

Turtle

Dives Again

Re-creating George Washington's revolutionary submarine

by TOM GIDWITZ

AT MIDNIGHT, SEPTEMBER 7, 1776, a strange craft on a deadly mission made its way down the Hudson River. Shaped like an egg, with a windowed copper conning tower, two spindly propellers, and a 100-pound time bomb on its back, the seven-foot-tall wooden submarine *Turtle* was the most daring invention of the Revolutionary War.

The brainchild of David Bushnell, a frail Connecticut ex-farmer and mechanical genius, *Turtle's* task was to affix the bomb to *Eagle*, the 64-gun flagship of the British fleet anchored in New York Harbor. Hundreds of men-of-war, transport ships, and gunboats also crowded the waters, and 30,000 British troops were bivouacked on Staten Island and Long Island. The force threatened to cut the colonies in half and crush the Continental army. If *Turtle* could destroy *Eagle*, it might alter the course of the war.

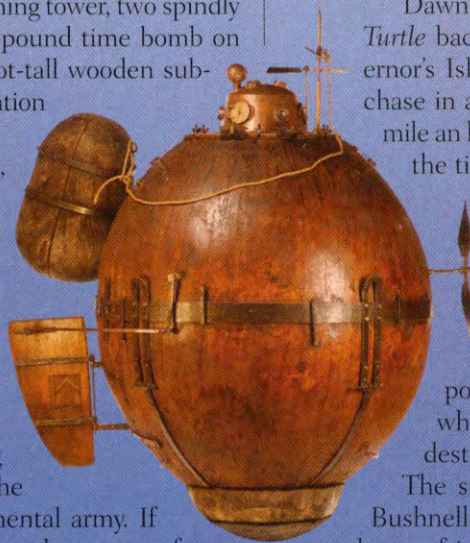
As the sub approached its target, its only occupant, Sergeant Ezra Lee, feverishly cranked two propellers and let enough water into the ballast tanks to submerge the craft and slip beneath the ship. But the auger mounted atop the sub,

meant to penetrate *Eagle's* hull and attach the bomb, bounced off. When Lee tried again, the sub skidded out from beneath the British ship and shot to the surface.

Dawn was breaking, and Lee turned the ungainly *Turtle* back to Manhattan. As he powered past Governor's Island, British sentries spotted him and gave chase in a barge. The *Turtle* couldn't even make one mile an hour and as the barge caught up, Lee released the time bomb. It drifted on the surface, and the Red Coats, sensing danger, hurried back to shore. An hour later, not long after *Turtle* was back in Manhattan, the bomb exploded, rocking the harbor and blowing a column of water high in the air.

A month later Bushnell was transporting *Turtle* up the Hudson aboard a sailboat when the British attacked, sinking the ship and destroying the innovative vessel in the process. The sub was the first ever used in warfare, but Bushnell never built another. The only surviving evidence of its design to survive are eyewitness accounts and letters Bushnell wrote at the request of a fellow inventor, Thomas Jefferson, 15 years later.

But now *Turtle* sails again, thanks to Rick and Laura Brown, two Massachusetts artists who resurrect lost technologies to help them better understand human ingenuity over time.





In 1776, the experimental sub *Turtle* was the most revolutionary weapon in George Washington's arsenal. Artists Rick and Laura Brown have created a faithful replica of the vessel.

With the help of historians, archaeologists, timber framers, blacksmiths, glassblowers, museum curators, U.S. Navy cadets, and the Browns' students at Boston's Massachusetts College of Art (MassArt), they built a new *Turtle* faithful to the design, materials, and techniques that Bushnell used himself. The result is an ungainly, oddly beautiful vessel reminiscent of a mad wizard's flying machine, with a nut-brown hull of carved wood and hammered metals bearing the marks of many hands.

The Browns are experts at revealing the past, but not with archaeological excavations. In their MassArt classes, they re-create ancient objects with rigorous exactitude, using the same materials and tools used for the originals. By tracking

down "very specific skills to a very specific location to a very specific material and a very specific time frame," Laura says emphatically, they can access the past through "the world of objects that reflect the humans that made them."

The Browns began their careers thinking more about contemporary sculpture than the past. But they were always fascinated by the history of the tools and materials they used. Soon they began to incorporate time itself as an integral part of their art, creating environmental installations from sculpted earth or concrete that eroded in the weather or that they altered themselves in response to events in the world. When they were asked to lend their skills to the re-creation of a pair of medieval trebuchets, or catapults, in England, they realized that experimental archaeology—replicating history's forgotten or misunderstood objects—would allow them, Laura says, "to better understand these innovations and the



Joel McCurry

Rick Brown, far left, helps split a spruce log that was hollowed out to form *Turtle*'s "shells," below left. Artist Matt Hincman, below right, demonstrates the vessel's dimensions. A drawing of *Turtle* done in 1875, facing page, depicts a roomier sub, and illustrates the perils of historical reconstruction by including propellers of a type not invented until the 19th century, long after the British destroyed *Turtle*. In re-creating the sub's components, like its brass hatch, facing page, the Browns used only 18th-century techniques.



Cary Wolinsky



"I took care to prove its strength to sustain the great pressure of the incumbent water, when sunk deep, before I trusted any person to descend much below the surface..."

—DAVID BUSHNELL

complexity of the people and places that surrounded them." They would test the boundaries of art and archaeology both.

They have gone on to re-create a sixteenth-century, five-story, human-powered crane and are currently reconstructing the wooden cupola of an eighteenth-century Polish synagogue destroyed by the Nazis. In 1999, in a Chelmsford, Massachusetts, stone yard, they settled the mystery of how the ancient Egyptians raised their obelisks by using a ramp, a pile of sand, and a 112-person crew tugging hemp ropes to gently set a 36-foot-tall granite obelisk upright. Their most ambitious projects are assembled in near round-the-clock marathons that can stretch for more than a week, with scores of helpers, ringing axes, flying wood chips, and long tables of artisans and students sitting down to share stories and soup.

In their pursuit of accuracy, the Browns and their students study the history, science, literature, technology, and art that shaped the original object. They strive to put themselves into the minds of the original makers, and, in essence, experience the past from the inside out. The Browns then bring the experience to the larger public through museum exhibitions and documentary films.

Rick, 56, is a round-faced, white-haired man with a gentle voice and a relaxed manner. Laura, 53, is energetic

and spirited, with narrow eyes and a Southern twang. Natives of Georgia, the Browns are sculptors. Rick is also a trained architect, and Laura is skilled at welding, timber framing, concrete construction, and can operate backhoes and bulldozers. They have built houses in Boston; immersed themselves in the folkways of Africa, Central America, and Asia; and have embraced the idea that the hand-fashioned object, well wrought and communally made, can reveal a truth as deep as that of any artist's masterpiece. Although they exhibit their own art in museums, their true love is teaching. "One of our objectives is to give education kind of a shot in the arm," says Rick.

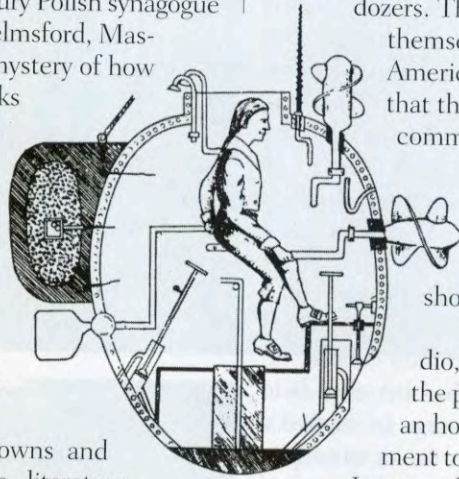
Their headquarters is the Handhouse Studio, a tall, graceful post-and-beam workshop in the pine woods of Norwell, Massachusetts, half an hour south of Boston. The building is a testament to their eclecticism and sense of community.

Laura and Rick spent a year cutting its timber frame, using Roman, medieval European, and nineteenth-century American wood construction techniques. They then staged an old-time barn raising, welcoming dozens of colleagues and friends who helped them erect the structure in two days.

In April 2002, the producers of *Ancient Arsenal*, a series on pioneering war machines, proposed that they rebuild *Turtle* for an episode of the show. Unlike the Browns' previous re-creations, the sub was a one-time product of a single individual, not a device refined over years of use. But David Bushnell intrigued them. His *Turtle* boasted the world's first sealed submersible chamber with an exhaust system for carbon dioxide, the first two-bladed propeller, the first depth gauge, a modern snorkel, and a time bomb with a flintlock detonator. "Bushnell's submarine was the greatest technological advancement of the American Revolutionary War," says Rick. "With it, Yankee ingenuity was born."

Other people had built or drawn versions of *Turtle*, but they included modern parts or components that never could have worked. To re-create *Turtle* accurately, the Browns had to explore the era's European, Native American, and Yankee raw materials and crafts.

They also studied Bushnell's original letters to Thomas Jefferson until they knew much of them by heart. In 1785, Jefferson was ambassador to France. An inventor himself, he was eager to foster innovation and technological self-sufficiency in the fledgling United States. He asked for details from Bushnell's original supporters, including George Washington, who called the sub "an effort of genius." Bushnell sent Jefferson a thorough description of *Turtle*, which Jefferson later published in the *Transactions of the American Philosophical Society*.



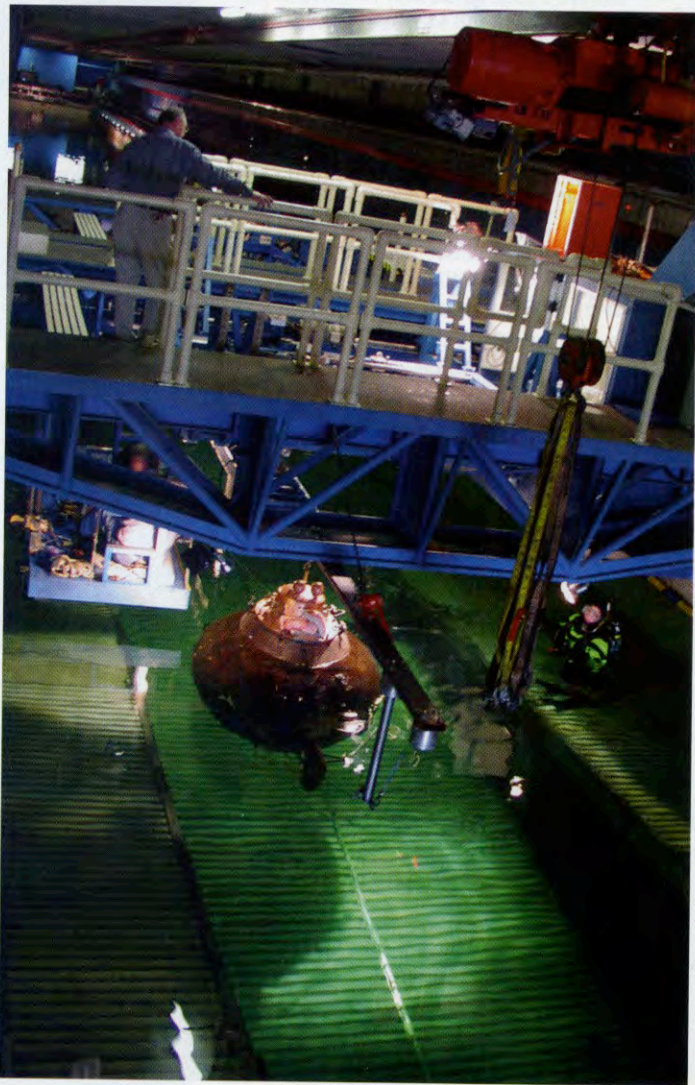
"I never suffered any person to go under water, until I found him well acquainted with the operations necessary for his safety."

—DAVID BUSHNELL

Bushnell was a farmer, not a shipwright, and he described the sub with a landsman's terms. "The external shape of the submarine vessel bore some resemblance to two upper tortoise shells of equal sizes, joined together," Bushnell wrote. It was egg-shaped with "the place of entrance into the vessel being represented by the opening made by the swell of the shell at the head of the animal." Pilot Ezra Lee described the hull as "composed of solid pieces of oak scooped out and fitted together," and "bound thoroughly with an iron band." After poring over these accounts, the Browns realized the hull had been cut from a single log, with the same techniques local Native American Pequots used to carve out their canoes.

The pilot sat on a bench inside a chamber that held enough air for a 30-minute dive. To submerge he tapped a foot-operated valve that let water into ballast tanks; to surface he worked two hand pumps to force the water out. He cranked two foot-long, windmill-shaped propellers to move forward, backward, up, and down. A compass provided direction, and a cork afloat in a glass tube connected to the water outside indicated depth; both were coated with foxfire—a glow-in-the-dark fungus—for visibility in the underwater gloom. On top, said Bushnell, "was a brass crown or cover, resembling a hat with its crown and brim" and the hull-piercing auger. Aft was a rudder and the mounted bomb. Secured to its bottom with iron straps were hundreds of pounds of lead ballast.

The Browns conferred with Joe Woods, head of MassArt's Small Metals Department, to come up with the appropriate eighteenth-century materials and tools for the scores of metal pieces. They studied leather and brass water pumps from the period at the American Museum of Firefighting in Hudson, New York, and spent an entire weekend with timber framers and engineers discussing how to carve and assemble the shell. They consulted specialists at the Smithsonian Institution, Boston Museum of Science, Winterthur Museum, Mystic Seaport, and Connecticut College Arboretum about the metals, marine technologies, and wood that Bushnell might have found available at the time. Archaeologist Kevin McBride of the Mashantucket Pequot Museum in Connecticut told them how the era's Native Americans burned out the centers of large logs and shaped them to make canoes, a process that Bushnell himself might have used. The project's educational reach extended to the United States Naval Academy in Annapolis, where Lew Nuckols, then a professor of ocean engineering, incorporated *Turtle* into his courses. "It was really a very good educational tool for the Naval Academy," Nuckols says. History students searched archives for information and



Laura Brown (2)



Turtle got its first manned test in January 2003, in Duxbury Harbor south of Boston, facing page. The sub then graduated to the U. S. Naval Academy's Hydromechanics Laboratory in Annapolis, where it successfully attached a replica bomb to a mockup of a British vessel's hull. Back in Massachusetts, a horse-drawn cart carried *Turtle* to the North River, where Rick Brown piloted it for an hour.

midshipmen helped design the hull and analyze the ballast and propulsion requirements.

In late December 2002, MassArt students and faculty, naval cadets, and artisans gathered in the cold at Handhouse to re-create *Turtle*. On one side of the studio, the Browns and MassArt colleague Matt Hincman set up a blacksmith shop to forge and hammer out the sub's iron parts, and a machine shop to fashion dozens of rivets, pins, brackets, bands, and other pieces.

A 12-foot-long Sitka spruce log, seven feet in diameter, arrived from British Columbia. (A huge piece of East Coast oak, although historically more accurate, would be nearly impossible to obtain legally today). Ten professional woodwrights and engineers from the Timber Framers Guild split the giant log with wedges, then used traditional hand tools to round and hollow out the hull's two halves. Back at MassArt, faculty members, alumni, and students cast the bronze window frames, hatches, and hinges. They attached them to the conning tower, which Joe Wood had hammered from a single piece of copper. The assembly was taken to Handhouse, where the hull and conning tower were cinched together with iron straps and sealed with felt gaskets slathered in a goo of beeswax, turpentine, boiled linseed oil, and lard.

Despite his long letters, Bushnell never recorded how he joined the various sections of *Turtle* together. "It was always a temptation to use silicone to seal the thing," says Rob Duarte, a MassArt student. "Then you realized that someone else had to figure this out with the same limited resources that we were using. That's just an interesting way to learn. You can't do it any other way than by actually doing it."

After 12 days of labor, the Browns immersed the completed *Turtle* in the chilly harbor of Duxbury, Massachusetts. Inside was Matt Hincman, who reported that the seals were watertight and the parts worked properly. Then, in March 2003, they launched the sub in an indoor test tank at the United States Naval Academy, where Nuckols made 10 dives. Inside, he says, "you feel very isolated from the outside world," for the six-inch-thick hull is virtually soundproof, and the three view ports let in little light. "If you had any sense of claustrophobia it would not be a very good experience." The sub moved slowly no matter how hard he cranked, and to steer he had to yank the tiller and use the rudder like an oar. Yet, after 227 years, *Turtle* finally completed its mission, albeit with the assistance of some modern technology. With directions relayed by radio from the surface, after three attempts he successfully planted a replica of the bomb on a mockup of *Eagle's* hull.

On April 6, 2003, at the North River in Massachusetts, the Browns launched the sub from a horse-drawn cart. Rick Brown took the vessel for a one-hour surface cruise. It was hot, exhausting, and edifying. "You have to experience firsthand the kind of things this guy had to confront, and I can understand how difficult it was," he says. Back in 1776, Ezra Lee in the primitive sub attacked "the most powerful navy in the world single-handedly, one man against the Royal Navy. That was a pretty courageous moment." ■

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