

Editor's Note:

Tech Code is a column for Gen Z explorers from around the world to observe how technology is reshaping China's intangible cultural heritage. In this edition, *Science and Technology Daily* visits Jingdezhen, the ancient porcelain capital of China. Our guide is Ozge Atalay from Türkiye, who came to study ceramics further and realized that broken pieces are not waste but data packets, and technology is their decryption code.

Yet Jingdezhen is more than a technological laboratory. It is a global village, home to more than 5,000 foreign ceramic artists who bring their own aesthetics to clay. Here craft and code do not compete. They flow together across borders.

Decoding Jingdezhen Ceramics with Tech

When Ozge Atalay, a ceramic art student from Izmir, Türkiye, learned the craft in her own country and Germany, she was taught to work only with her hands.

Then she spent half a year in Jingdezhen in east China, renowned as the millennia-old porcelain capital of China, and her Chinese friend Zhao Nan, a young inheritor of Peking Opera facial mask making, showed her otherwise.

In her studio, Zhao showed Ozge how she uses 3D scanning. "When I make some small artworks and want to enlarge them, it's hard to keep everything the same because handmade pieces always differ," Zhao explained. "So I use 3D scanning to expand my small structure into a bigger size. I found it really easy to change the size of my work (with 3D scanning)."

For Ozge, this was a revelation. "I never knew there was such technology," she said. Watching the digital model rotate on the screen — an exact replica that could be scaled, studied and shared without even touching the original clay — she found herself wondering: could technology give ceramics a kind of life beyond the physical? A life that does not crack, fade or break?

It was the first time she considered that eternity might come not only from preservation in a museum, but from data.

From fragments to a living archive

Zhao promised to take her to a place that would help her truly understand what ceramics are and the journey began as they walked into the Jingdezhen Imperial Kiln Institute in the Imperial Kiln National Archaeological Site Park, a heritage zone in Jingdezhen. Here, the galleries are filled with broken and restored ceramics and to an untrained eye, the fragments might seem like failures.

However, Ozge learned that these "imperfect" pieces record centuries of uninterrupted firing in the "porcelain capital" and preserve details long buried by time. Now thanks to technology, these details are being transformed into data that will never decay.

Behind the quiet galleries lies a powerful digital infra-

structure: the Ceramic Gene Bank. It is the world's first systematic digital platform built around the concept of ceramic genes. Its construction began in 2022, drawing on nearly 20 million porcelain shards unearthed from the imperial kiln ruins over the past 40 years.

Xiong Zhe, head of the institute's technology laboratory, explained the unique advantage they enjoy. The institute's predecessor was the Jingdezhen Ceramic Archaeology Research Institute. Over nearly four decades starting in the 1980s, they excavated about 20 million shards. Based on this foundation, they selected the most representative pieces for sampling and specialized research.

Restoring the unseen

Having a genetic reference is only one part of the story. The real challenge lies in how to bring a shattered object back to visual wholeness without faking its history. That challenge is being met in a restoration workshop not far from the gene bank.

Hao Guojiang, head of the institute's restoration department and a recognized restorer of ancient ceramics, showed them a virtual pattern restoration software developed jointly with Peking University. "It helps us restore the patterns on pieces we have already pieced together," Hao said.

He then described the old way of working. "In the past, when a piece was missing a pattern, we had to search through literature or look at surviving pieces in museums for reference." Using traditional methods, his team spent four years restoring 116 pieces. "Traditional restoration required adding material to the missing part and then painting it by hand. But hand painting always carries a degree of subjectivity," he said.

Now, the combination of the virtual restoration software and a proprietary waterslide decal technique developed in-house has changed everything. "We print the missing design directly onto the restored area," Hao said. "It now takes only five minutes."

He pointed out a key advantage: The decal does not

touch the original surface. "You can see a clear boundary between the original and the restoration. This preserves the maximum authenticity of the piece."

Color as calculated poetry

Restoration addresses the missing parts and patterns, but what about the colors that make a ceramic piece breathe? That question led Ozge and Zhao to a different kind of laboratory — one where chemistry and data meet.

At the Jingdezhen Ceramic Research Institute, Hu Zi, director of the Craft Materials Research Laboratory, introduced them to the physical principles behind glaze colors: why *qinghua* is blue, how underglaze red forms, and how different kiln conditions affect color. "By measuring thermal expansion," Hu said, "we can determine the sintering temperature of a material. This is the point where shrinkage reaches its maximum, and that temperature is the optimal firing temperature."

He then demonstrated a thermodilatometer, which shows the material's initial melting point. "This is the most common test we run in ceramic materials research," Hu said.

Ozge realized that unlike relying on experience and intuition, like she had in the past, she and Zhao were now creating with relatively precise data. They tried preparing their own glaze formulas. With modern technology, they could precisely regulate glaze colors from off-white to sky blue to deep blue. Colors were no longer happy accidents, but calculated poetry.

Beyond silent pictures

Data gave them control over color. But could data also capture shape, texture and the feeling of holding a ceramic object?

That is precisely what a different kind of technology promises to do. At the digital asset exhibition hall, technicians were operating precision instruments to capture every detail of a porcelain painting board. On the screen, an optical digital model rotated slowly — each ice crack line in the

glaze, every kiln transformation mark, even the tiny bubbles formed during firing were completely captured and permanently preserved in the digital world.

"This is far more than just 'taking clear pictures,'" said Li Xiaoling, chief operating officer of Zhongsheng Technology Company. He explained that traditional documentation of cultural relics only provides rough dimensions and shapes without revealing the fine, tactile details that truly define a ceramic work. "Today, using the domestically developed Timiro technology, we can capture every texture of a porcelain piece with precision," Li said.

Timiro is a multidimensional, interactive media technology, different from conventional images, videos or 3D models. Based on Timiro, his team creates what they call "optical twins." "We turn a cultural relic into a digital asset," Li said.

Users can zoom in to see brushstrokes with stunning clarity, or examine the grain of a stone glaze as if holding the object in their hands.

Whether for museum exhibitions, academic research, or online viewing by ceramic enthusiasts, the technology enables people to experience the beauty of porcelain from multiple angles and in full dimension, exploring the secrets hidden in every curve and color.

Timiro technology, Li added, breaks through the key technical bottlenecks in ceramic digitalization, such as the difficulty in ensuring digital fidelity, managing data securely, and making files easy to use.

In this way, it empowers the protection, innovative inheritance of ceramic cultural heritage and multilateral exchanges.



① Ozge Atalay (center) and Zhao Nan (left) talk with Wisam Alsamad about his work. ② The night view of the creative market at Taoxichuan. (PHOTO: S&T Daily, XINHUA & VCG)

China's Porcelain Capital Embraces the World

For centuries, Jingdezhen has been known as China's porcelain capital. There's an old saying: "Craftsmen come from all directions; porcelain goes to all lands." The city with a thousand-year kiln history has always had an open, welcoming soul.

At its peak, more than 60,000 ceramic artists and makers flocked in to chase their dreams. Over 5,000 of them came from overseas. Many bought homes, started families and opened studios. Most importantly, they stayed.

Back in 1998, Li Jianshen had just returned from studying ceramic art abroad. He bought four old farmhouses in Jingdezhen and founded the Sanbao International Ceramic Art Village, a name that reflects its true nature. Then he invited other ceramic artists from the United States and Canada to come work alongside him. To date, Sanbao has welcomed over 100,000 international artists and travelers. As Li puts it, "We must turn our local resources into a global language, one that the world can understand and see."

The clay under Sanbao's hills once created the bluish-white porcelain of the Song Dynasty (960-1279). "The two most important elements of ceramic culture here are craftsmanship and the continuation of a post-agrarian lifestyle," he said. As the city grew more famous, the narrow Sanbao valley filled up with hundreds of ceramic studios run by locals and foreigners alike. Many never left.

Wisam Alsamad, an Iraqi ceramic artist known for blending traditional and contemporary elements, arrived in Jingdezhen in April with his daughter to prepare for a solo

exhibition.

Alsamad finds every day a profound source of inspiration. He immerses himself in clay, walks in the beautiful surroundings, and absorbs the spirit of this unique place. "Sanbao is much more than an artist residency," he said. "For centuries, some of the finest porcelains in the world were created here and sent across continents, carrying with them stories, culture and craftsmanship. It offers a rare combination of history, community and artistic freedom. From Mesopotamia to Norway, and now to Jingdezhen, the journey continues."

A few streets away, another artist is telling his story with clay, though on a very different level. Michael May, a 38-year-old ceramic artist from the U.S., has found a home for his boundary-pushing work. Passionate about creating 3D-printed ceramic works, he has built his own customized machines from scratch — designed entirely on his tablet, assembled with modified parts, and coded by his own hand.

Now he incorporates traditional techniques with 3D printing. His approach has not gone unnoticed. Artists across Jingdezhen have begun experimenting with similar fusions of digital and handmade methods, inspired by what May is creating.

"I'm happy that I can inspire people because they can also do something that maybe I haven't thought of, and then we can continue to build on all these new ideas," he said.

He has quietly settled into local life, no longer feeling

like an outsider. Jingdezhen's openness and inclusiveness convinced him to stay, keep running his studio, teach courses, and share his methods.

The same spirit shows at Taoxichuan in the heart of Jingdezhen's East City. It is a cultural project built from old ceramic factories. Walk into Taoxichuan today, and you will see tall chimneys, sawtooth roofs, and weathered red bricks. The old factory buildings have become creative studios, a dream space for ceramic lovers. Taoxichuan has been recognized as a national base for mass entrepreneurship and innovation. That means it is not just about art, but also about helping people turn their ideas into businesses.

Kang Shuying, a marketing official at Taoxichuan, said the park began operating in 2016 and now hosts 33,000 ceramic artists from about 50 countries. Whatever idea an artist has, Taoxichuan provides the space and materials to realize it. The environment is convenient, and supplies are easy to get. She said from the very beginning, this place has been popular with international artists.

Italian ceramic artist Marcello De Simone is one of them. He finds the city "efficient, professional and friendly." Materials and kiln space are easy to obtain. Local technicians know their craft. And the people around him are always willing to help. For him, that combination has made Jingdezhen feel like home.

Jingdezhen has always proved that its real treasure isn't just clay. It's the way it welcomes the world. And the world keeps coming in.



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