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## Liberty Bell's past rings true

By Michael Stroh  
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PHILADELPHIA — Anybody can knock off a life-size Liberty Bell look-alike. But how about a Liberty Bell sound-alike?

A family-run French bell foundry and high-tech Baltimore measurement team think they can do it — create a copy of the 252-year-old icon so acoustically accurate that it would ring true even to Colonial ears.

"Our aim was not to make another replica. We want to get as close as possible to the original sound of the bell," says Paul Bergamo of Cornille-Havard, the Villedieu les Poeles foundry that will cast the replica.

"Liberty," he says, "will recover its voice."

The French government commissioned the replica to help celebrate the 60th anniversary of the U.S. invasion of Normandy, which led to the liberation of Europe in World War II.

Bergamo said provincial officials probably would have been content with a standard Liberty Bell copy, similar to replicas the Treasury Department shipped to the states in 1950.

But when Paul Bergamo talked it over with his father, Luigi — a 59-year-old engineer who bought the bell foundry a quarter century ago — Gallic pride wouldn't allow anything so elementary.

Creating a note-perfect knockoff of the Liberty Bell won't be easy, they concede. Historians know of only three recordings of the Liberty Bell tolling — all made in the mid-20th century, long after the bell had cracked. In those recordings, the bell rings an A-flat.

Written descriptions of the Liberty Bell's sound and design are even more scarce — and the few that survive reveal that the American icon wasn't always the popular

symbol it is today.

The 2,080-pound bronze original was forged at the Whitechapel Foundry in England in 1752. (The nickname came much later, when abolitionists adopted it as their symbol.) Its original purpose was to herald important public events and summon Pennsylvania legislators to the State House — now Independence Hall.

But the Whitechapel bell cracked the first time its clapper struck bronze, a fact that a few cheeky Americans never forgot: In 1976, a small group gathered outside the Whitechapel factory, pumping signs that read, "We Got A Lemon" and "What About The Warranty?"

Less obstreperous than their descendants, Colonial legislators decided not to return the bell and instead hired a pair of local metalworkers, John Pass and John Stow, to recast it. The duo, more familiar with pots and pans than pealing bells, decided the original casting was too brittle and spiked the remake with extra copper. It was a sonic dud.

So Pass and Stow tried again, creating a bell that legislators decided to live with. But not everybody liked it. In 1772, a group describing itself as "divers Inhabitants of the City of Philadelphia, living near the State-House" complained that they were "much incommoded and distressed by the too frequent ringing of the great bell."

It's still a matter of debate when the Liberty Bell started to fracture. Frequently mentioned dates include 1824, 1830, 1832 and 1835 (when it reportedly cracked during Chief Justice John Marshall's funeral). "There really isn't a lot of hard detail," says Karie Diethorn, chief curator of Independence National Historical Park.

In any case, historians are almost certain that the bell

was cracked by 1846. On Feb. 26 of that year, a Philadelphia newspaper reported the bell had "received a sort of compound fracture in a zigzag direction through one of its sides" and now "hangs in the great city steeple irreparably and forever dumb."

To prevent the crack from spreading, the repairmen widened it and installed two metal rivets. A more subtle fracture now snakes from the rivets to the crown of the bell.

The first step in creating the bell was to record all these flaws and remove them from the new casting. So the Bergamos hired Direct Dimensions, an Owings Mills, Md., company that has used state-of-the-art laser tools to measure treasures such as the Lincoln Memorial and the prop on the original Wright Flyer.

Their orders: to scan the Liberty Bell and capture on a computer every curve and crease, every scratch and scar.

Lugging trunks full of laser probes and precision cameras, the team recently slipped into the new Liberty Bell Center in downtown Philadelphia to begin its work. "If you can feel it with your fingernail, we can measure it," says Michael Raphael, the company's owner.

Another benefit of laser measurement is that the instruments don't have to touch the bell. Under the watchful gaze of a National Park Service ranger, Jeff Mechlinski from Direct Dimensions demonstrated the technique as he swept a hand-held laser probe over the Liberty Bell's celebrated 2 1/2-foot scar.

Peeking over his shoulder at a humming computer, he smiled as a crisp copy of the fissure appeared on screen. By midnight, Mechlinski and his colleagues had created the first 3-D digital mold of the



Baltimore Sun/Gene Sweeney Jr.  
Michael Raphael, left, and Jeff Mechlinski from Direct Dimensions, set up equipment to measure the Liberty Bell in order to create replica.

bell.

National Park Service officials said the millions of digital measurement points could help conservators track and prevent deterioration of the original bell. The data may also provide new clues to the bell's somewhat murky past, including its biggest forensic mystery of all — how it cracked.

"They can do things to the computer model that they can never do to the real bell," curator Diethorn says.

Working from modified patterns, the bell makers will craft molds that follow the contours of the bell's interior and exterior. By tradition, molds are made from clay, goat hair and horse manure — an additive, some speculate, that makes the clay more heat resistant.

"I don't know why, but it works," Luigi Bergamo said.

Tests have shown that the Liberty Bell is composed of

roughly 70 percent copper and 25 percent tin, with traces of lead, zinc, arsenic, gold and silver.

Rather than mimicking the original formula, the Bergamos plan to cast the new bell with a slightly more modern mix of copper and tin, pouring the molten metal into the cavity between the interior and exterior molds.

Once the bell cools, it will be tuned by shaving metal from interior walls with a lathe — while monitoring the work with sophisticated sound spectrum analyzers. They're necessary to sort out the complex harmonics of an ancient instrument so complex that it continues to provide experimental fodder for physicists.

"When you play a bell," Paul Bergamo said, "you don't just hear one note — you get a chord."

Of course, all these changes raise the question:

Will this 21st century Liberty Bell still be the Liberty Bell? Not everybody is convinced.

The idea of creating an acoustic replica, says mechanical engineer Gary Koopmann, "is kind of silly."

But Koopmann, director of the Center for Acoustics and Vibration at Pennsylvania State University, isn't surprised that people would be curious to know what the original sounded like.

In 1999, he combined measurements of a replica on campus with sophisticated acoustic and structural computer models to simulate the original sound of the bell — which was broadcast on National Public Radio.

Of course, Koopmann says, there's an advantage to trying to re-create the sound of a bell that last tolled more than 150 years ago. Even if the copy doesn't ring true, "nobody will ever know."