

DNA used for storing data

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Researchers used synthetic DNA encoded to create the zeroes and ones of digital technology.



(Photo: PhotoDisc)

A team of British researchers has used DNA — the genetic building blocks of life — to record Shakespeare's sonnets and excerpts from Martin Luther King Jr.'s "I Have A Dream" speech.

The experiment, along with another published late last year, show that what we think about as life's alphabet can also be used to preserve our greatest creations, perhaps for thousands or tens of thousands of years.

"The idea that DNA, which people think of as a biological molecule, can be used as a physical storage tape in a non-biological function is pretty incredible," said Drew Endy, a Stanford University bioengineer who was not involved in the work.

"It's a really nice example of how a fundamental investment in a basic scientific tool can lead to (amazing things)."

The researchers used strands of DNA synthesized by a machine — not from a living creature — encoded to create the zeroes and ones of digital technology. Although the two teams worked independently and used different codes, their papers are "fraternal twins," Endy said, that show it will soon be both realistic and practical to record vast reams of information in strands of chemicals too small to see.

Scientists have been able to recover DNA from a woolly mammoth, dead for 20,000 years, so the researchers at the European Bioinformatics Institute who conducted the new study said they expect information stored on DNA will be around for a while. Also, since all life on earth is made of DNA, we should have the capacity to read that information regardless of how technology changes over the next millennia.

The first team, a group at Harvard University led by geneticist George M. Church, published its results in *Science* in September.

Europeans Ewan Birney and Nick Goldman, whose study appears in *Nature*, said they first thought of the idea in a pub, when they were discussing the challenges of archiving vast amounts of data on costly magnetic tape or hard drives. By the second beer, they were sketching their idea out on napkins.

Church, who was involved in the Human Genome Project, said when people would ask him where we were going to store all the information his genome scans would turn up, "I would respond glibly, well, DNA's not a bad place to store it."

But both groups are serious now. They managed to use a commercially available sequencing machine to generate the amino acid components of DNA, which are abbreviated as A, C, T and G.

Because repeated letters caused errors, the European group came up with a code to avoid them. In their version, Shakespeare's sonnet, "Thou art more lovely and more temperate ..." begins "TAGAT, GTGTA, CAGAC..."

Also to prevent errors, every stretch of DNA is repeated four times, twice backward, in overlapping strands that the computer can quickly put back together and read accurately, Goldman said.

Reading the DNA is the expensive part right now, though both teams predict that cost will come down exponentially within the next decade, putting DNA storage potentially within reach of average people. Birney predicted that couples could soon be storing their wedding videos on DNA, to be seen by their grandchildren.

Storage of the DNA should be relatively inexpensive and easy, both teams said. A cold, dry, dark place is ideal, so there will be no electricity bills. And DNA is incredibly small and virtually weightless. One Shakespearean sonnet weighs 0.3×10^{-12} grams, Goldman said, and information that would fill more than a million CDs can fit in a vial smaller than a pinkie.

Church said he has heard from search engine companies and storage media manufacturers since his publication, interested in learning more about the technology and potentially developing it for commercial use.

"I thought this was really refreshing that they were willing to think out of the box even though this could conceivably be disruptive to their industry," he said.

Both teams said they would not consider storing information in a living creature, because the error rate would be too high and the storage less secure.

"We wanted to make something practical," Church said.

Church said security is a potential concern with DNA storage, because of how easy it will be to store and retrieve data. It's a bit like posting bomb-making

directions on the Internet, except in this case, the bomb ingredients would be on the same page, and making the bomb could be as simple as "click here," he said.

Archivist Lisa Long Feldmann said she is excited about the potential to store important documents without the expensive humidity controls needed to preserve paper. But Feldmann, who works at the Isabella Stewart Gardner Museum in Boston, said via e-mail that it will be a while before people in her profession will be willing to embrace such new technology. "We are a cautious bunch."