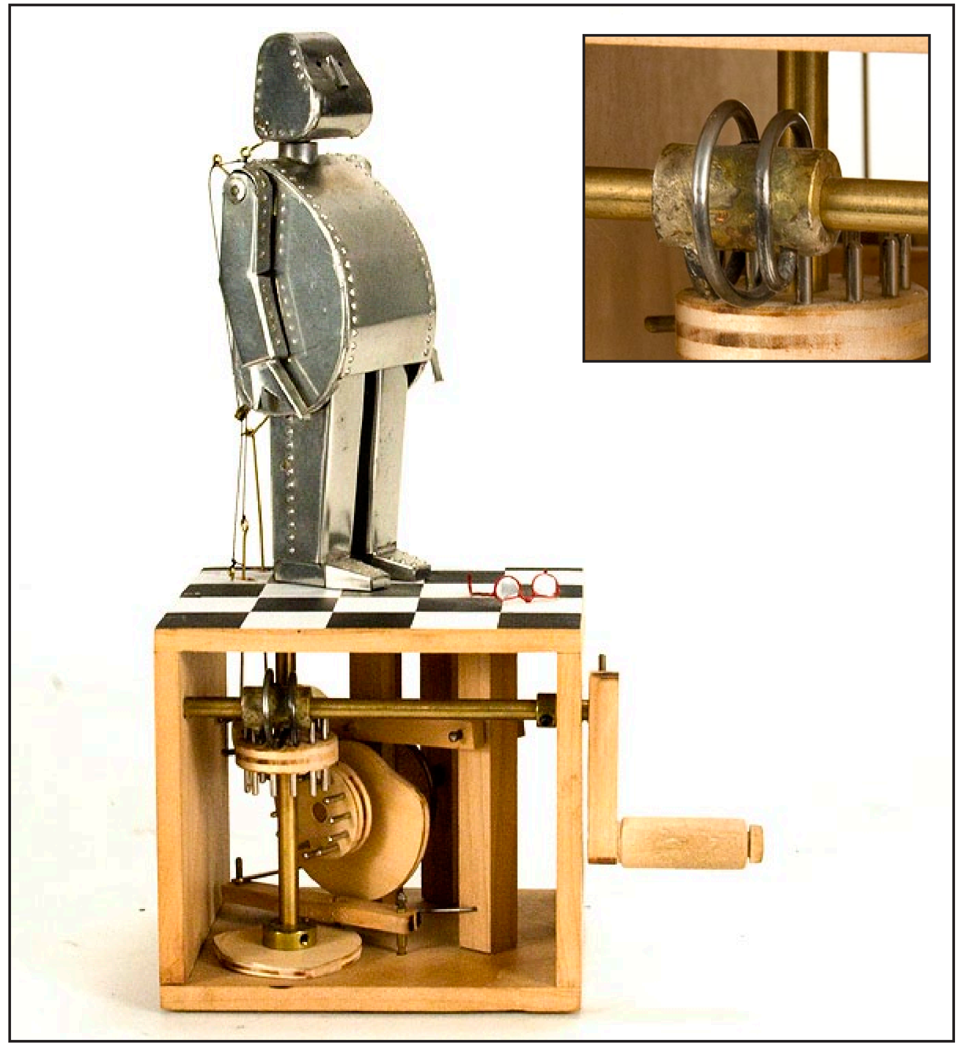
In the last issue of *Automata Magazine*, I described how to make a worm gear out of a common washer. In this issue I'll show you a different method, using a piece of wire. There are several ways to approach this subject. I'll show you one that works for me, but don't let that stop you from experimenting with others.

My pinwheel has wooden teeth with a pitch of 3/8" (9mm), as can be seen in **photo 1**, so my worm gear will have to match it (see **figure 1**).



1. The pitch (distance between the teeth) of this pinwheel is 3/8" (9mm).

Choose a suitable wire for your worm gear. It should be stiff enough to withstand a little pressure without deforming, but not so stiff that it is difficult to work with. For this demo, I am using 1/16" (1.5mm) aluminum welding rod.



Walter is powered by a worm gear made of wire bent into a helix. The worm engages a 12-tooth pinwheel gear, so it takes twelve turns of the crank to put the robot through his paces.

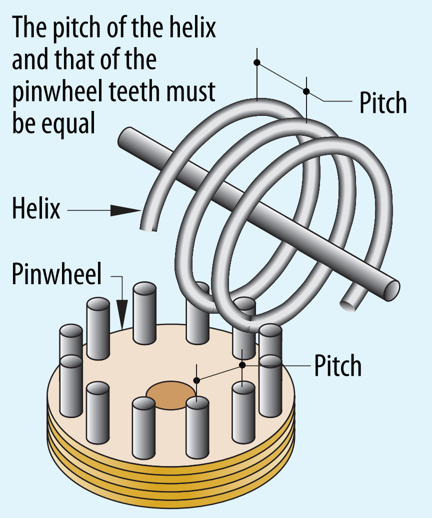
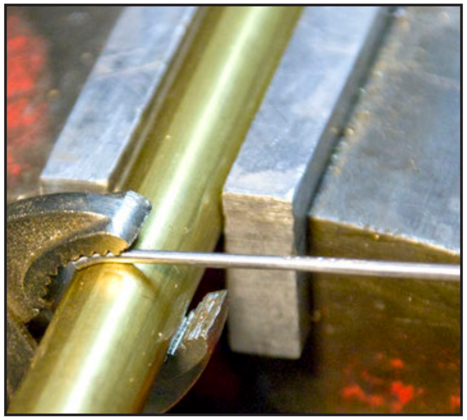


Figure 1—Gear pitch

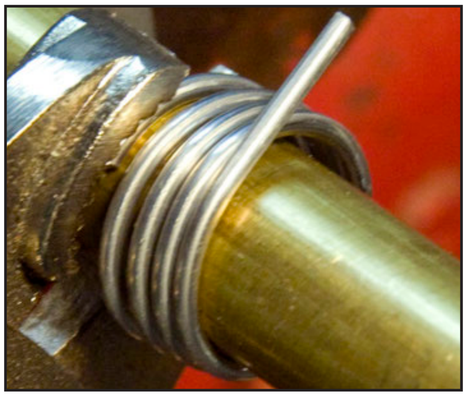
To form the worm, you bend the wire around a mandrel—something round. You could use a wooden dowel or a piece of metal rod, like I did. The thing that you wrap the wire around should be at least twice the diameter of the shaft that the worm gear will ultimately be mounted on.

Hold your mandrel in a vise. Then, using locking pliers or some other kind of clamping device, clamp the wire to the mandrel (**photo 2**). Be sure the wire is securely clamped and can't move. Wrap the wire tightly around the mandrel at least three or four full turns (**photo 3**). Wrap each coil close to the next one. When you let go of the wire, it will spring back some, and the resulting diameter of the coil will be larger than when it was wrapped around the mandrel (**photo 4**).

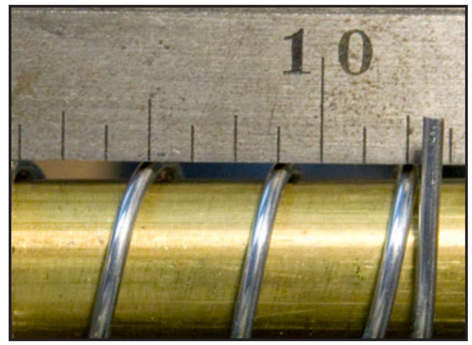


2. The wire is clamped 90° to the mandrel.

3. Wrap three or four coils closely around the mandrel.

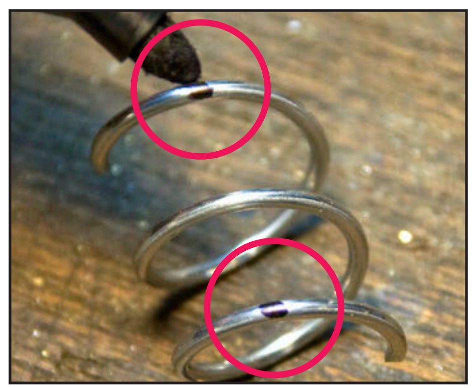


4. The released coil will be a little larger.



5. The helix has been stretched so that the coils are $3/8$" apart.

6. The helix off the mandrel.



7. Spots are marked two coils apart.

Now here's the tricky part—the coil must be evenly stretched. Your objective is to match the pitch of your pinwheel or wood gear. That means that the distance between the coils must be the same as the distance between the teeth of the gear. In my case, this is $3/8$" (**photo 5**). This may take a little tweaking but it can be done with a little effort. I find it easier to stretch the helix while it is still on the mandrel. Measure it several times as you go. The finished helix should look like **photo 6**.

Mark spots on your helix that are exactly two full coils apart (**photo 7**). From the point of the spots, straighten the ends of the wire. It need not be perfect but should be pretty straight. Leave a length on each end that's about one diameter of the helix, then trim off the remainder (**photo 8**).

Carefully bend each end 90° toward the center (**photo 9**). When you look down the end of your helix, the bent end should bisect the diameter of the helix and the two ends should line up with each other (**figure 2**). I found it easiest to do this with the helix held in a corner of the vise jaws and the bend made with a pair of flat-nose pliers. When the distance between the ends is measured, that measurement should be twice the pitch. In my case, that would be 3/4" (18mm—**photo 10**).

You should be able to slide the shaft that will carry the worm into the helix, beneath the cut ends, as shown in **photo 11**. You may have to trim the cut ends to do this. When trimming, though, be careful not to trim them too short. If you do that, you may have to start over. If the ends scrape one edge of the shaft, that's okay, as long as you can slide the shaft under them.

Mark the shaft where the pins touch (**photo 12**), then carefully drill through the marks with a drill the same diameter as the wire (**photo 13**). Use a drill press, with the work held in a vise, if you can. If not, just drill very carefully with your hand drill or rotary tool.

If you've done your work well, the cut ends of the helix should easily slip into the holes (**photo 14**). When you look at the assembly end-on, the shaft should be centered in the helix (**photo 15**). Adjust it as closely as you can.

The bent ends of the helix should go straight down the middle. Also, the ends should align with each other in the same plane.

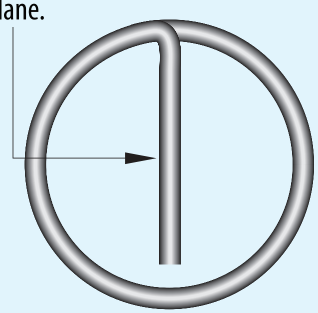
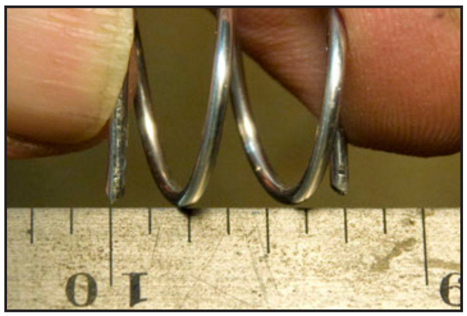


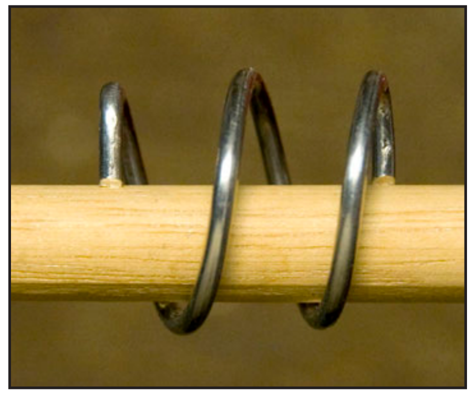
Figure 2—Bending the end

8. Ends are straightened and trimmed.

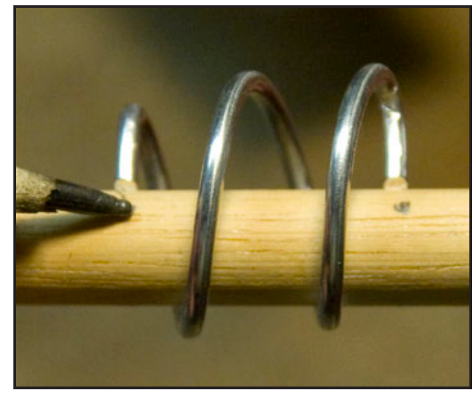
9. Ends are bent 90°.



10. The distance between the ends should be twice the pitch.



11. The wooden shaft is slid into the helix below the cut ends.



12. The shaft is marked for holes.

13. Drilling the holes.

14. The helix, mounted on its shaft prior to centering.

15. The shaft is right in the center of the helix.

16. The finished assembly, with the helix centered on the shaft and glued in place.

Once everything is looking good, add a couple of drops of thin CA cement where the ends of the helix go into the shaft, to secure everything. If you are using brass wire and a brass shaft, solder the assembly together. The finished assembly can be seen in **photo 16**.

When the gears are set up for operation, the centerline of the engaged pin of the pinwheel gear should intersect the centerline of the worm gear's shaft. Also, the pin or tooth that's most engaged should be in the middle of the helix. Again, this isn't critical and you might want to play with the optimum position of the gears for best operation. In **photo 17**, I've set my demo gears up in my lathe to check the alignment and to make sure the mechanism functions properly. It works a treat.

Subscribers can see a video of the worm gear in action on our website. Click *here*.

17. The worm and pinwheel being tested in the lathe.

BUILDING BLOCKS

The six simple machines: Part 2—inclined plane, screw, and pulley

by Paul Giles • Sun City Center, Florida, USA • Drawings by Marc Horovitz

In the last issue of *AM*, I discussed the first three simple machines: the lever, the wedge, and the combined wheel and axle. With just these three machines I was able to design a sophisticated automaton—a country bumpkin pushing a barrow full of flowers down a bumpy road. This time I'll begin to explore the possibilities of three remaining simple machines: the inclined plane, the screw, and the pulley.

Inclined plane

The inclined plane may seem similar to the wedge, but it is quite different. Think of an inclined plane as just a slanted line, whereas the three-dimensional wedge has a bottom. The wedge is used as a block to stop motion or as a fulcrum for a lever to lift another object. We can use the inclined plane to lift ourselves or to more easily move a load up or down. Have you ever driven up and down a steep hill or mountain? You were actually experiencing the inclined plane in action.

To continue the previous example of the country boy with the barrow, you could add an inclined plane to your model (**figure 1**). You might see him struggling uphill and over that bumpy lane, determined to reach his girl with those flowers. Or you could make his life easy, as he has crested that last ridge and can now easily jog downhill to her house. Once again, an easy-to-overlook simple machine has added a delightful element to your automaton.

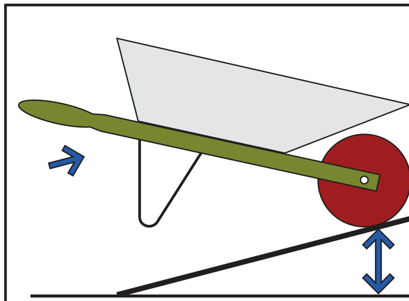
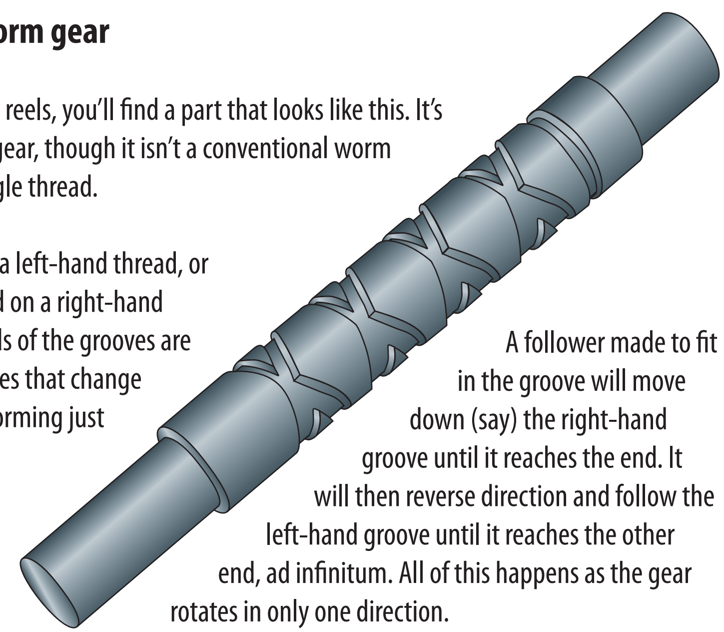


Figure 1
An inclined plane will raise the height of the wheelbarrow

The screw

Most people think of screws only as a way to join things. But for automata, screws can be a wonderful way to create an easy-to-customize and repeatable linear motion. However, instead of the screw thread—the helix—being raised on the outside of the shaft, for an automaton, you can create a helical groove cut *into* a shaft. And, rather than using a nut to pull the screw tight, a follower will be added. This follower can be just a short piece of dowel that will travel the path of the groove.

Figure 2
Two-way worm gear



In many fishing reels, you'll find a part that looks like this. It's called a worm gear, though it isn't a conventional worm gear with a single thread.

This device has a left-hand thread, or groove, overlaid on a right-hand groove. The ends of the grooves are joined by grooves that change the direction, forming just a single groove.

A follower made to fit in the groove will move down (say) the right-hand groove until it reaches the end. It will then reverse direction and follow the left-hand groove until it reaches the other end, ad infinitum. All of this happens as the gear rotates in only one direction.

If you have ever opened a fishing reel, you'll have seen crossing grooves on the (typically) steel rod connected to the lever (**figure 2**). Those crisscrossing paths are actually different sections of a single groove. The more crossings that you see, the faster (more turns) you must turn the crank to retrieve the fishing line. That is exactly the concept that you'll use in creating your project's linear motions, but automata screw projects will normally move a follower, not retrieve a line. (**figure 3**).

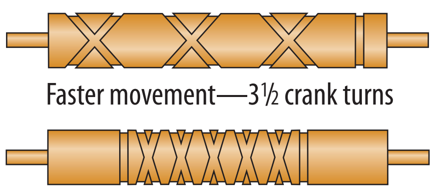


Figure 3

To create grooves on a wooden dowel, you'll need a suitable length of sewing thread, a thin rule, and a sharp, soft pencil. Pieces of tape will help to hold the thread in place. I recommend thread instead of string because it is thin and does not stretch easily. A soft-lead pencil is easier to use on some woods than a hard lead. As an alternative, if you are good at math and are a decent artist, you could also rotate your dowel a quarter or third of a revolution and add extra reference marks, then simply connect the dots freehand.

Before tracing the groove's path, think about the motion you want to achieve. Even with similar lengths of dowel, you can greatly alter the travel speed of your piece. If you want an extremely fast motion, lay out the groove from the front of the left side, wrap the thread halfway around the dowel, and end at the back of the right side. Just a half turn of the crank will then give the entire travel.

If you want a much slower motion, wrap the thread around the dowel maybe a dozen times. For pleasing results, though, both of these examples are too extreme for most projects (but I'll still use one of them in a moment). You don't want to create a blur and you certainly don't want to bore your audience. You need to visualize a happy medium before laying out your groove on the dowel. The example I'll present will create a mechanism for a child on a sled, and his dog.

Once you decide on the number of crank turns necessary to advance your piece, you'll need to lay out the groove's path on the rod. Let's assume that the usable length of your dowel will be 4" (10cm). You'll need additional length to attach a crank, gear, or other driver, plus enough space to support the rod so it will spin.

In the diagram, the dowel will make four full revolutions before the groove reaches the end of its advance. To do this, lay your dowel next to the rule and make a mark every inch (2.5cm)—one through four. Also mark the starting point, halfway around the dowel, ½" (1.25cm) to the left of the first mark (**figure 4**). These marks will help to make the thread easier to wind accurately and to keep the travel uniform, without any annoying speed changes.

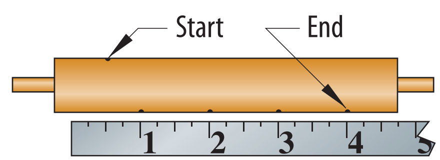


Figure 4
Marking the dowel

Ater the marks have been made, it's time to wrap the thread across them. A bit of tape to hold the thread in place at the beginning will make this easier. Just make a half revolution from the starting point and end at the first mark, ½" (1.25cm) along from the start. If you kept a fairly constant tension on the thread, it will have wrapped around the dowel evenly. Continue wrapping until you reach the end mark. A final inspection will let you know that you have created a constant-looking path (**figure 5**). Carefully trace this path onto the dowel with the pencil, and you're ready

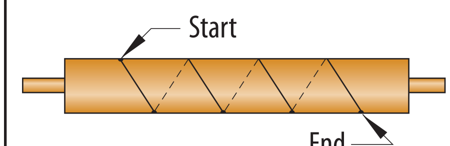


Figure 5
Running the thread for the first helix

to move on.

These four loops around the dowel will equate to four turns of the hand crank. This part of the motion will become the loyal pooch hauling his friend up the hill. The best sled rides go downhill a lot faster than up. We'll give the two playmates a very fast ride down. This is where the analogy of the fishing rod comes in, as we want to turn our crank in the same direction, while reversing the direction of the sled.

Staying at the four-inch mark, rotate the dowel half a revolution and add another tick mark exactly opposite the end point of the first thread. Add another mark exactly opposite the start point. Using the thread again, hold it against the new mark and wrap it halfway around the dowel, but traveling the entire way between the start and end points (**figure 6**). This portion of the path will become

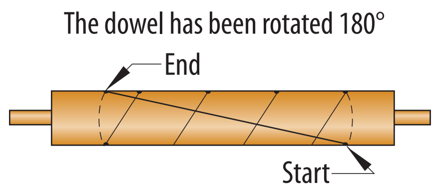


Figure 6
Running the thread for the second helix

the fast downhill ride.

Now it's time to carve the entire groove into the dowel. Not having the rock-steady hands of a brain surgeon, I've found it easiest to carve this groove in a series of steps. First, follow the path with a sharp marking knife. Don't try to cut too deeply. Instead, repeat the cut several times. The cut will be smoother if you take your time and use gentle passes. At both ends of the paths, gently turn the marking knife to round over the point where the two paths meet. If you have steady hands, you can save a lot of time on the grooves by using a rotating carving tool, like a Dremel. A bit with a small sphere on the cutting end will quickly define both the width and the depth of the path.

Once you have established the groove, move to a V-shaped carving gouge. Pay more attention to the width of the groove than its depth. The more precise the width of the groove, the smoother the action will be. Once you have established the width, use either your carving knife or a small U-shaped gouge to finish the depth.

All that's left is to add a small knob, a bit of dowel, or even a slightly rounded-over guide to the bottom of the sled, to form the follower. Think about which of the six simple machines will be necessary to get the dog to jump into and out of the sled.

The pulley

In the days of wooden ships and iron men, pulleys helped to bring every corner of the earth into reach. Without them, the larger, heavier sails of the time would have been impossible to tame in

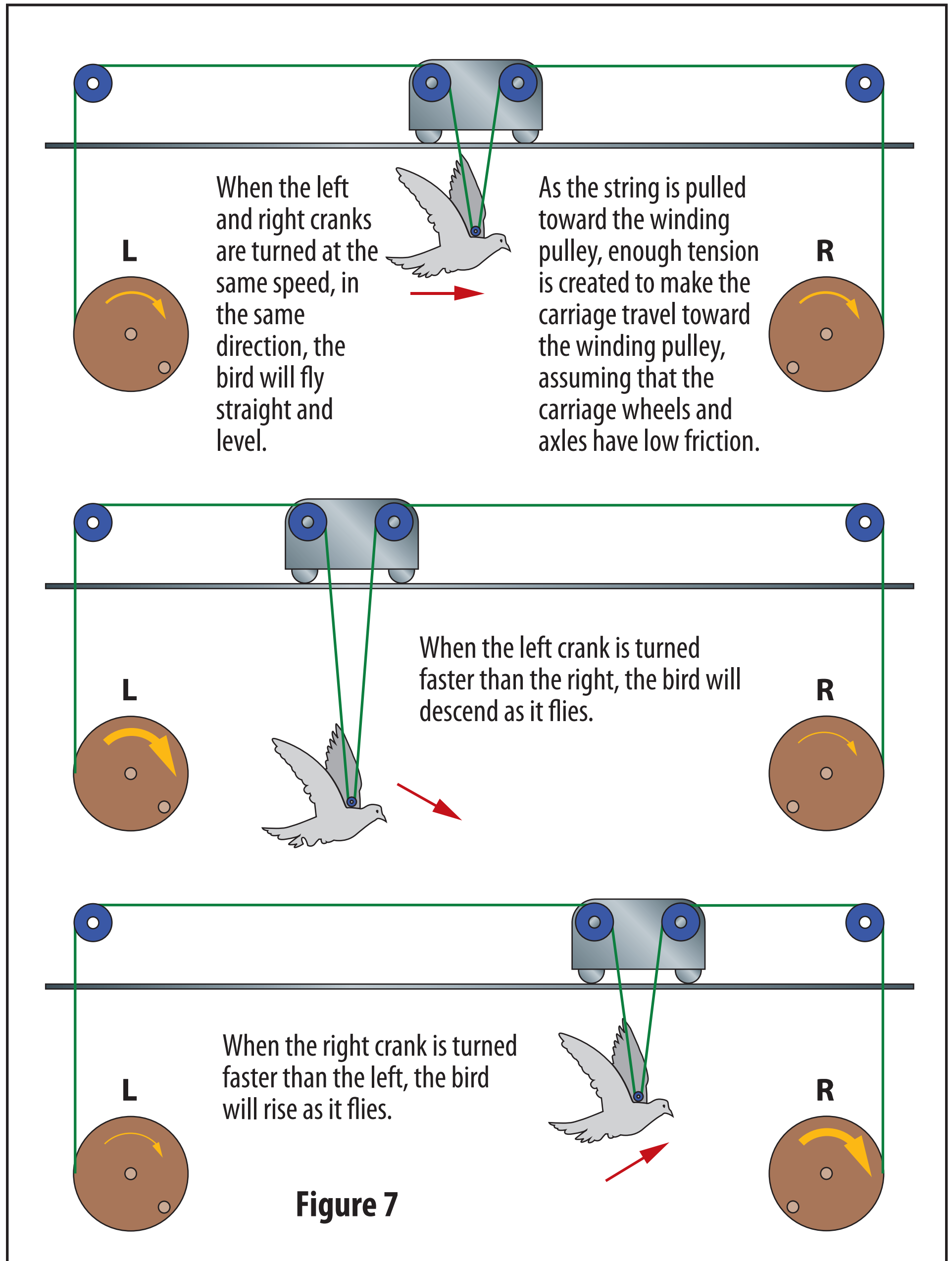


Figure 7

all but the calmest weather. Today, we think about using pulleys only when we want to lift a heavy weight. One person with the right pulley system can easily lift an engine block from an automobile.

Pulleys have their place in automata too. We just need to think outside the box—and not even that far. Remember that a single pulley is great for changing direction.

In the example I show here, pulleys are used to get a bird to fly to us, land, then take off again. To make this work you'll need to add a second crank and spool for the pulley rope (**figure 7**). For now, though perhaps not the most elegant solution, you can just attach the bird's wings with flimsy springs, connecting each wing spring to the bird's body.

This example may be the first automaton that you've considered with more than one crank. Always remember to bring your imagination to your designs—there are no rules for the number of cranks or power inputs.

Here, both cranks are necessary because the secret is to control the length of string between the two identical-sized spools. If each spool is cranked clockwise at the same speed, the spool on the right will collect all of the string that comes off of the left-hand spool. The bird, attached to the string, will fly left to right in a straight line.

If the speed of just the left-hand crank is increased, then more string will unroll from it than the right crank can take up. The bird will glide down to the surface. Once it has had its fill of the bird seed, it will fly off again.

To recreate that gentle takeoff angle, you must crank the right handle faster than the left. The right spool will then take up more string than is released by the left spool, and the bird will fly into the air. Once it has reached the right altitude, the bird will maintain level flight if you crank both handles at the same speed.

Never stop thinking about next steps in your automata! What if you kept the same mechanism but replaced the bird with a helicopter? In addition to all of the movements just described, the helicopter could be made to fly straight up and down. For it to take off vertically, you would turn both cranks in opposite directions, so that both take up string evenly. Landing vertically would be nothing more than turning the cranks in the opposite directions. AJ

Making a two-way worm gear

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

The finished mechanism. The little flag on top indicates where the follower is pointing.

I was intrigued by Paul Giles's column here, especially his description of how to make a two-way worm gear (for lack of a better name). I decided to give it a try, though I was frankly skeptical that I could replicate a piece of fine machining in steel, using simple hand tools on a wooden dowel.

I started by following his instructions, working with a piece of ⅝" (1.6cm) diameter dowel. I first drew a line parallel to the axis on the dowel, then marked it in 1" (2.5cm) increments for four inches (10cm—**photo 1**). Then I did the same, halfway around the dowel, but marked it in 2" (5cm) spaces.

1. Marking the dowel.

Next I wrapped the dowel with thread, carefully aligning it with the marks I made, and using tape to secure the ends (**photo 2**). Holding the dowel in the vise, I drew a pencil line next to the thread, from one end to the other (**photos 3** and **4**). I then did the same with the line going the other direction, joining the two lines at the ends with straight lines (**photo 5**).

2. The thread is wrapped around.

3. Marking the dowel along the thread.

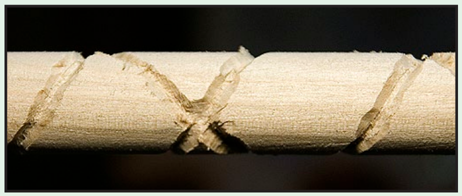
4. One helix has been marked.

5. Both helices are marked on the dowel.

Paul suggested using a sharp knife to score the line. I decided to use a small saw I had instead (**photo 6**). The line it left was rough

6. Initial cutting of the groove with a saw.

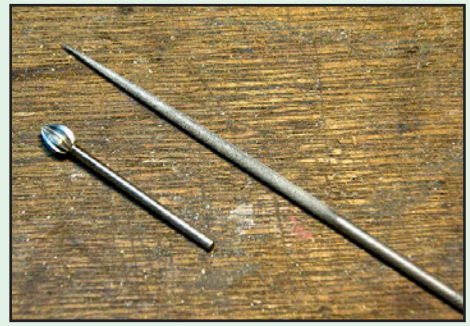
7. The rough dowel after sanding off the burrs.



8. The groove after being deepened with a Dremel bit.

and ragged. I sanded the dowel to smooth the burrs left by the saw (**photo 7**). Then, using a pointy tool in my Dremel, and again holding the dowel in the vise, I slowly cut the groove deeper, all the way along both threads (**photo 8**). It was difficult to get a smooth cut and even depth, holding the tool in my hands. If there'd been a way to rigidly hold the tool while somehow rotating the work on a mandrel under it, this might have worked better.

Paul had suggested using a ball-shaped tool to deepen the cut. I couldn't find one with the diameter I wanted, so I decided to see what could be done with a small rattail file instead. (The Dremel tool I'd previously used and the file can be seen in **photo 9**.) This turned out to



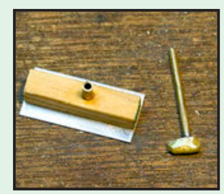
9. The Dremel bit and the file used for additional grooving.

be a good decision. The file made a uniform cut in the previously established but roughly finished trench, while it smoothed the sides as well. The preliminary result is shown in **photo 10**.

10. After being filed, the semi-finished groove.

Cutting the straight lines that connected the two helices at the ends proved problematic. I realized that the lines shouldn't have been straight, they should've curved around, from the end of one groove to the beginning of the next. This is pretty much what I ended up with, using the file, which is probably what I'd use if I were to do this again.

For the follower, I carved a little boat-shaped thing out of brass, drilling a 1/16" (1.6mm) hole in the top for a brass rod. The follower would be loosely engaged in a part of the mechanism to which a figure or some other object might be attached. I'm calling this the slider, which would have to slide in a groove or slot parallel to the worm gear. I made the slider out of a bit of wood, with a small piece of tinplate on the bottom, for a retainer. In the slider is a piece of 3/32" (2.4mm) tubing to capture the rod on the follower. Follower and slider can be seen in **photos 11** and **12**.



LEFT: 11. Follower and slider.

RIGHT: 12. Follower inserted into the slider.

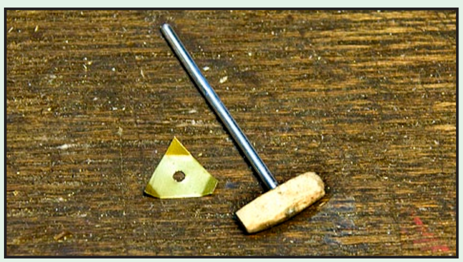
To test the mechanism, I first drilled the ends of the large dowel to accept a 5⁄16" (8mm) dowel as the axle, then cut lengths of the smaller dowel. I slapped up a box out of plywood, with strips of thin ply forming the top with the slot in it (**photo 13**). It's not beautiful, but for the purposes of this experiment, it was adequate.

13. The box with the grooved top.

I assembled the dowel in the box, with the follower above it, trapped by the slider, which in turn was trapped by the slot. I'd mounted the dowel low enough under the top to leave room for the follower and slider. I glued a crank to one end of the small dowel. The whole thing could be disassembled for adjustments, if necessary.

Adjustments *were* necessary. The mechanism immediately bound up. The depth of the helical groove was not consistent and the follower hit bottom. I marked the high places in the groove with a pencil, filed them out, then tried again. This time it was better but I found that the follower was too small. It needed to be long enough to extend across the various intersections. This one was not, and it would often want to take a side road when it was supposed to stay on the main line.

The only thing to do was to make a new, larger follower. This one I made out of wood. I also added a little spring, made of shim brass, between the follower and the slider, to keep the follower pressed into the groove and the slider up against the bottom of the slot. The new follower and spring are shown in **photo 14**.

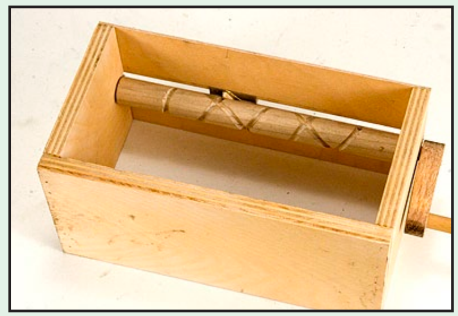


14. The new wooden follower with the brass spring.

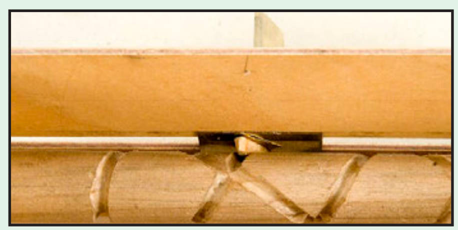
This time things worked better—there was hope. However, the follower still bottomed out occasionally and would sometimes get hung up at the intersections.

After three or four more episodes of marking the groove and filing, and reshaping the follower just a little, I have a mechanism that now works smoothly in either direction, much to my astonishment. Because of the way the worm was designed, as Paul said, it travels at one speed when going out and a higher speed (fewer turns of the crank) coming home. Cool! A1

If you'd like to see a brief video of the two-way worm doing its stuff, click *here*.



The worm in the box, from the underside.



A close-up of the follower in the groove.

Write an article!

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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!).

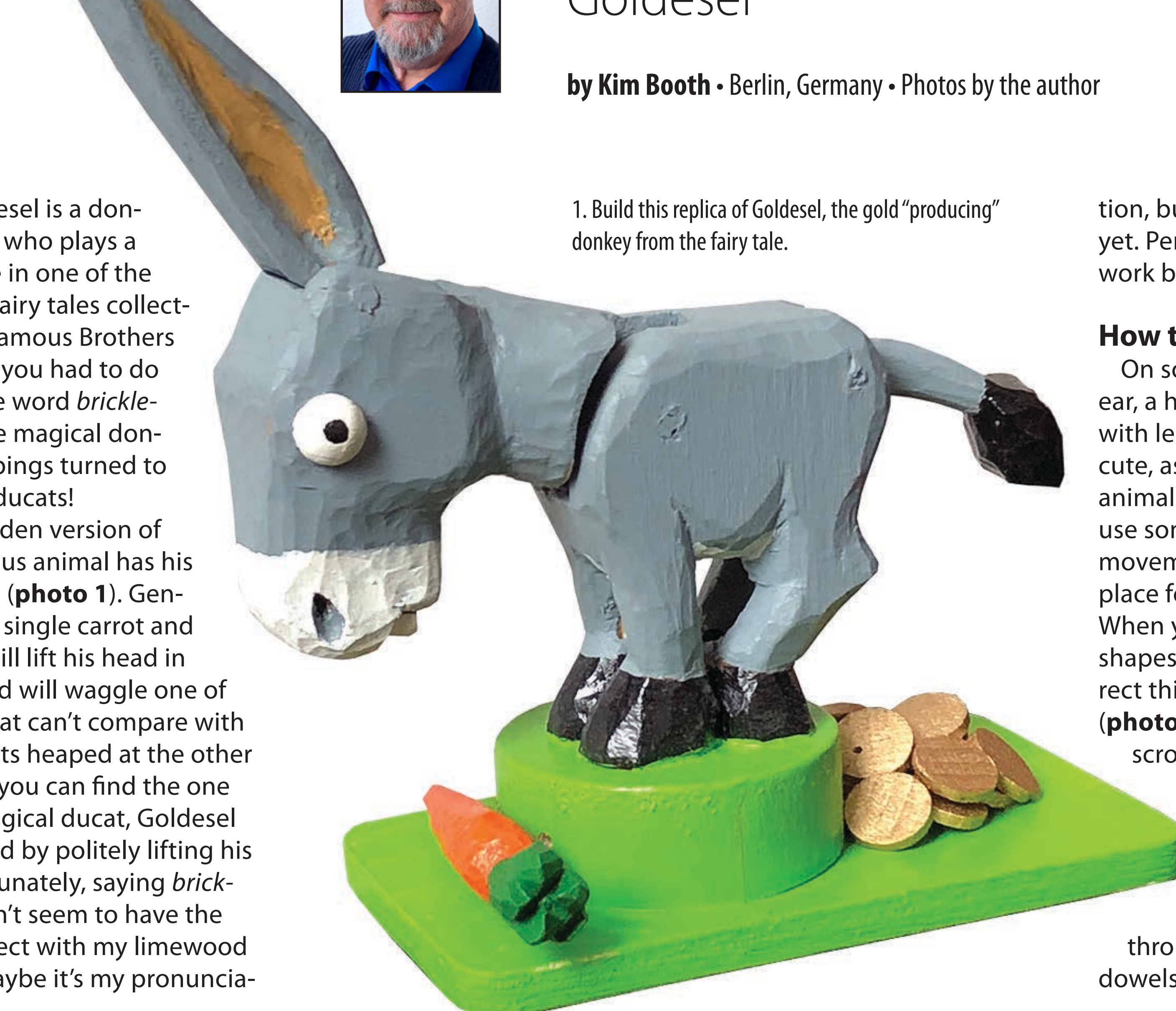
And don't forget our Gallery. To be included, please send photos and descriptions of your projects.

automatamag@comcast.net

Get Moving

Goldesel

by Kim Booth • Berlin, Germany • Photos by the author



1. Build this replica of Goldesel, the gold "producing" donkey from the fairy tale.

Goldesel is a donkey who plays a role in one of the European fairy tales collected by the famous Brothers Grimm. All you had to do was say the word *bricklebrit* and the magical donkey's droppings turned to pure gold ducats!

This wooden version of that fabulous animal has his own magic (**photo 1**). Gently pull the single carrot and Goldesel will lift his head in wonder and will waggle one of his ears. That can't compare with the 24 carats heaped at the other end, but if you can find the one special, magical ducat, Goldesel will respond by politely lifting his tail. Unfortunately, saying *bricklebrit* doesn't seem to have the desired effect with my limewood version. Maybe it's my pronunciation, but I haven't given up hope yet. Perhaps your version will work better.

How to make your Goldesel

On some stiff card, draw one ear, a head, a tail, and the body with legs. Bigger heads look cute, as they suggest a young animal. Cut out the pieces, then use some pins to try out the movement and work out the best place for each hinge (**photo 2**). When you are satisfied, trace the shapes onto wood of the correct thickness and cut them out (**photo 3**). At this stage, I actually scroll-cut three ear shapes, as that shape looked close enough to a carrot shape for me to be able to carve it into a carrot. Drill two holes through the head for 3mm (⅛") dowels—one for the ears hinge and one for the head-to-body hinge (**photo 4**). For the hinge between the ears and the head, drill the head so that the dowel is a tight fit. For the head to move freely on the dowel in the body, drill out the second hole in the neck a little for a loose fit. Drill the holes in the wood where you had put the pins in the card when you checked the movement.

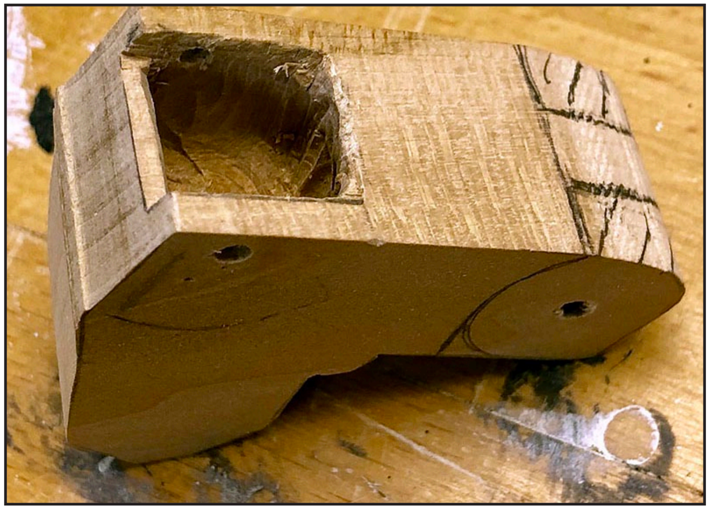
This clever donkey needs a hole chiseled in its head for the ears to move (**photo 4**). Try fitting the ears to confirm that the hole is big enough for them to move freely. I left enough space for a small plastic washer between the ears, to make sure that they can move separately (**photo 5**).

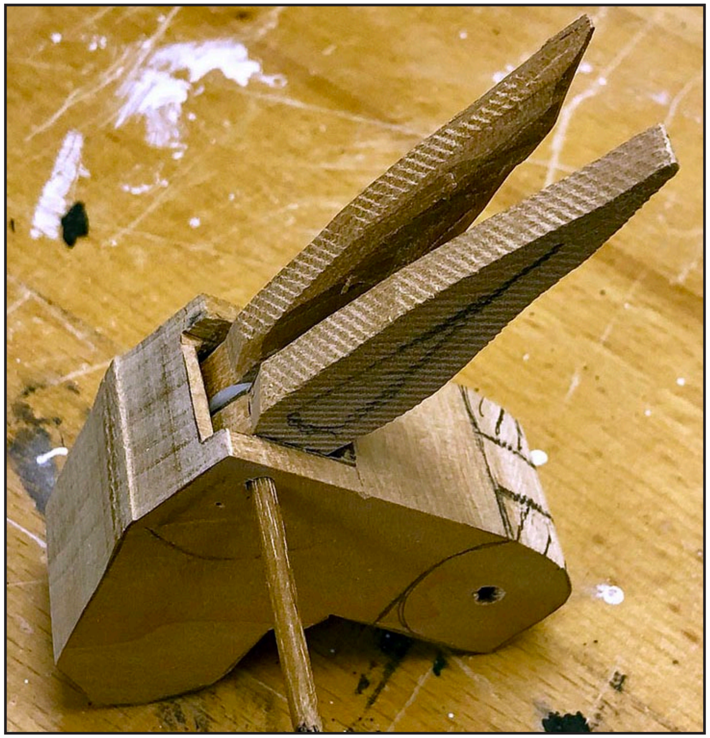
For the neck hinge, mark the wood that needs cutting away (**photo 4**), using the cardboard templates to check what needs to be removed before sawing. To cut the arc shape in the neck, to mate well with the body shape, a sharp chisel is required. Roughly carved, head and ears look like **photo 6**.

I used a piece of cord to waggle the ears and the tail. I tried cotton

2. Parts templates are drawn on card, then cut out and put together with pins to test hinge points.


3. Parts are cut from wood on a scrollsaw.


4. Two holes have been drilled—one for the ears and the other for the neck attachment. A depression must be chiseled in the head for the ears. The wood around the neck connection has not yet been carved away.


5. The ears are being test-fitted into the head. There is a plastic washer between them. Both ears and head await final carving.

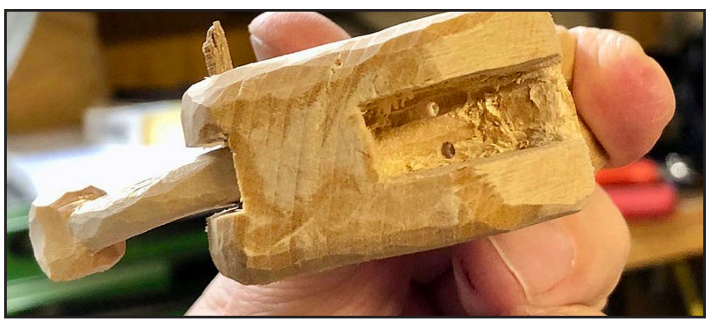
thread, but that caused too much friction. So I then tried fishing line, but that was too stiff when relying solely on gravity to pull the ears down. What finally worked was thinner, 1.5 kg (3.3 lb.) nylon cord, which is smooth and flexible enough for the job.

Photo 7 shows that two holes have been drilled through the neck, the long way, one for each ear. Note that, when routed like this, the cord that pulls the ears up will also pull the head up when the ears have moved as far as they can. The thinner, smoother nylon cords, ready to thread through the body, can be seen in **photo 8**.

Now drill two holes in the body to tightly hold the dowels, on which the head and the tail pivot (**photo 9**). Note that it is best to drill the holes while the wood is still solid and the sides flat. That makes it easier to be precise and it's less likely that thin bits will break off. Then chisel out the spaces in the body needed for the neck to rotate at the front, and for the tail to rotate at the rear. Pencil markings on the outside

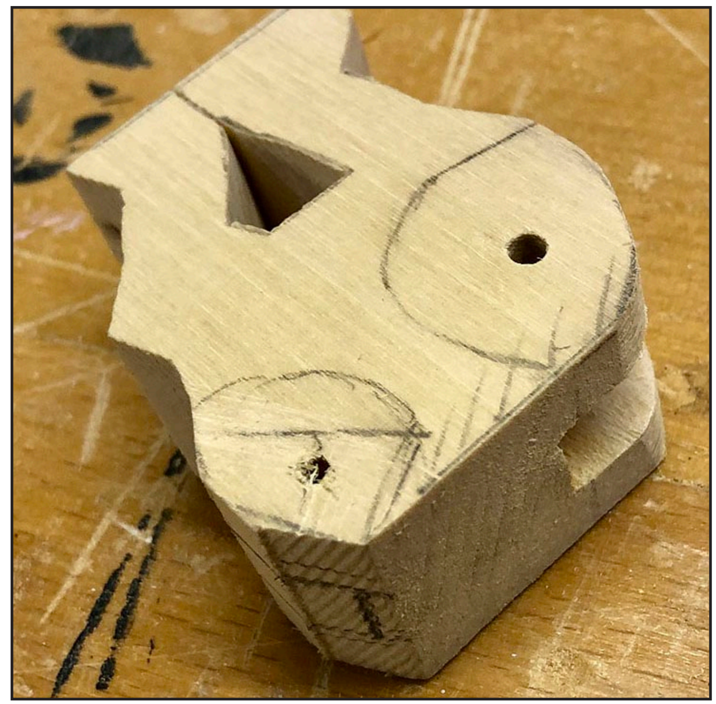
6. The ears and head, carved to their final shapes. Pull-cord holes have yet to be drilled in the ears.

8. The holes are visible in this photo. Nylon cords have been substituted and work well.



10. Body and tail have been carved, and the tail has been installed. Holes have been drilled in the legs, for the ear cords.

7. Holes have been drilled through the neck, the long way, and pull cords have been inserted. These cords proved unsatisfactory.



9. The body has been roughly cut to shape, pivot holes drilled, and the space for the neck chiseled.

show roughly how much space is needed for the movement.

Once you have made enough space for the neck to move freely, drill two holes through the body for the ear pulls (**photo 10**). For those ear pulls, I fed the cords down through the front hooves (**photo 11**). One hole is enough for the tail pull—there was enough space between the two rear hooves for the cord.

I recycled an old round wooden base for Goldesel to stand on, and I added some smooth pieces of dowel inside to reduce the friction where the cord has to turn 90 degrees (**photo 12**). Two holes at the front allow the ear-pull cords to connect to the carrot, while one hole at the rear connects the tail pull to a coin.

Carve a carrot and drill two holes in it, one for each ear pull (**photo 13**). I'm afraid my gold ducats are only made from beechwood dowel with a lick of gold paint (**photo 14**). Go for the real thing if you feel like it!

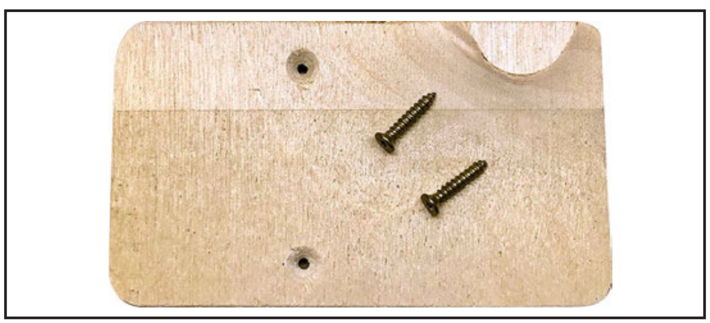
We need a base for the carrot and the ducats. I made mine out of a piece of plywood (**photo 15**).

11. Holes were drilled through the hooves and up the legs, to conceal the ear cords. The tail cord descends between the rear legs. Dowels hold the pieces temporarily in place.

12. A circular wooden base the author had on hand was used for the donkey to stand on. The round dowel inside eases the path of the cords.

13. The carrot in its final form, before being painted.

14. Ducats were cut from a piece of dowel, then painted with gold-colored paint. One coin was drilled for a pull cord.



LEFT: 15. A base for the entire automaton was fashioned from plywood and screwed to the donkey's round base.

ABOVE: 16. Press-to-release tweezers were helpful in stringing the cords through the various holes.

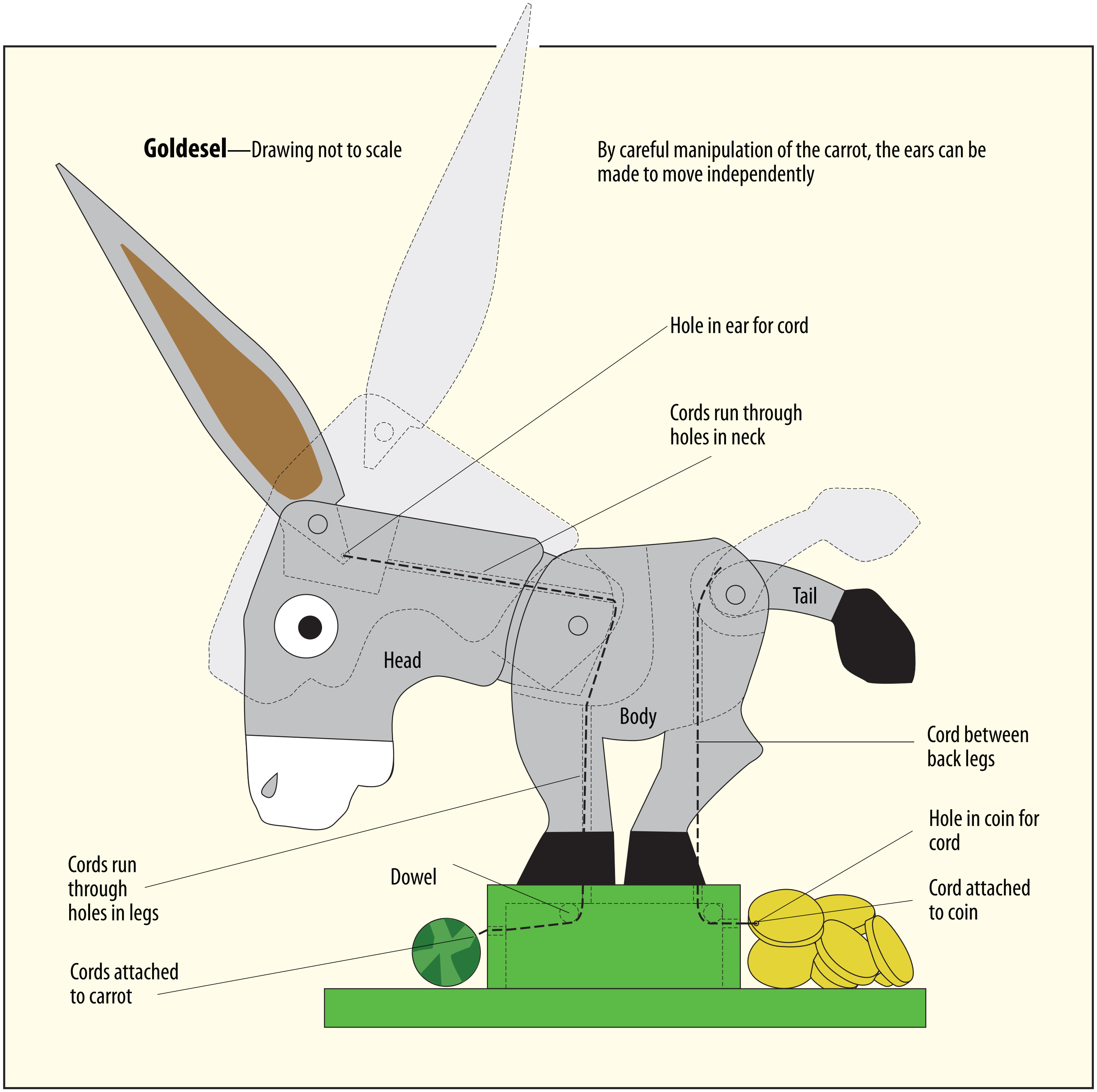
The two mounting holes align with corresponding holes I drilled in the round base. Two screws hold the pieces together.

Now everything is ready to be assembled. Threading and tying off the fine cord can be quite testing. I found a pair of press-to-release tweezers (**photo 16**) to be quite handy and they kept my frustration level down.

Goldesel was an interesting experiment in using pull cords running inside the figure, like an inside-out marionette. Unlike a thumb puppet, it has no spring, relying on gravity to return ears, tail, and head back to their starting positions.

Before demonstrating Goldesel, it is vital to practice your braying. Onomatopoeias for braying are hee-haw or ee-yore. Curiously, *National Geographic* thinks that donkeys say *wee-snaw*. As a fan of Winnie-the-Pooh, I personally go for Eeyore. AM

See how Goldesel works at:
https://tinyurl.com/kimsgoldesel



AUTOMATA FOR BEGINNERS

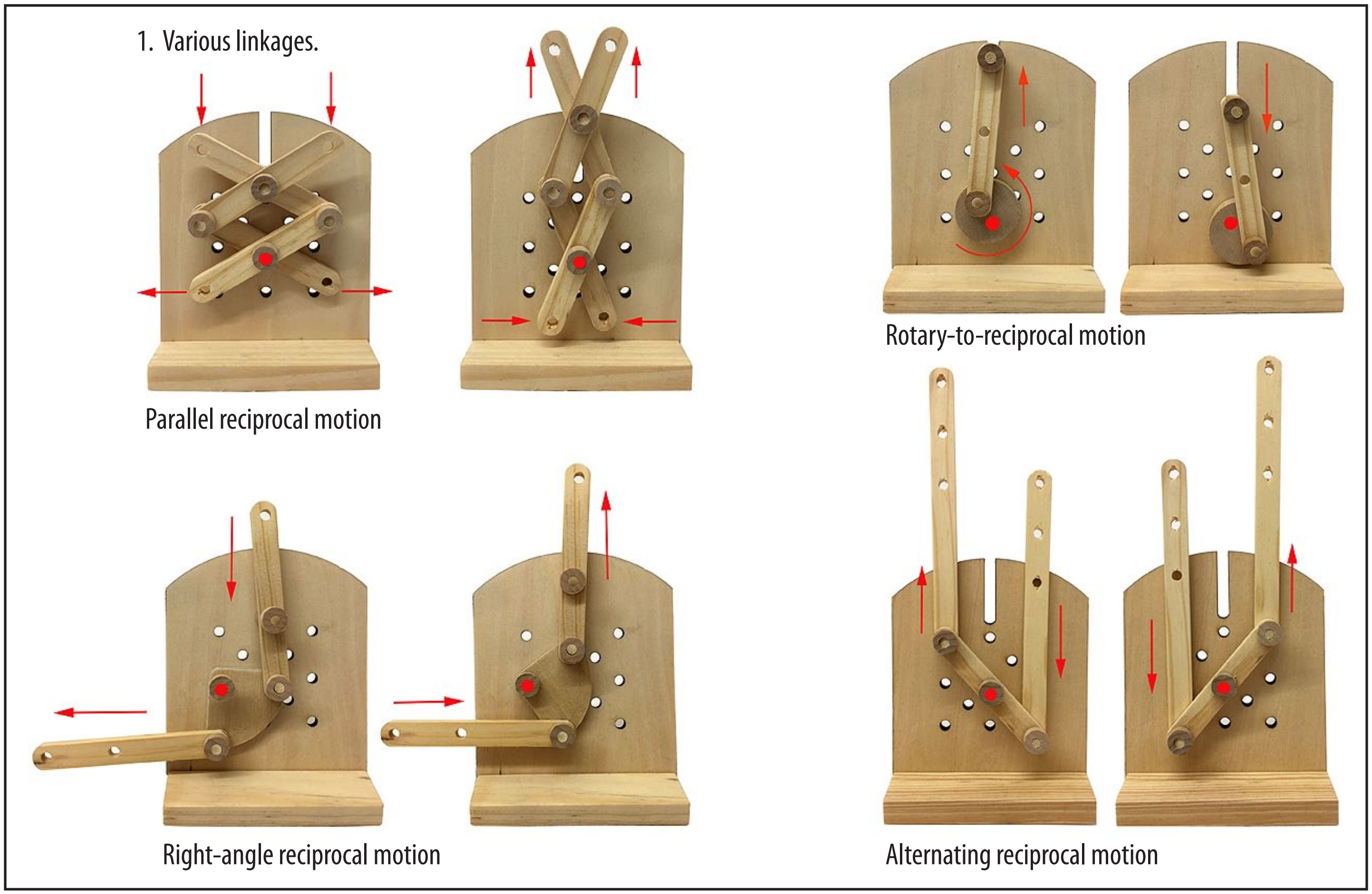
Linkages

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

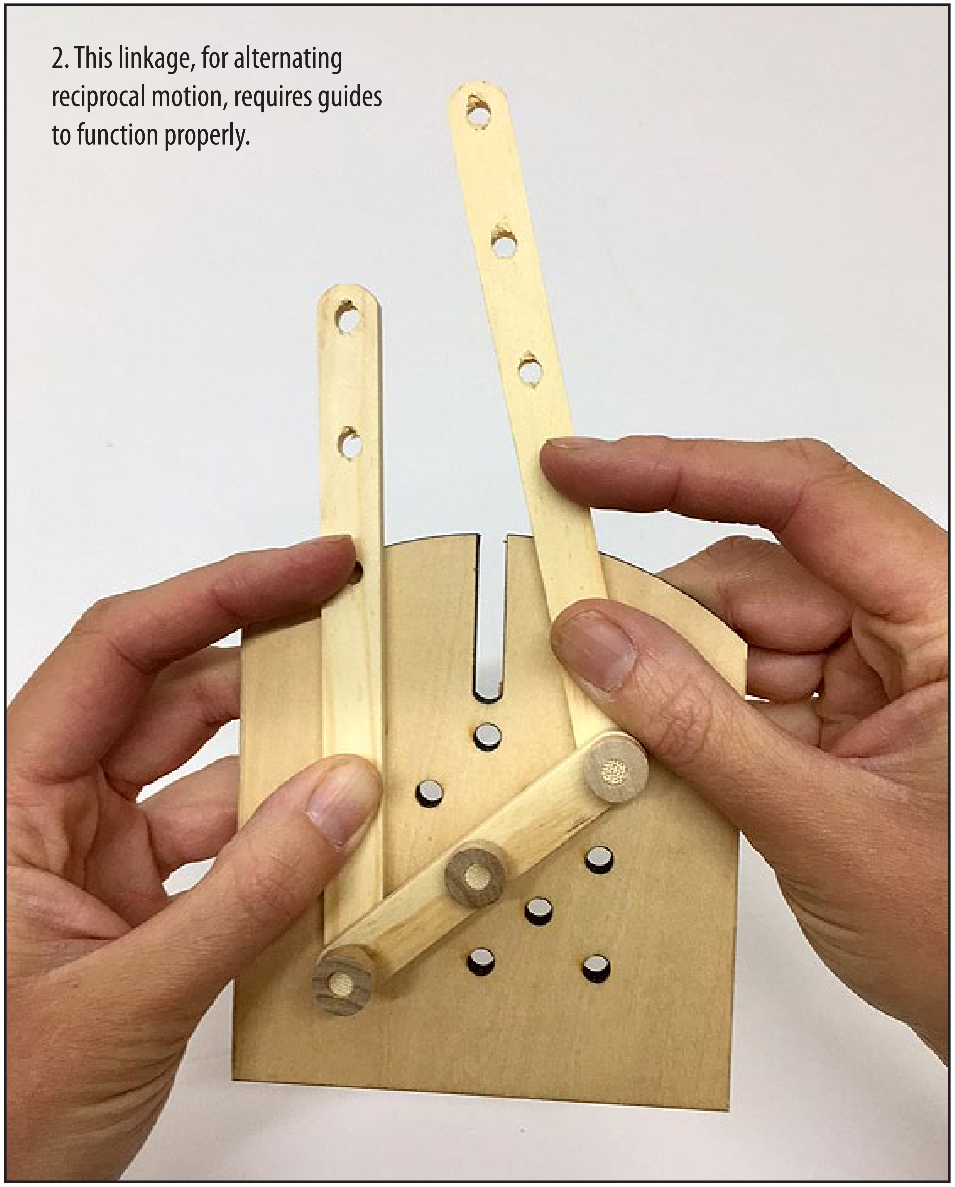
A linkage is a connecting piece in a mechanism that does the pushing and pulling. The distance, direction, and force of its action can vary, depending on its shape, size, and the position and nature of its pivots.

In their simplest form, linkages can transfer movement from one place to another. This could be at some distance from the source of the movement (e.g., a motor or handle turning a shaft), linking around a corner, changing a small movement into a big movement, or changing a reciprocal movement (backwards and forwards) into a rotary (round and round) movement. The possibilities are endless.

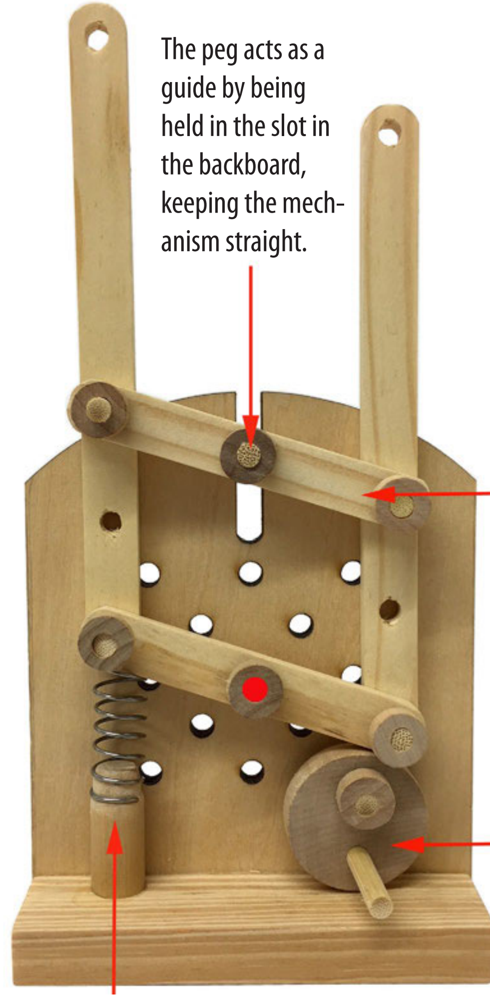
Photo 1 shows some simple examples of linkages. The fixed pivot points are marked in red and, by



1. Various linkages.



2. This linkage, for alternating reciprocal motion, requires guides to function properly.



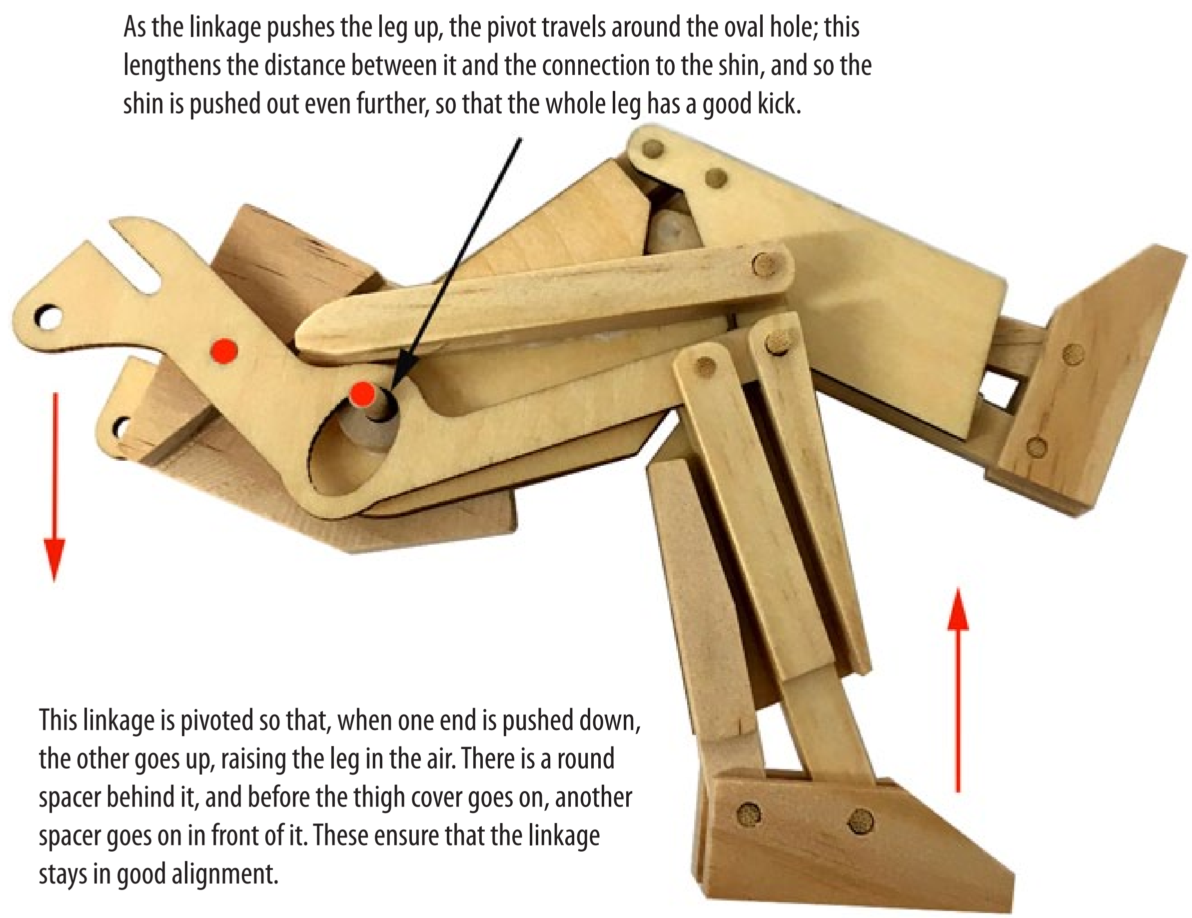
3. Guided linkages

necessity, are made of pegs that pass all the way through to the backboard. The other pivots are floating and only pass through their neighboring moving components. These samples are loosely put together with levers and pegs and were made only to demonstrate basic principles.

It's important to have components that you can play and experiment with. The one being held in **photo 2** would not work on its own however. It needs guides, something to drive it, return it, etc., as seen in **photo 3**.

4. Timberkits' *Demon Dentist* uses sophisticated linkages.

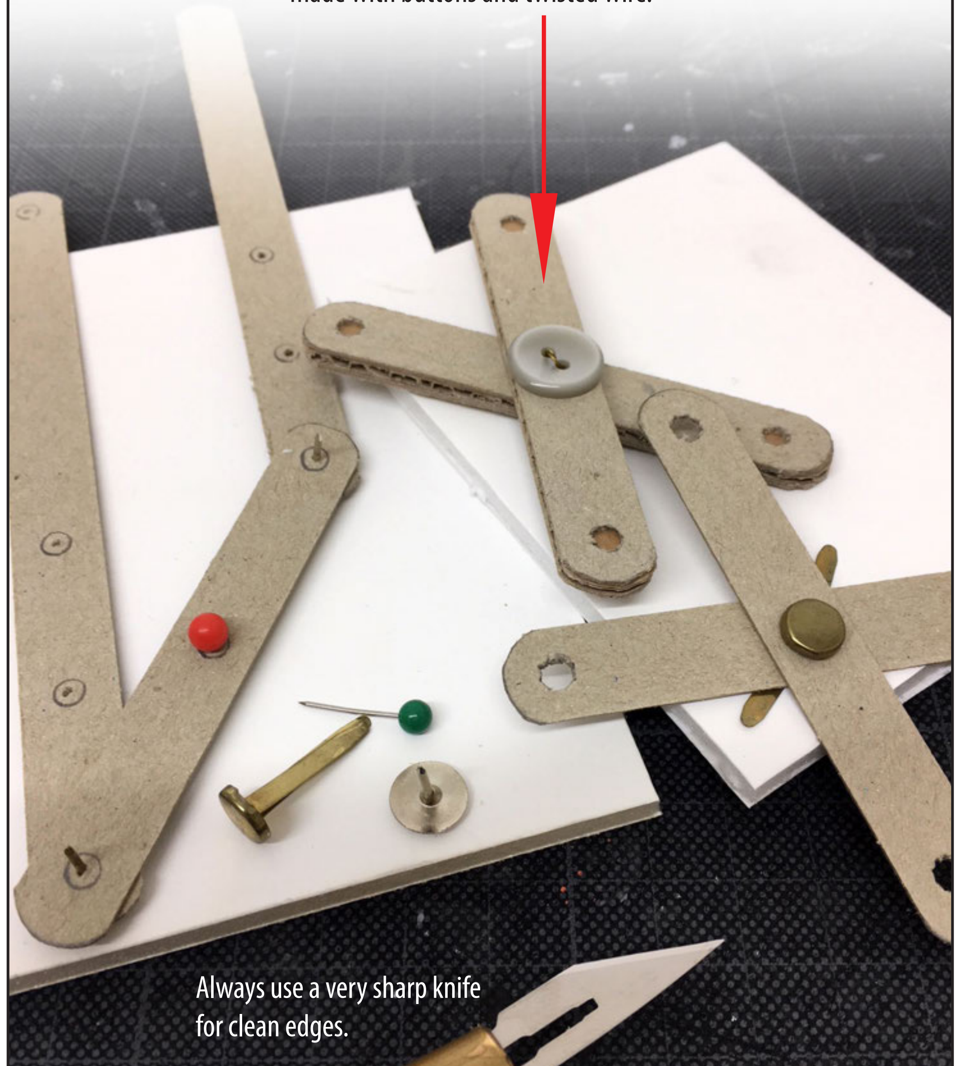
5. The leg linkage.



External features of the model itself often form part of the linkage arrangement. In Timberkits' *Demon Dentist* (**photo 4**) the thigh, shin, ankle, and hip are all part of the linkage assembly, as are the internal components (**photo 5**).

Timberkits offers a kit of linkage components that are great for initial experiments (**photo 6**). They work in lots of different combinations, and the backboard provides a stable structure for pegs and pivots. If you can only use cardboard,

6. A variety of linkage parts, including levers, pivots, backboards, and more.



7. Cardboard linkages

Linkages made with corrugated cardboard, sandwiched between two layers of plain card, are quite strong. Pivots are made with buttons and twisted wire.

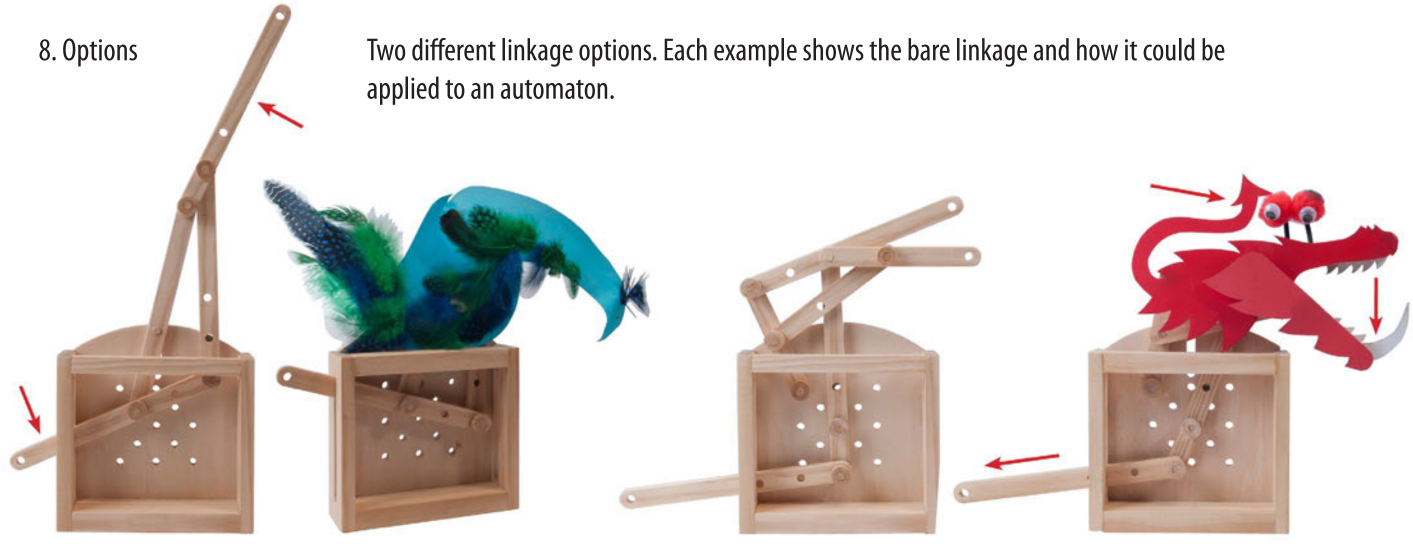
The author doesn't personally like to use paper fasteners as pivots because their legs get in the way. When she's experimenting with card, she uses pins stuck into foam board for fixed pivots, and uses upside-down drawing pins for floating pivots.

however, here are some tips. Any mechanism made with a flimsy material will be difficult to keep tidy and true, so it's worth going to some trouble to choose decent card and to make laminates (layers of card glued together—**photo 7**).

Once you are confident with basic structures and have found a building technique that suits you, try some more complex arrangements (**photo 8**). Study bits of machinery around you to identify their linkage arrangements and their applications.

These can include can crushers, gym equipment, folding baby buggies, and umbrellas.

And if, like me, you become slightly obsessed, here are some beautiful drawings from a book called *Five Hundred Mechanical Movements*, c. 1862, by Joseph Willcock, Patent Solicitor (**figure 1**). See how many of these you recognize as comprising some of the basic arrangements shown above. ▣



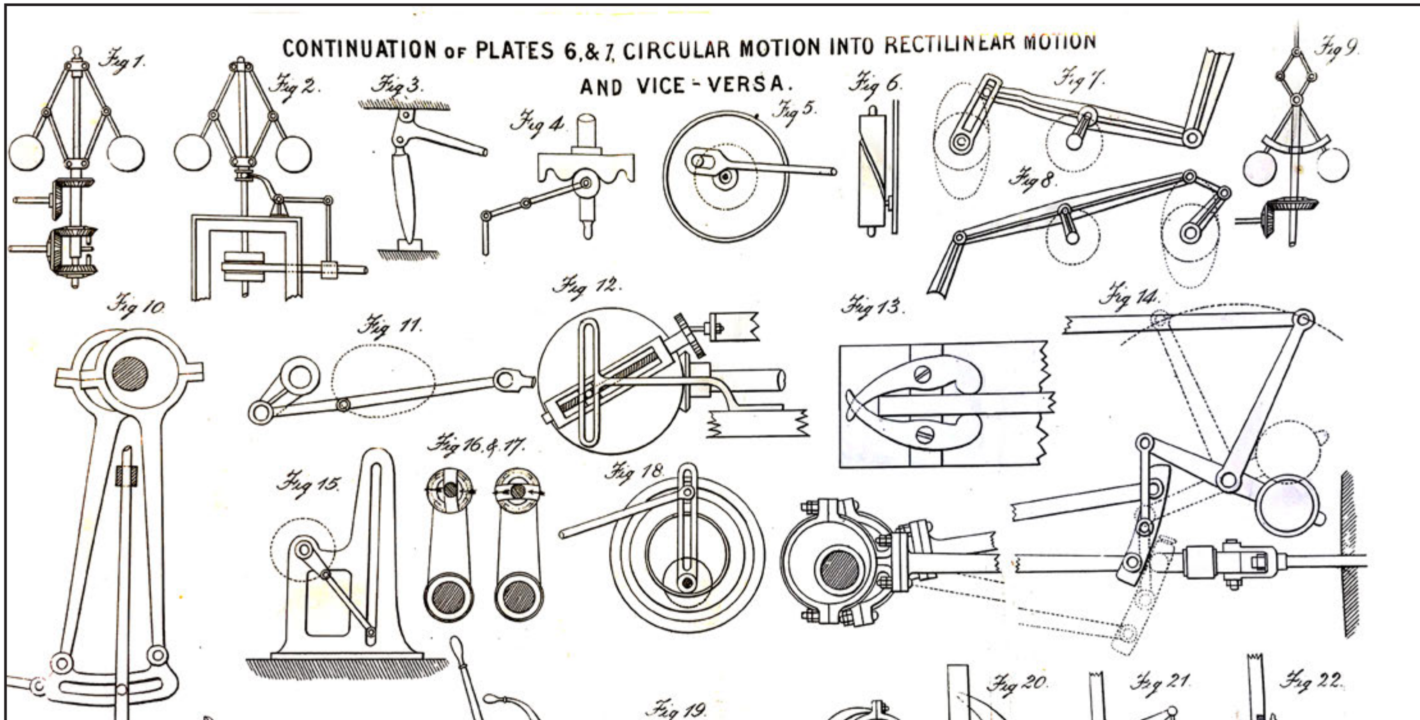


Figure 1. A portion of Plate 8 from Joseph Willcock's book, *Five Hundred Mechanical Movements*.

Contacting Sarah

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

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

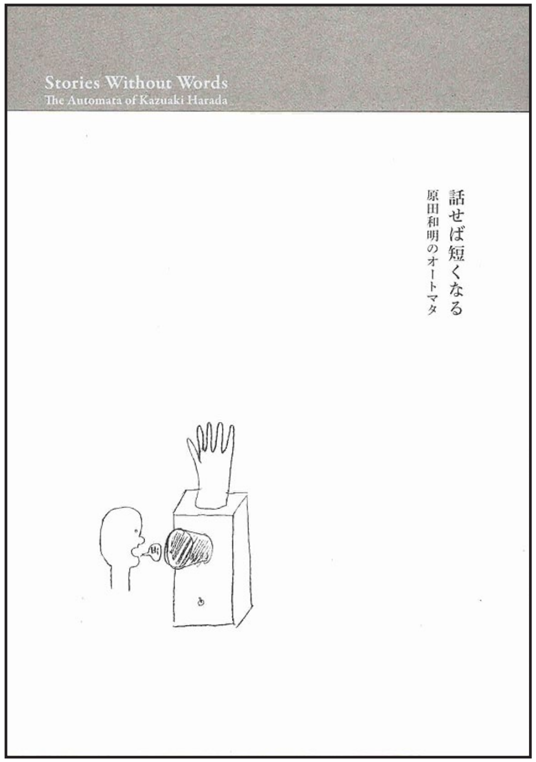
REVIEWS

BOOKS

Stories Without Words: The *Automata of Kazuaki Harada*
by Kazuaki Harada
aptp books, 2019
https://aptp.jp/publishing/
6 x 8¼" (15 x 21cm)
144 pp., softbound
Price: ¥2,800
ISBN: 978-4-909786-02-9

The release of any new automata book is exciting. This particular book is well worth the excitement. Kazuaki Harada is a well-known, modern-day Japanese automatist. He studied contemporary crafts at Falmouth University in the UK and did an apprenticeship with Matt Smith. Many of his simple, thoughtful, and beautifully made automata can be seen working in videos on his YouTube channel (*https://tinyurl.com/kharada*). His new book offers more insight into both the work and the artist.

The book is printed in Japanese and English. It is divided into two main sections: gallery and notebook. Before the gallery section is a brief, concise forward by the artist, essentially explaining that he expresses his ideas better and



more clearly through his automata, rather than in words.

Symbols are used to help describe the mechanics of each automaton. These are described on two pages after the table of contents. A total of 16 symbols are used, representing things like cams, cranks, ratchets, gears, magnets, and so forth.

A total of 43 automata are shown in the book, in the first 110 pages. Each piece shown typically occupies two pages. On the left-hand page are the name of the piece, the symbols that pertain to the automaton shown, and the date of completion, followed by comments by Harada about the piece. The actual mechanics of the piece are suggested by the symbols at the top of the page but are generally not discussed in the text.

A single, large color photo of the piece typically occupies the right-hand page. Additional small color photos may appear below the text on the left side.

There are a few exceptions to this rule. These include *Voice of a Peach* (it farts), *Like a Rolling Stone* (a stone spins, as if by magic), and one or two others. Each of these pieces cover four pages, with additional photos that often show more of the mechanics.

The last section of the book is a notebook. This part is preceded by a paragraph in which Harada discusses the notebook and his use of it, providing the reader a glimpse into the artist's process.

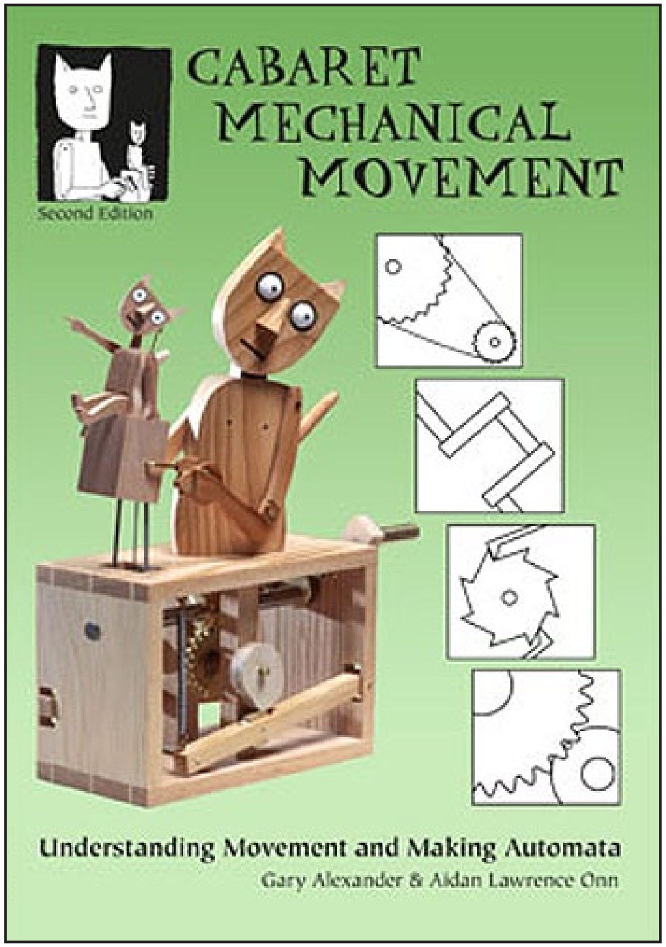
I always find it fascinating to learn how others approach their creations. Harada's first step is to jot down his ideas—in the form of quick sketches—in a notebook. The pages presented in this volume are photographs of actual leafs from his personal notebook. At first glance, the sketches look a little chaotic, but careful examination reveals the creative thought that goes into each concept. Harada is wonderfully inventive and his automata reflect the quirky and funny ways he looks at life.

The book itself is a piece of art. It is beautifully designed and presented. There is a lot of white space inside that sets off the text blocks and the photographs. The book is softbound, printed on uncoated stock. The notebook section, which is printed only in black, is on a slightly different kind of paper.

The text in the book is, unfortunately, printed *very* small, making it a little difficult to read. Also, some of the color photos are printed rather dark, so some detail is lost.

On the whole, though, this is a charming little book. Kazuaki Harada's work is elegant and his imagination is clearly evident in all of his work. The automata are cleanly constructed to a high level of finish and the book shows them well. This is a valuable addition to automata literature. It should be on every enthusiast's bookshelf. —*M. Horovitz*

Cabaret Mechanical Movement
by Gary Alexander & Aidan Lawrence Onn
Cabaret Mechanical Theatre, 1998
https://cabaret.co.uk/store/books/cabaret-mechanical-movement/
or available electronically (Kindle format):
http://amazon.com **or** *http://amazon.co.uk*
5.8 x 8.3" (14.8 x 21cm), 124 pp., softbound
Price: £9.99
ISBN: 978-0-952872-93-1



When we hear the name "Cabaret Mechanical Theatre" today, we are reminded that the world of automata we now live in originated there. Before Cabaret, the world knew little or nothing of clever, hand-cranked scenes on a stand, amusing us with their wit and charming us with their handmade artistry. Now that we live in a post-Cabaret Mechanical world, the style and innovations of the Cabaret artists are what we have come to expect from all automata.

And so, when we see a book titled *Cabaret Mechanical Movement*, we expect an inside look at how those clever, amusing, charming little scenes are made. And the book does not disappoint.

This volume is not unique among how-to books, as many other similar works have chapters with these familiar names: Levers, Shafts, Cranks, Cams, Springs, Linkages, Ratchets, and Drives & Gearing. Thus, I won't go into those, except to say that they are very well written and are illustrated with wonderful drawings that reflect the style of today's automatists. They're as informative as those in any other book, but the illustrations are much more fun to look at. They form a really excellent reference for the mechanical basis of our little machines.

What sets *Cabaret Mechanical Movement* apart from other similar books are the final two chapters, entitled Control and The Checklist. The control chapter goes into the mechanical principles of an automaton (indeed, any machine), how they are activated, and how input movement is translated to output. This is great stuff to bump a designer's thinking up a level. Then it moves into what is for me new territory: simple electronic controls (i.e., electro-mechanical, not computerized). The last section of this chapter shows how to make an automaton into a coin-operated machine (just like at Cabaret!).

Finally, the authors give us a checklist—a road map of steps to follow in the making of an automaton of your own design. You might think this would take you from initial idea to complete machine, but in fact, it starts well before the idea, with observing how things around you move, discussion (trying out your idea on others), and then to inspiration. From there, you can move down the checklist, through drawings, prototypes, and construction, to the end (or starting over, with lessons learned).

Although the original copyright date is 1998, the book has been updated and reprinted many times, most recently a couple of years ago. And it's no wonder that this book is s till in print twenty years later. It has the content and the quality to make it a classic. Highly recommended. —*V. 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. We'll be reviewing more of these in upcoming issues of *AM*.

The End