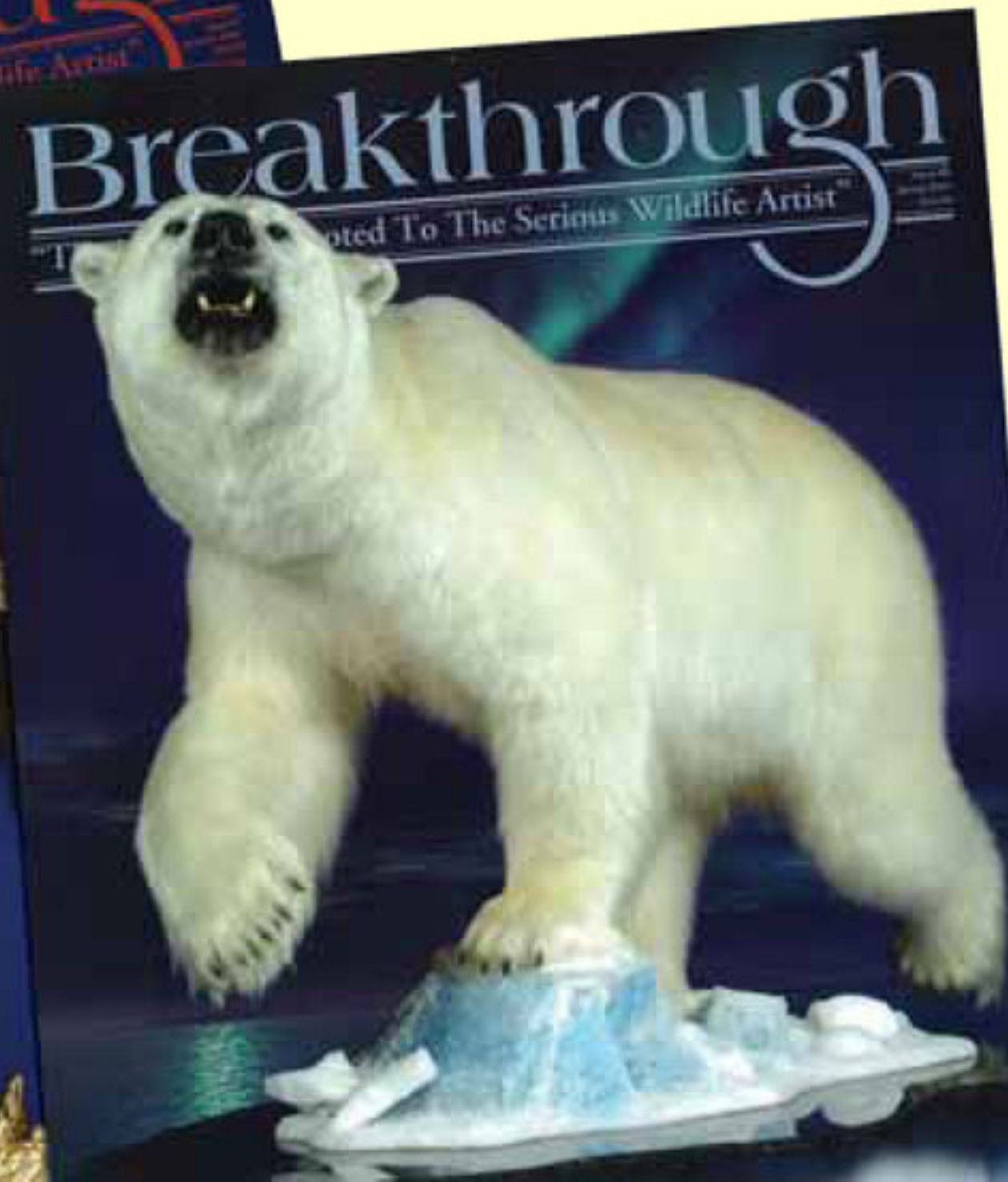
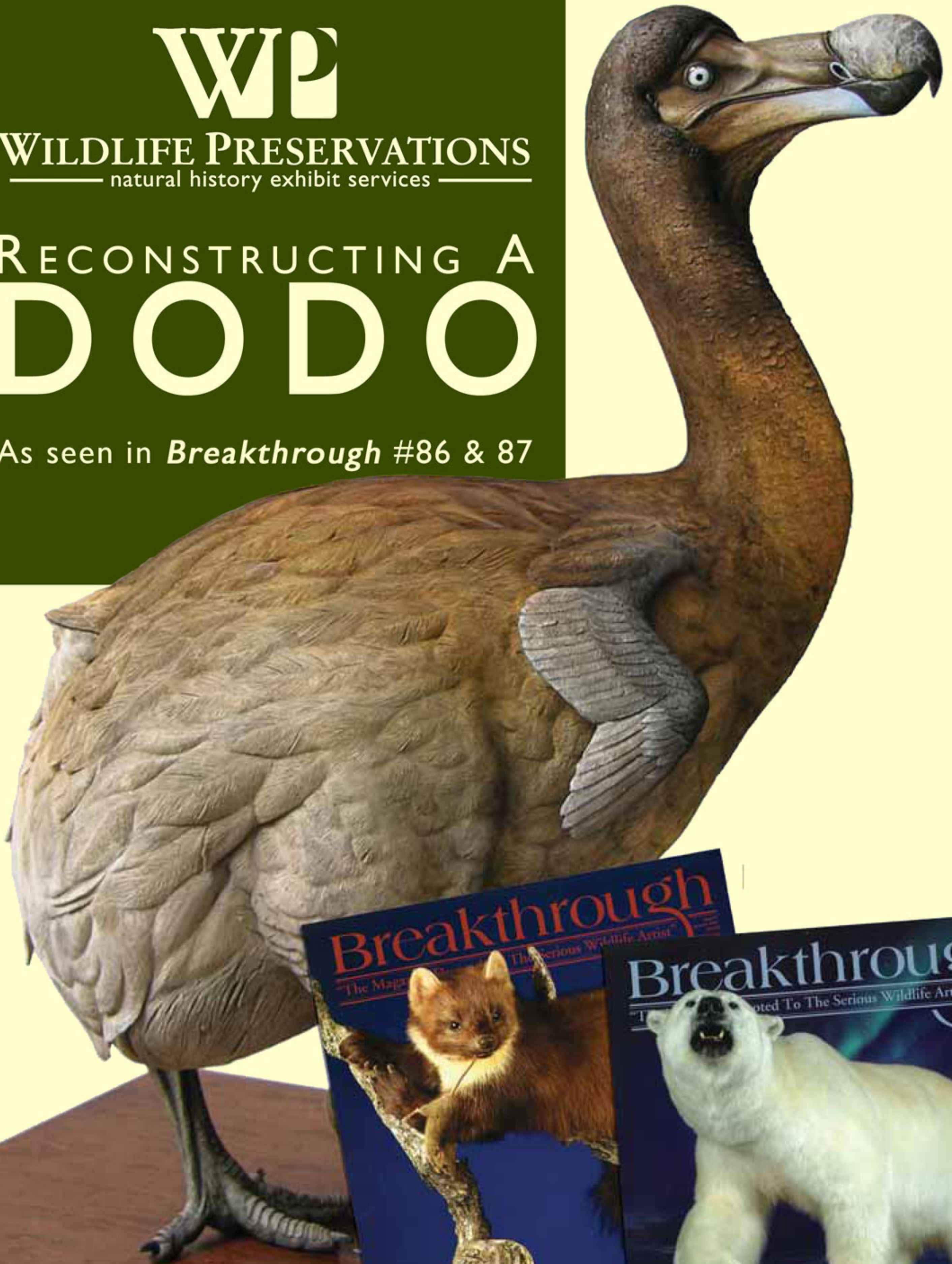


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WILDLIFE PRESERVATIONS
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RECONSTRUCTING A DODO

As seen in *Breakthrough* #86 & 87



BY JOHN SCOTT LUCAS
DIRECTOR OF RESEARCH AND DEVELOPMENT
FOR PHIL FRALEY PRODUCTIONS, INC.

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IN THE WINTER OF 2005, THE RAFFLES MUSEUM of Biodiversity in the Republic of Singapore commissioned Phil Fraley Productions to create “the world’s most accurate model of a dodo.” While I am quite proud of the model we produced, I feel I need to get one thing off my chest: a passenger pigeon would have been *SO* much easier to do.



1. A Google image search for “passenger pigeon” pulls up 788 photos, all remarkably similar. Dozens of museums across North America have excellent specimens of passenger pigeons—taxidermy, salted skins, wood carvings, polymer models, archival photos, you name it. It’s out there in spades, and they all look reasonably the same.



2. Perform a Google image search for “dodo” and it pulls up 104,000 images of startling variation. There are fat dodos, thin dodos, white dodos, grey dodos, brown dodos, ornate dodos, and unadorned dodos. There are dodos on stamps and coins, there are elaborate baroque oil paintings, Victorian lithographs, stylized cartoons, and field sketches that range from crude to sublime. Many museums have models of dodos, but, once again, there is distressing inconsistency amongst these as well.

Here is the crux of the problem with trying to re-create an accurate model of a dodo—everybody thinks they know exactly what a dodo looked like, but in fact, very few people actually do. The reason for this confusion is that the dodo went extinct so quickly after it first encountered humans that very few people ever actually saw one dead or alive. Until this decade, very little real evidence of the bird existed. Consequently, our image of the dodo was shaped largely by second-hand illustrations and reconstructions that were executed by artists who had never actually seen a living example of this ill-fated bird.

3. An (All-Too) Brief History of The Dodo. Mauritius, the home of the dodo, is one of three small volcanic islands, collectively known as the Mascarenes. Situated about 500 miles east of Madagascar, their nearest neighbor, the Mascarenes are about as close as you can get to the middle of nowhere. DNA analysis indicates that the dodo’s nearest living relative is the Nicobar pigeon, *Caloenas nicobarica*, from the Nicobar Islands, which are off the coast of Burma in the Bay of Bengal, a



good 4,000 miles away. Ornithologists believe that some forty-million years ago, the ancestors of the dodo started island hopping westward across the Indian Ocean, probably landing on many volcanic islands and coral atolls that have long since sunk below sea level. The first dodos are thought to have arrived on Mauritius about twenty-six million years ago.

Around three to four million years ago, dodos lost the ability to fly. Flying burns up lots of calories, so most birds prefer not to do it unless there is a compelling reason. (For a practical demonstration of this principle, I direct you to common city pigeons, distant relatives of dodos, which can’t be bothered to flap their wings to avoid being trampled by cars or pedestrians). Had there been predators on Mauritius, whatever evolutionary trend favored bigger dodos would have played out just before the birds became too fat to get off the ground, so as to avoid becoming lunch. Since there never were any predators on Mauritius, dodos thrived for several million years, living their entire lives on the ground, their vestigial wings a reminder of how they first arrived at such a remote place. Generations of dodos walked around on sturdy legs and foraged for food, mated, laid eggs, and raised their chicks, and nobody gave them a hard time, really.

Then the explorers showed up.

4. It is thought that Arab traders discovered the Mascarene Islands sometime in the 1400s but never settled there. In 1512, Portuguese explorer Pedro Mascarenhas rediscovered the islands, named them after himself, then sailed onward, never to return. Then, in 1598, a fleet under Admiral Jacob Cornelis-zoon van Neck, funded by the Dutch East India Company, claimed the Mascarenes for the Netherlands. Heyndrick Dircksz Jolinck, who sailed with van Neck, wrote the first description of the dodo in the ship’s log. The last line in that very brief paragraph read,



Engraving of a dodo from Jacob Cornelis-zoon van Neck’s *Het Tweede Boeckje*.

“This particular bird has a stomach so large it could provide two men with a tasty meal and was actually the most delicious part of the bird.”

Dodos were tragically unafraid of humans. Ignorant of any predators, they walked right up to sailors who gleefully killed them by the scores. To a sailor who just spent months at sea with nothing to eat but maggoty biscuits, freshly roasted dodo must have tasted like a slice of heaven. Dodos that weren’t consumed on the spot were butchered and salted for the long voyage home.

The ease with which dodos could be killed gave rise to their reputation for being stupid, and may have been the origin of its name. The archaic Dutch word “dodoor” means “sluggard,” and the Portuguese word “doudo” means “foolish” or “simple.” Scholars have proposed other origins for the name. It is possible that “dodo” is an imitation of the bird’s cooing. The Dutch also called the bird “dodarsen” which may mean “fat arse” (or “fat ass,” as we’d say in America). Other names given to this bird were “dronte” which means “disgusting bird” and “walgvogel” or “walgvogel” which mean “nauseating bird.” Whether dodo meat was tasty or “...offensive and of no nourishment,” as sir Thomas Herbert



OTHER EXTINCT SPECIES FROM THE MASCARENE ISLANDS

wrote, seems to have been a matter of personal preference.

The story of the dodo's extinction took on new relevance after the publication of Darwin's *On the Origin of Species*. The idea that the dodo was self-selected for extinction because it was too stupid to avoid human hunters provided an elegant demonstration of natural selection at work, however, like a lot of things about the dodo, the accepted story was only partially true. It wasn't man who drove the dodo to extinction, but the animals that traveled with him.

Rats may have begun to decimate the dodo population even before humans established permanent settlements on the island. In 1606, Admiral Cornelius Matelieff de Jonge traveled to Mauritius to set up a "refreshment station" for Dutch ships returning home from India. He released goats and pigs to establish a source of meat, and these animals continue to thrive on the island to this day. His attempts to plant fruit trees and other crops, however, were largely frustrated by rats, which had already infested the island. Dogs, cats, and monkeys were introduced to the island later. All are a scourge to ground-nesting birds, but rats may have already set the dodo on the road to extinction long before humans began to hunt it.

5. Dodos were not the only animals on the Mascarene Islands who could not survive the ravages of man. Entire ecosystems vanished as Dutch settlers put land into production and replaced native flora and fauna with domesticated plants and animals. The Rodrigues solitaire, the red rail, and the broad-billed parrot, all large ground-dwelling birds, most likely met the same fate as the dodo for similar reasons. So did the Mauritius blue pigeon, the Mauritius scops owl, the Mascarene parrot (which was grey, with a black hood and a beak "the color of fire") and the huppe (a type of starling with a big white crest like a conquistador's helmet). There is a beautiful painting to remind us of Newton's parakeet, but only a crude woodblock illustration of Leguat's gelinote, and the Rodriguez night heron has been reduced to an ink sketch of a few dozen "Vs," to represent a flock in flight.

Birds were particularly vulnerable, but other animals suffered as well. The small Mauritian flying-fox became extinct in the mid 1700s when the ebony forests where they lived were cut down to build ships. There was a giant tortoise, a giant skink, and a giant gecko (which was the largest ever, about the size of your forearm). On the other end of the size spectrum was the tiny trochid carinate snail. All these animals became extinct within one-hundred years of the death of the last dodo. To heap insult upon tragedy, they are largely forgotten as well.

Whatever the cause of its demise, what is truly amazing about the

dodo is that it became extinct less than 100 years after it was first recorded. Peter Mundy, an officer of the Dutch East India Company, made two trips to Mauritius between 1628 and 1634. Mundy reported seeing dodos in captivity in Surat, India, but not on his first visit to Mauritius. He scoured the island looking for dodos on his *second* visit to Mauritius, but as he later wrote, "...Mett with none..." One could infer from this that the bird may already have been scarce, or at least smart enough to avoid humans.

In 1662, shipwreck survivor Volkert Evertsen and several fellow castaways caught and ate a number of dodos while foraging for food. The reliability of Evertsen's account, written seven years after the event, is open to debate, but if he was telling the truth, he may have been the last person to see dodos alive in the wild. In 1681, Benjamin Harry, chief mate of the English merchant ship, *Berkly Castle*, wrote that dodos still existed on Mauritius, but did not say that he saw any himself, whilst Dutch Chief Lamotius reported seeing dodos in 1688.

In 1708, Huguenot refugee Francis Legaut published his celebrated and quite comprehensive travelogue, *A New Voyage to the East-Indies*. Legaut was marooned on the island of Rodrigues for two years between 1691 and 1693. Lack of female companionship eventually drove him to make a desperate voyage (in more ways than one) in a hand-made boat across several hundred miles of ocean to reach Mauritius, where he spent another year waiting for a ship to take him back to civilization. Legaut wrote and illustrated detailed descriptions of the Rodrigues solitaire (which he studied and feasted upon with equal gusto) but made no mention of dodos on Mauritius. This leads most historians to conclude that the probable outside date of the dodos' extinction falls sometime after the report of Chief Lamotius in 1688, but before Legaut's arrival on Mauritius in 1693.

What Did a Dodo Really Look Like?

6. This is probably the best-known image of the dodo in the world. It was painted in 1626 by Flemish artist Roelandt Savery, but it is commonly known as *Edward's Dodo* after the English ornithologist, George Edward, who commissioned the work. Savery did more to perpetuate the canonical image of the dodo than any other artist, not only because he produced so many works that either featured or included the dodo, but also because so many other artists were influenced by Savery's paintings (or just plain copied them).

7. Artists who cribbed from Savery include his client George Edward, and his nephew Jan Savery.

8. Most famous, Sir John Tenniel's illustration for Lewis Carroll's *Alice's Adventures in Wonderland* borrows heavily from *Edward's Dodo*. Unfortunately, all these artists were copying from a flawed model.

Many historians and ornithologists believe that Savery may have only ever seen a stuffed dodo specimen, and a badly stuffed one at that. Others argue that Savery *might* have seen a live dodo in the menagerie of Rudolf



Edward's Dodo by Roelandt Savery.



Jan Savery's Dodo

Sir John Tenniel's Dodo from *Alice in Wonderland*

and frilly, and the four white feathers of the tail plume, while mentioned in some eyewitness accounts, were probably modeled after ostrich feathers, which were all the rage for military hat decorations in Savery's day. But how do we *know* the popular image of the dodo is wrong? More to the point, if Savery got it wrong, then what did the dodo *really* look like?

9. Reliable descriptions of the dodo are few and far between. The majority of written accounts come from sailors and castaways, who seemed most concerned with the bird's edibility. Natural science was far from a formal discipline in the 1600s, and the enthusiasm with which many writers attempted to describe the natural world was not necessarily matched by any particular aptitude. Even the best eyewitness observers were reduced to comparing the dodo to other common birds, which makes the handful of earnest attempts at a description somewhat vague. One of the most evocative eyewitness accounts of the dodo comes to us from the English theologian and historian, Sir Hamon L'Estrange, who wrote: *About 1638, as I walked London streets, I saw the picture of a strange looking fowle hung out upon a clothe, and myself with one or two more in company went in to see it. It was kept in a chamber, and was a great fowle somewhat bigger than the largest Turkey cock, and so legged and footed, but stouter and thicker and of a more erect shape, coloured before like the breast of a young cock fesan, and on the back of a dunn or dearc colour. The keeper called it a Dodo...*



Terra Cotta Dodo from the London Museum



Actual Dried Dodo Head and Foot from the Ashmolean Museum at Oxford.

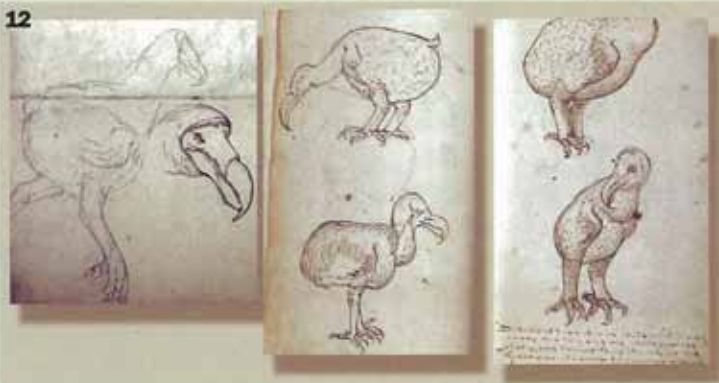
10-11. It is possible that this very dodo wound up as a taxidermy specimen in the collection of John Tradescant. In 1659, Tradescant bequeathed his vast collection of oddities, including his stuffed dodo, to Alias Ashmole, founder of the Ashmolean Museum at Oxford. Most dodo articles retell the story of how, in 1775, the Oxford dodo was looking so ratty that most of it was burned in a rubbish fire. Dodo expert R. F. Ovenell claims that this is yet another dodo myth. The removal of the Oxford dodo from display was a curatorial decision to preserve what little could be salvaged from a badly degraded specimen. What could be saved amounted to the head, one foot, and some feathers. Until 2002, these few remnants of the Oxford dodo, along with a

II of Prague, but the specimen was obese due to lack of exercise resulting from a life in captivity, and deformed as a result of an extended voyage in a cramped shipping crate. Whatever the case, the consensus is that Savery's illustrations of the dodo were inaccurate. The bird is too fat and squat, the wings are too big

and frilly, and the four white feathers of the tail plume, while mentioned in some eyewitness accounts, were probably modeled after ostrich feathers, which were all the rage for military hat decorations in Savery's day. But how do we *know* the popular image of the dodo is wrong? More to the point, if Savery got it wrong, then what did the dodo *really* look like?

In an attempt to address this lack of hard evidence, Richard Owen, comparative anatomist at the British Museum in London, sent out an appeal for physical remains of dodos. His request was answered some twenty years later, in 1865, when George Clarke, Master of The Government School at Mahebourg, collected a large quantity of dodo bones from a bog on the south coast of Mauritius, known as the Mare aux Songes. These bones, and casts of these bones, were distributed to museums around the world, and were incorporated into dodo reconstructions on display in London, Oxford, Cambridge, Dublin, New York City, Harvard University, and Durban. Most museum visitors assume that these are taxidermy specimens and therefore true to life, however, aside from the skeletal elements, these are reconstructions of plaster and chicken feathers. The artisans who created these models relied heavily on pictorial reference. Since the best illustrations of the dodo were thought to come from Savery, his somewhat fanciful interpretation of the dodo became even more deeply entrenched in the public imagination.

12



Dodo Sketches from the Log of the Gelderland.

12. Dodo experts agree that there are only two definitive illustrations of the dodo made from life. One is a handful of sketches made in 1601 by trained artist Joris Joostensz Laerle in the logbook of the Dutch East India Company's flagship, *Gelderland*;

13



Ustad Mansur's Dodo of Surat

13. The other is an exquisite miniature, made around 1625, by Ustad Mansur, the court painter to the Mogul Emperor Jahangir. Since Jahangir's menagerie was in the city of Surat, India, this painting is commonly referred to as the *Dodo of Surat*.

Note that *Edward's Dodo* is not included in the above list. So, how did Savery's flawed image of the dodo become familiar to the world while these more accurate painting remained obscure? The answer is one part timing, one part luck, and

one part sociology. Very few of Mansur's paintings survive at all, and most of those languished in obscurity after the fall of the Mogul Empire.

In 1955, A. Ivanov saw the *Dodo of Surat* while visiting an exhibition of Indian miniatures at The Institute for Oriental Studies, in Saint Petersburg, Russia. Three years later, German ornithologist Erwin Stressman described *Dodo of Surat* in a paper titled, "Wie hat die Dronthe ausgesehen?" (How Did the Dodo Look?). Stressman's paper was published in the *Journal für Ornithologie*, which wasn't nearly as widely read as, say, *Time* or *Field and Stream*, and so the existence of Mansur's painting remains virtually unknown outside the demimonde of ornithology. Laerle's dodo sketches in the 1601 ship's log of the *Gelderland* suffered a similar fate. They were lost and forgotten in the archives of The Hague until 1991. By contrast, Savery was active at a time when a burgeoning European middle class was increasingly willing and able to pay for art. Savery's own dodo paintings, combined with the work of his many imitators, created the 17th century equivalent of a virile marketing plan.

Fat or Thin?

In 1990, the Marquis of Bute, then chairman of the board of trustees of the National Museums of Scotland, asked Andrew Kitchener, Curator of Birds and Mammals at the Royal Museum of Scotland, to come up with a new reconstruction of the dodo. The motivation for this request was purely financial; the Marquis envisioned selling life-sized models of dodos as lawn ornaments to wealthy Americans. (This plan to challenge the kitschy dominance of the plastic pink flamingo never came to fruition).

14. As Kitchener began to collect references for his model, he noticed that there was a discrepancy between images of dodos made on the bird's native island and those painted by European artists. The field sketches, while crude, depicted a much less portly bird than the fat specimens featured in the exquisite oil paintings made by European artists such as Savery. Kitchener began to suspect that dodos kept in captivity had become obese due to lack of exercise, whereas dodos in the wild would have remained lean because they had to burn calories foraging for food. Kitchener decided to test his theory. He weighed and measured hundreds of dodo bones from the collections of the Oxford and the London Museum, and used this data as the basis for building his own reconstruction. The model he produced was a thinner, more athletic looking dodo than the popular perception. Kitchener subjected his model to various forms of statistical analysis. He also compared his model to large living birds, and cross-referenced his results with the historical evidence. Everything pointed to a wild dodo that was much more lithe and athletic than the image made popular by Savery. In 1990, Kitchener's groundbreaking dodo model went on permanent display in the conservation exhibit "The World in Our Hands" at the Royal Museum of Scotland in Edinburgh. One year later, the rediscovery of Laerle's dodo sketches in the



Andrew Kitchener's "Slimline" Dodo.



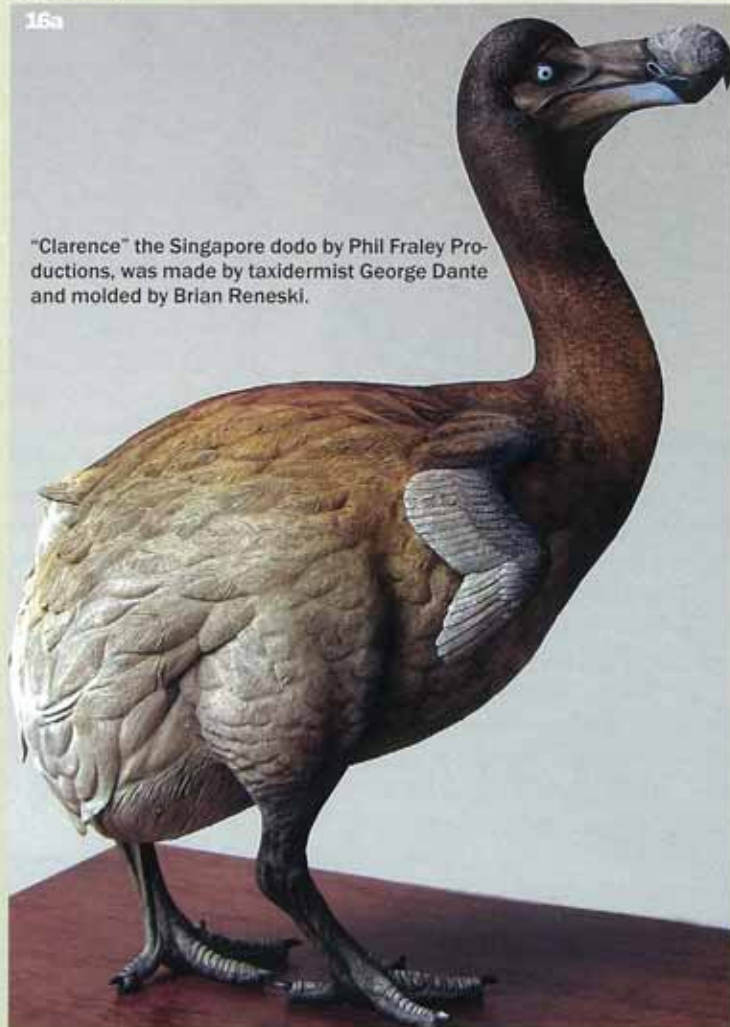
Pangolin Dodo by Nick Bibby

log of the *Gelderland* independently corroborated Kitchener's model of a thinner dodo.

15. Kitchener's model was the first to correct the world view of a fat and ungainly dodo, and as such, it is a tremendous scientific achievement. As a work of

art, however, his model lacks grace and fine details. The Mauritian Wildlife Foundation commissioned an English foundry, Pangolin Editions, to

16a



"Clarence" the Singapore dodo by Phil Fraley Productions, was made by taxidermist George Dante and molded by Brian Reneski.

produce an exquisite bronze statue of the dodo, which is installed on the Ile aux Aigrettes, which lies off the southeastern shore of Mauritius. Scientific guidance for this statue was provided by Dr. Nick Arnold of the British Natural History Museum, and Errol Fuller and Dr. Julian Pender Hume, authors in the field of extinct species and natural history. The Pangolin Editions dodo, sculpted by Nick Bibby, has excellent proportions and details.

16a. Phil Fraley Productions, Inc., is the first company to produce a full-color dodo model that is scientifically accurate in proportions, fine details, and color, and also aesthetically beautiful. Three identical models are installed at the Singapore Science Center, the Raffles Museum of Biodiversity Research, and the Jurong BirdPark, all in Singapore. The last section of this article will attempt to summarize the team effort that went into producing a dodo model, which British paleontologist Julian Pender Hume calls, "...a work of art with scientific clout."

Reconstructing a Dodo

The Singapore Dodo was researched, sculpted, cast, painted, crated, and shipped in just nine weeks. It was a team effort that drew upon the skills of artists, craftsmen, researchers, historians, ornithologists, and museum curators.

16b. The process began with a field trip to the American Museum



The American Museum of Natural History Ornithology Department

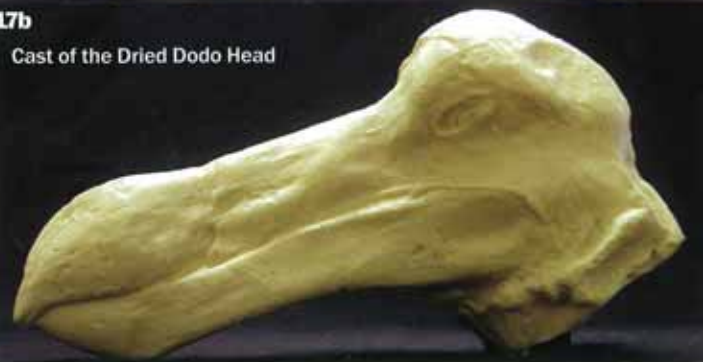
17a

Cast of the Copenhagen Dodo Skull



17b

Cast of the Dried Dodo Head



of Natural History in New York City. Phil Fraley and taxidermist/sculptor George Dante took measurements and photos of actual dodo bones from the collections room of the museum's ornithology department, including the metatarsus, femur, and most importantly, the keel bone. They also examined a dodo reconstruction created by legendary British naturalist, hunter, and taxidermist Rowland Ward, which is not currently on public display.

17a-b. Most importantly, the American Museum generously loaned Phil a cast of the Copenhagen dodo skull and the Oxford dried dodo head. These casts provided a reference point for the overall scale of the new model, and a duplicate of the cast of the dried head was incorporated directly into the clay model.

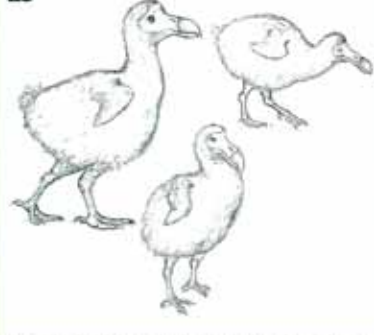
18. By the time Phil and George returned to the Phil Fraley Studios in New Jersey, I had already done a preliminary Web search for dodo images. Using printouts of these photos, and the knowledge gleaned from the trip to the American Museum, George quickly produced several preliminary sketches of the dodo in assorted poses. These were presented via e-mail to the client for review.

Once the client selected a pose from the preliminary sketches, George began to sculpt a half-scale maquette. A maquette is a sculptor's small preliminary model or sketch used to visualize and test shapes and ideas. A maquette offers the sculptor an opportunity to experiment with shapes and ideas in a relatively risk-free way before committing to a full-scale sculpture.

Capturing a Split Second

19. If an animal sculpture is going to look truly dynamic, the sculptor must capture an exact moment in the life of the subject. This is harder to do than it sounds. To say that the animal is "running" or "feeding" is too vague. Generalizations lead to poses that look generic. In the case of the Singapore dodo, Phil and George decided that the dodo

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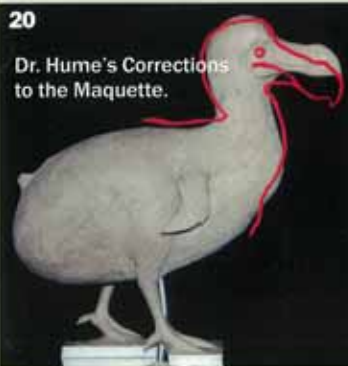


George Dante's Preliminary Sketches

19

George Dante's Maquette
(a sculptor's small preliminary model).

20

Dr. Hume's Corrections
to the Maquette.

is foraging for food when a sound startles it, causing it to snap to attention and look and listen for danger. Choosing the exact right moment to portray is the easy part—making it look convincing takes talent, skill, and a lot of hard work.

Once George had the maquette reasonably close to completion, we began to solicit comments from our experts. Dr. Julian Pender Hume is a well-known authority on extinct animals and has written and lectured extensively on the dodo. Dr. Anwar Janoo is an ornithologist who is considered one of the foremost authorities on the dodo. Patrick Rummans is a taxidermist and wildlife artist who is most famous for bringing the AFLAC duck to life. Mr. Rummans is not a dodo expert, but his deep understanding of avian anatomy proved extremely useful on numerous occasions. These three men all brought unique perspectives to the project, but they were all equally generous with their time and advice. Whenever two or three of them independently agreed on something, (which happened more often than not) I knew I was on the right track.

Even with all of our reference material, we still had a lot of questions about what the dodo looked like in life. How long was the neck, and how wide? What was the size and shape of the legs? How big was the gullet? What was the proper angle for the sternum? Where did the wings attach and how big were they? And the burning question that really went to the heart of the matter—exactly how big was the dodo's butt? This last question is far from settled among dodo experts. Some argue that seasonal variations in the dodo's diet caused extreme fluctuations in weight. Others claim that it was only captive dodos that got fat. Still others believe that there never were any fat dodos—the extra pounds only existed in the minds of certain painters and taxidermists. We had decided that the evidence pointed to a thinner dodo, but when it came to the rump, were we going too far or not far enough?

20. I took photos of the maquette and e-mailed them to our experts for feedback. Sometimes they sent back images of their own as ref-

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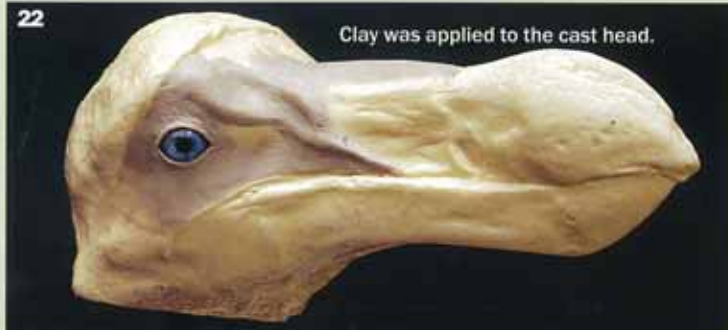


Phil Fraley (left) and taxidermist George Dante correct the maquette.

erence material. A few times Mr. Rummans or Dr. Pender Hume actually traced a new outline over the image I sent and returned it to me.

21. Phil and George would use all of this feedback to make physical edits to the maquette. Then I'd send new photos back to our experts, and they would once again weigh in, usually the very same day, if not within a few hours. All of these guys have busy lives, and nobody was paying them for their consultations, but it seemed like everybody wanted to be a part of this project.

22

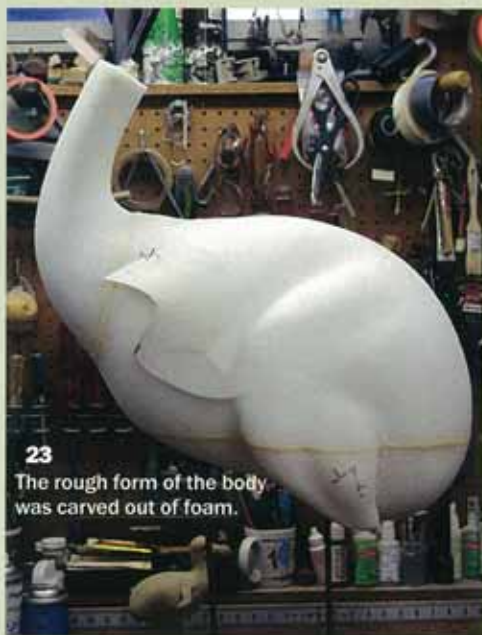


Clay was applied to the cast head.

22. Once the maquette was finalized, George began sculpting the life-sized model. Normally, sculptors start massing forms from the hips out, but the cast of the dried dodo head was going to be incorporated into the model, and that meant that the body would have to conform to the fixed size of the head.

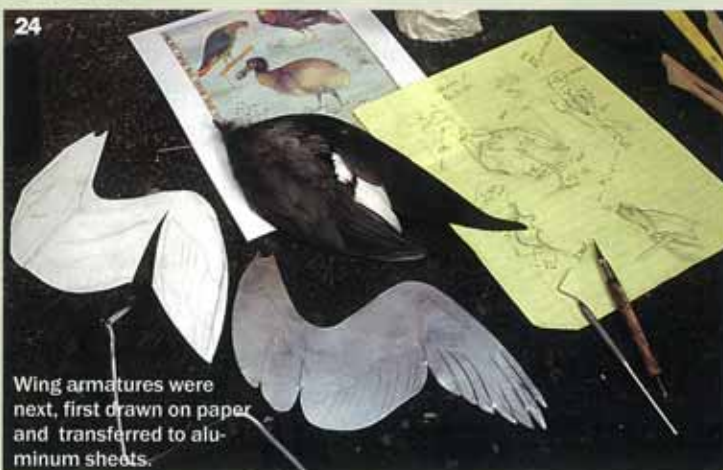
Using the head for scale, George created a full-size paper template of the body, legs, and wings of the dodo. Next, George laminated blocks of foam together to create a blank larger than the final sculpture. George pricked pinholes along the outline on the paper template, pinned the template on the foam, and then rubbed over the lines with charcoal pencil, which filtered through the pinholes and transferred the pattern to the foam block.

23. George then began to carve out the rough forms of the dodo



The rough form of the body was carved out of foam.

24



Wing armatures were next, first drawn on paper and transferred to aluminum sheets.

from the foam blank. He used ordinary fillet knives for this part of the process. Once he was satisfied with the rough proportions, George switched to rasp files and smoothed the planes.

24. From careful examination of Mansur's painting, George determined that a dodo's wings resembled those of most common birds with some slight variances. Eyewitness accounts say that the closest relation of the dodo, the solitaire of Rodrigues, would keep in contact with each other by flapping their wings very quickly to create a buzzing sound. George reasoned if this were true, then the wings would have to be small and stiff. Using a common merganser wing as a feather group reference, George drew paper templates to scale, then transferred the patterns to aluminum sheets. Armature wire provided support for the wings and a means by which they could be attached to the body.

25. When George was satisfied with the foam core, he covered the entire surface with a layer of clean clay and massed-out major muscle groups. George used clean clay for two reasons: first, it never dries out, which gave him unlimited time to make corrections to the sculpture; second, clean clay does not react with silicone rubber, which is used during the molding process. (Clay that contains sulfur prevents silicone from curing.)

George and Phil met again at this point to make sure that the insights gained from the maquette were reflected in the full-scale pose. The neck and gullet were refined, the wings were repositioned slightly, and once again, they asked that all-important question: was the butt too big? Phil and George were confident that the *Dodo of Surat* and the sketches in the 1601 log of the *Gelderland* were accurate, but all of these illustrations showed the dodo strictly in profile. No illustrations showed the dodo from behind or above, nor did we have access to any dodo re-creations we believed were anatomically accurate. In the "end," George and Phil made a judgment call based on their knowledge of bird anatomy and their years of natural history experience.

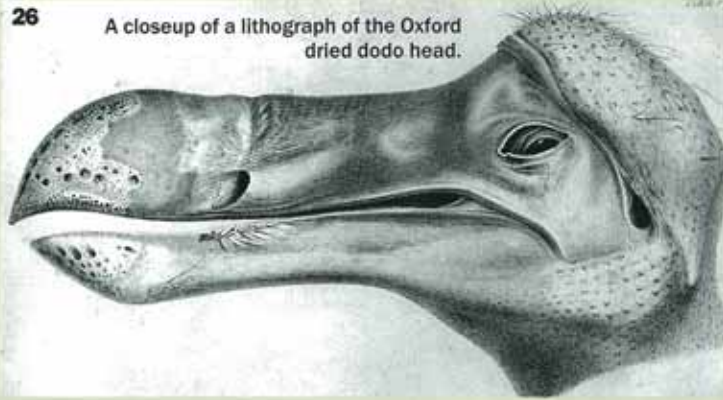


Clay was applied over the foam to replicate the major muscle groups.

Adding Textures and Details

26. DNA evidence indicates that the closest living relatives to dodos are large ground-dwelling pigeons from Southeast Asia, including the Nicobar pigeon, the crown pigeon of Papua New Guinea, and the tooth-billed pigeon of Samoa. Dr. Janoo, however, advised that the feathers of

26 A closeup of a lithograph of the Oxford dried dodo head.

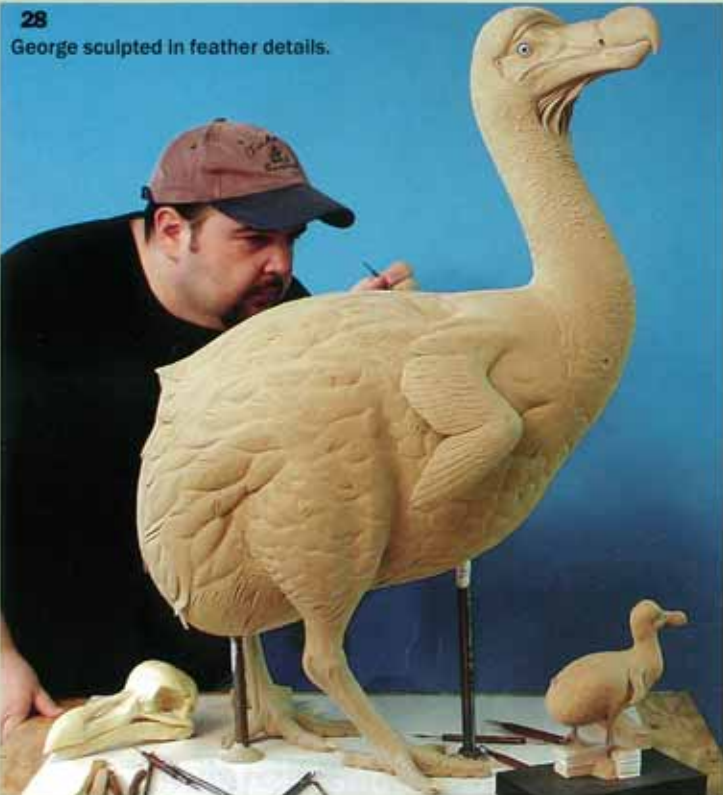


27 George sculpted the feathers half pigeon and half rail.



the dodo were closer to that of flightless rails. Dr. Janoo had the privilege of examining the dried head of the Oxford dodo up close. Even though the specimen appears to be completely devoid of feathers, it retains the calumi, the tips of the quills that anchor the feathers into the skin. The shape and stiffness of the calumi suggested to Dr. Janoo that the feathers would be like those of a rail—short and stiff.

28 George sculpted in feather details.



27. So George compromised and made feathers that were halfway between pigeon feathers and those of a rail.

28. George produced a sample of feather details for approval before he began to add feather textures to the final sculpture.

Dodo Feet



The London Dodo Foot (lithograph).

29. The feet of the dodo were based on a lithograph of the preserved foot of a dodo from the London Museum of Natural History. George used a silicone casting from the leg of a rhea, a large ground-dwelling bird whose legs and feet are a close match to that of a dodo, to add texture to the clay.



Cast of the leg of a rhea.



Texturizing the feet was next.

30a-b. This is the cast of the rhea leg. With the feet and feather texturing complete, the dodo was ready to be cast. ■

NEXT ISSUE: Molding, Casting, and Finishing

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The Casting Process

OUR CLIENTS IN SINGAPORE ULTIMATELY REQUESTED three copies of the dodo model, so the mold would have to be capable of producing multiple pulls.

Brian Reneski is one of the best mold-makers in the business. Brian has twenty-two years of experience in creating various types of exhibits for museums, and he has produced many models of challenging subjects that are scientifically accurate, exquisitely detailed, and beautiful. He currently oversees projects for Phil Fraley Productions at the Carnegie Museum of Natural History and at our Pittsburgh studio.

A Composite Mold



Cross section of the 2-part mold

32. Brian created a composite mold. A composite mold consists of a hard outer shell, called a "mother mold," which provide a rigid structure for the center of the mold, which is made from silicone rubber. Silicone captures the minute details of the sculpture, but it is too soft to stand up on its own.

33. The first step in the mold-making process is to establish where to place the seams. Brian determined that the mold would have to be made in six pieces in order to allow the wings, head, and feet to pop out freely. Brian first poked holes along the model where he wanted to place the first seam. Then he stuck thick gauge wires at regular intervals along the length of the seam. Next he created a shelf along these wires out of 1/2-inch wire mesh.

34. Finally, Brian covered the wire mesh with clean clay. As we will see later, this clean clay shelf stops the silicone from dripping beyond the seam line when it is applied. Brian used clean clay, because it contains no sulfur. Sulfur reacts with some types of silicone and prevents it from curing.

35. Brian sculpted bumps at regular inter-



Moldmaker Brian Reneski, one of the best in the business, built a wire shelf at the seam.



Wire shelf with clean clay added.



Keys were sculpted in the clay shelf.

vals along the clean clay shelf to create a key which would help the six parts of the mold fit together as precisely as possible.

Creating The Mold



RTV was placed in the vacuum chamber.

36. Once the first seam line was marked off, Brian mixed up a batch of brushable RTV rubber. (RTV stands for "room temperature vulcanizing," and refers to a rubber material that cures completely at room temperature without needing heat treatment). This first coat of RTV rubber was placed in a vacuum, and the pressure inside the chamber was reduced by one atmosphere to remove the air bubbles that were created when the rubber was mixed. Bubbles in the surface of the rubber mold will create imperfections in the cast. Brian used a homemade vacuum chamber, but commercially made units are available.



The first RTV layer was brushed on.

37a. Brian brushed the RTV rubber directly onto the dodo sculpture to capture the most minute details.



37b. Brian used a dental probe to pop any bubbles that formed on the surface of the RTV rubber before it cured.



38. Two more coats of RTV rubber were applied to give the inner mold strength. Pulling the casts from the mold can cause it to tear if the rubber is not thick enough. Since the second and third coats do not come into contact with the sculpture, they do not need to be vacuumed, but a fixitrope was added to the RTV rubber to make it thick and brushable. Each coat was a different color, which helps the mold maker ensure complete coverage of each successive coat.



A drying booth speeded up curing.

39. To speed up the curing time between coats, Brian placed the entire sculpture into a drying booth. RTV rubber will eventually cure without heat, but when you are fighting a deadline, everything you can do to speed up the process helps. The drying booth Brian made was a simple frame of PVC pipes covered with plastic tarps sealed with duct tape. A heavy-duty hair-dryer stuck under a flap in the plastic provided the heat. It wasn't a very stylish set up, but it got the job done.



Fiberglass was applied to the mother mold.

Creating The Six-Part Mother Mold

40. Once the RTV rubber cured on the first section of the mold, Brian covered it with a layers of fiberglass cloth soaked in epoxy. This epoxy shell, which gives the mold its structural integrity, is called the "mother mold."



Bolts were added at the seams. A 6-part mold will be the end results.

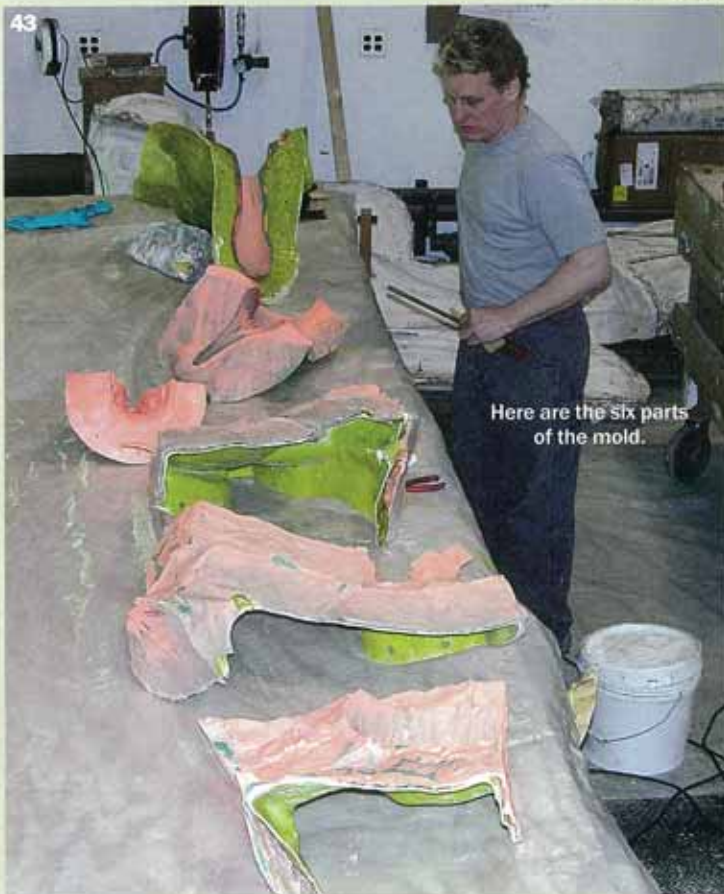
41. Once the mother mold was completed on the first section of the dodo, Brian flipped the sculpture over and repeated the entire casting processes on the adjoining side. After pouring on three coats of RTV rubber, and constructing the mother mold for the second section, he bolted these two parts of the mold together at the seam. The molding process was repeated on four more sections of the dodo until the entire sculpture was encased in a six-part mold.



The original sculpture was of course badly damaged in the process.

42. Once all parts of the mold were cured, they were removed from the sculpture in the reverse order in which they were created. In other words, the last part molded came off first. (Unfortunately, this part of the process badly damaged the original sculpture).

43. The inside of the mold was cleaned using a mild solution of soap and water and a very soft brush. Any clay that was stuck in deep cavities was cleaned out with dental tools.



Here are the six parts of the mold.



The inside of the mold was cleaned of all clay, then inspected.

44. Finally, the entire surface of the RTV rubber was inspected for rips or tears.

Pouring the Cast

There are two ways to pour a multi-part mold. You can assemble the pieces first, and then pour in the casting material. You can also pour each of the individual sections separately, and then assemble them afterwards. Because the dodo model had several prominent undercuts, Brian decided to go with this second method.



Brian coated the inside of the mold with gel coat, creating a very thin layer.

45. Because the mold itself and the casting material were both non-porous, Brian did not need to

paint the inside of the mold with release (petroleum jelly). He began by painting the inside of the mold with a surface coat of epoxy, called a gel coat. The gel coat provides a durable, workable surface that can be carved and accepts paint well. Brian only applied a very thin layer, about $\frac{1}{16}$ of an inch. If gel coat is applied too thickly, say more than $\frac{1}{8}$ inch, it can cause a thermal chemical reaction, or the gel coat may tend to sag or crack.

The gel coat was allowed to cure until it passed the "thumbnail test." If you can't make a mark in the surface with your thumbnail, it's set.



Five layers of fiberglass were applied.

46a. Brian then applied layers of fiberglass to the back of the gel coat to provide rigidity. Essentially, this step is like building a mother mold *inside* the cast. Since this model was not a structural piece, (in other words, it was not meant to bear weight, or stand up to being touched repeatedly), he determined that five layers was sufficient.

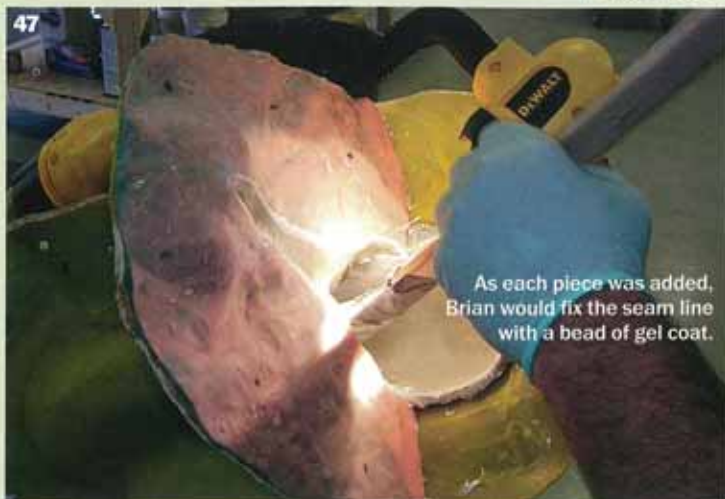


Brian trimmed the seams of excess fiberglass.

46b. Once each section was cast, Brian used a pneumatic modeling tool to trim the excess that extended beyond the seam.

47. Once all six sections were cast, Brian, with help from his assistant Joani Turbek, began the assembly of the individual pieces of the mold with the cast sections inside. He began from the feet and worked his way up to the forehead and the top of the beak. As each section was pieced together, Brian would fix the seam line with a bead of gel coat. It's sort of like caulking the seams of a ship as the sections of the hull are put into place.

The one obvious problem with this method of assembly is that there is no way to seal the very last seam from the inside. So, when Brian placed

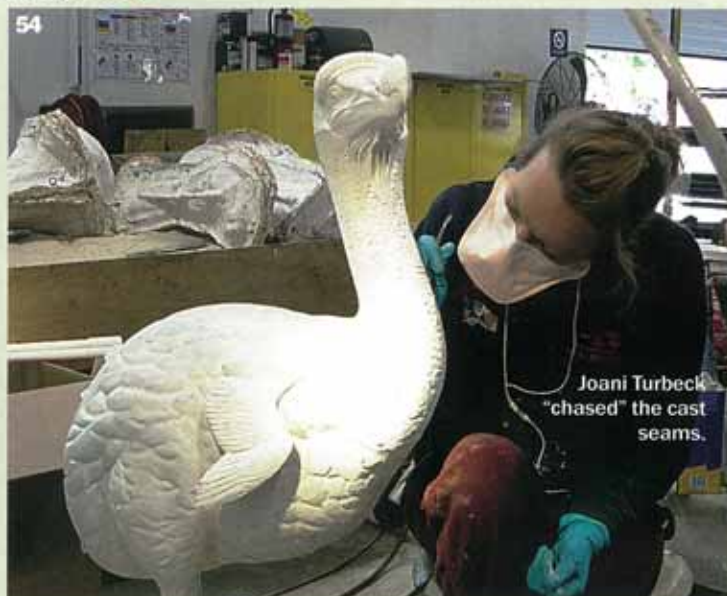


the last section of the dodo cast (the top of the forehead and beak), he added gel coat mixed with chopped up bits of fiberglass cloth around the seam before he bolted on the mold. This reinforced gel coat oozed out between the seams of the mold, leaving a thin plane of material called "flashing." The flashing was easily cut away with scissors.

48-53. Once the entire dodo was assembled and allowed to cure, each section of the mold was removed, again in the reverse order from which it was assembled.

We now had a complete dodo, but there was still one last step.

Chasing



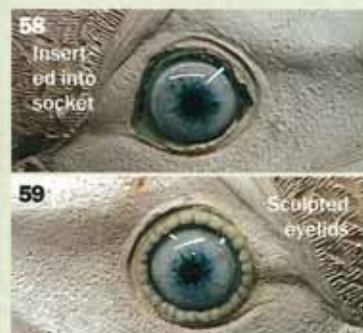
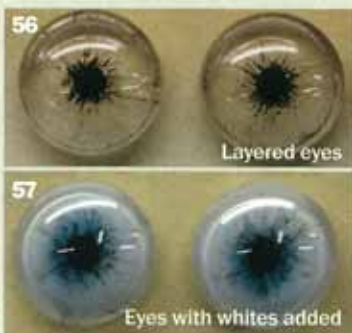
54. The cast that comes out of the mold is never perfect. There is always a line at the seams in the mold, and it is inevitable that there are sections of the cast that need to be touched up. This process of fixing all the minor imperfections in the cast is called "chasing." It's a long and tedious job, but it is essential, because any obvious seam lines or mistakes on the cast would ruin the illusion that this polymer model is an actual bird. Brian and Joanie used a variety of tools to artfully disguise the seams and make the dodo model look like it was carved from a solid block. Afterward, the dodo was ready to go back to George one more time.



Painting and Placing the Eyes

55. George took the measurements for the eyes and eyelids directly from the cast of the Oxford dodo's dried head. He used Tohickon brand clear flint glass eyes, which he painted a ghostly bluish white, after the Mansur painting.

Painting the Dodo ▶



Both Dr. Janoo and Dr. Pender Hume had independently expressed the opinion that Mansur's miniature was the best full-color illustration of a dodo made from life. Kitchener's research strongly indicated that Mansur got the shape of the dodo right, but how could we know if he got the colors right? Fortunately, there are four other bird species in Mansur's painting, all of which are still alive today. The other birds are a pair of immature bar-headed geese, *Anser indicus*; a pair of painted sandgrouse, *Pterocles indicus*; a western tragopan, *Tragopan melanocephalus*; and a chattering lorry, *Lorius garrulus*. I found pictures of each of these birds and compared them to Mansur's painting. Some of Mansur's details were off, but his eye for color was dead on. Since he did a good job with the living birds, it seemed like a safe assumption that he got the dodo right as well.

There is one problem with this argument—it's the same line of reasoning used to defend Savery's illustrations of the dodo. Savery's paintings of living birds are spot on, too, but his depiction of the dodo is now considered flawed. If what's good for the goose is good for the gander (excuse the expression), how can we accept Mansur's version of the dodo as correct, but reject Savery's? While it's true that we will never know if Mansur's dodo painting is 100 percent accurate, his dodo includes morphological characteristics mentioned in contemporary accounts, such as downy plumage and a dark head. Also, Mansur's version is closer to Kitchener's reconstruction of the dodo as a leaner bird with a more upright stance. Finally, while Mansur's dodo morphology differs greatly from Savery's, when it comes to color, *Dodo of Surat* and *Edward's Dodo* have more in common than not. Both show a blue patch on the lower jaw, light-colored wing tips, and sandy colored legs with black claws.

George sent a copy of the *Dodo of Surat* to Chuck Brunner at Smith

Paints, the makers of Wildlife Colors acrylic airbrush paints. Mr. Brunner, who is always willing to go above and beyond the call of duty for his customers, analyzed the colors in the *Dodo of Surat*, and mixed the paints George used to paint the model.

60. George primed the entire model with a two-part epoxy (Transtar 2K Epoxy Primer Sealer #6144, and Transtar white Activator, #6104). Then he covered the entire model with a black wash to bring up the details in the sculpture.

61. Finally he developed a paint schedule for building the layers of the actual colors of the dodo. (George's paint schedule could be the subject of an entire article in and of itself). The entire painting process took about two days.



George primed the dodo cast.



While George painted, Brian built a custom shipping crate.

Shipping the Dodo

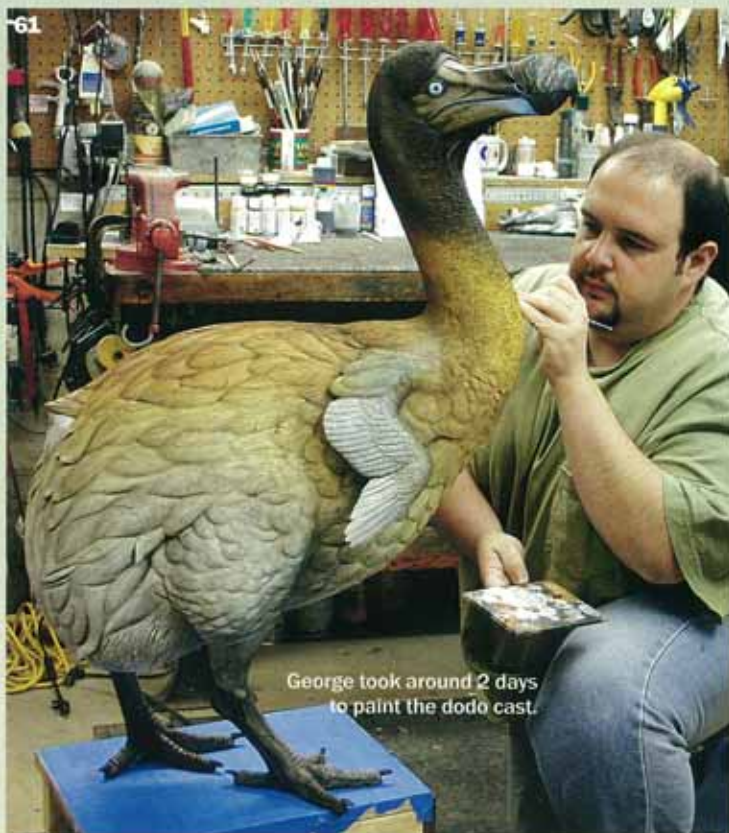
62. While George was painting the dodo, Brian was building a custom shipping crate. The shipping crate was designed with an internal pallet on a rolling base, so only one side of the crate needed to be opened to remove the dodo model safely from the crate.

The Unveiling

Only nine weeks after placing their order, the Raffles Museum of Biodiversity Research unveiled its new dodo model to the public. The Raffles Museum gave the dodo model the nickname "Clarence," after Clarence Sirisena, the Assistant Chief Executive of Projects and Events at the Singapore Science Centre and a driving force behind the dodo project. An exact copy of the dodo went on display at the Jurong Bird Park six weeks later. Both have become "must see" attractions. A third copy of "Clarence" went on display at the Singapore Science Center late in 2006.

A few short weeks after "Clarence" the dodo arrived at its new home in Singapore, an international team of scientists arrived at the Mare aux Songes for a third season of excavations. The Mare aux Songes is the same mosquito-infested marsh where George Clarke excavated a large cache of dodo bones in 1865. With government funding and modern equipment, this summer's dig has produced a wealth of animal and plant remains far beyond anything Clarke could have wished for. As Dr. Kenneth Rijdsdijk, the leader of the excavations, put it to the *New York Times*, "You name it, we've got it. We've found the whole ecosystem."

Who knows what secrets the Mare aux Songes will give up about the dodo? Will "Clarence" the dodo enjoy immediate validation, as was the case with Dr. Kitchener's dodo model, or will our picture of the dodo be completely changed once again? ►



George took around 2 days to paint the dodo cast.

Your guess is as good as mine. But for now, "Clarence" remains the most accurate version of the dodo the world has ever seen. ■

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