

## The 'genetic hard drive' that could store the complete works of Shakespeare (and revolutionise the way computers work)

- Same technique also used to store 26 second excerpt from Martin Luther King's 'I Have A Dream' speech
- Breakthrough could have major implications for computer storage with DNA hard drives
- Could lead to drives that can store high definition version of every film and TV programme ever created in a teacup sized drive

By [Damien Gayle](#)

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Researchers have downloaded Shakespeare's sonnets on to synthetic DNA in a breakthrough that could lead to major advances in computer storage

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A genetic storage device has been used to 'download' all 154 of Shakespeare's sonnets on to strands of synthetic DNA.

Scientists were then able to decode the information and reproduce the words of the Bard with complete accuracy.

The same technique made it possible to store a 26 second excerpt from Martin Luther King's 'I Have A Dream' speech and a photo of the Cambridgeshire laboratory where the work took place.

Researchers were also able to turn a copy of Watson and Crick's paper describing the nature of DNA into genetic code.

The landmark study paves the way to storing huge amounts of data using the same method evolved by Nature to write the 'Book of Life'.

Theoretically, 100million hours of high definition video could be stored in a cupful of DNA - equivalent to every film and TV programme ever created.

Unlike magnetic tape, which degrades within a decade, DNA is a hardy material that can last for tens of thousands of years. A DNA archive also requires no constant supply of electric power, as do hard disks.

For their experiment, the British scientists employed a California-based company to create strands of artificial DNA that corresponded to their coding instructions.

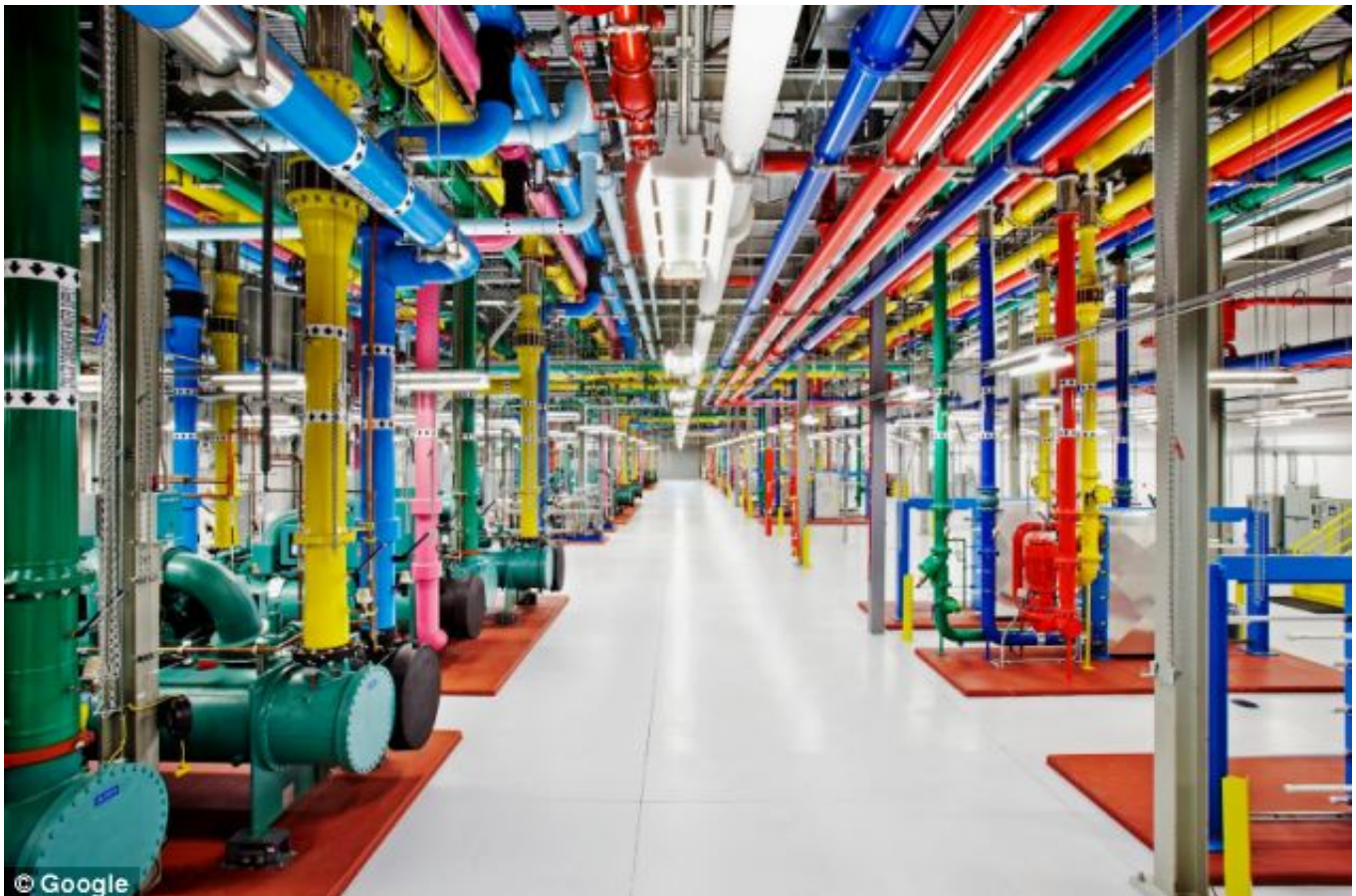
The end result was a small test-tube the size of a little finger containing a tiny amount of dry dusty material. This was the DNA, which was then 'read' and decoded to reproduce the original files.

Details of the technique are described today in the journal Nature.

Five genetic 'letters' from the genetic code - A,C,G and T - were used to represent the noughts and ones that make up 'bytes' of digital information.

For instance, the upper case T in the word 'Thou' from the second line of Shakespeare's Sonnet XVIII - 'Thou art more lovely and more temperate' - was encoded by the sequence TATAT.

Dr Nick Goldman, from the European Bioinformatics Institute at the Wellcome Trust Genome Campus in Hinxton, Cambridgeshire, said: 'We already know that DNA is a robust way to store information because we can extract it from bones of woolly mammoths, which date back tens of thousands of years, and make sense of it.'



Currently data centres such as Google's shown here, rely on traditional hard drives. However, they could one day be replaced by the DNA drives revealed today

'It's also incredibly small, dense and does not need any power for storage, so shipping and keeping it is easy.

'We've created a code that's error tolerant using a molecular form we know will last in the right conditions for 10,000 years, or possibly longer.

'As long as someone knows what the code is, you will be able to read it back if you have a machine that can read DNA.'

The scientists crossed a major hurdle by incorporating 'error correction' similar to that found in devices such as laptops and mobile phones.

This involved overlapping short strands of DNA and independently writing every million-molecule fragment of code four times.

Effectively, three back ups were created for each fragment, greatly reducing the chances of mistakes.

'You would have to have the same error on four different fragments for it to fail - and that would be very rare,' said co-author Dr Ewan Birney, also from the European Bioinformatics Institute.

Currently the technology is restricted by the length of time it takes to sequence DNA and its high cost - around £8,000 per megabyte of stored material.

Even so, DNA-based storage could today be cost effective for archives of several megabytes over long time periods of 600 to 5,000 years, computer models predict.

Ten years from now the rapid development of more efficient, cheaper DNA sequencing could make genetic storage a practical possibility for archive life spans of less than 50 years, say the scientists.

They stressed that the DNA used was wholly artificial and different to the genetic molecules of life.

'The DNA we've created cannot be incorporated accurately into the genome (genetic code),' said Dr Goldman. 'It uses a completely different code.'

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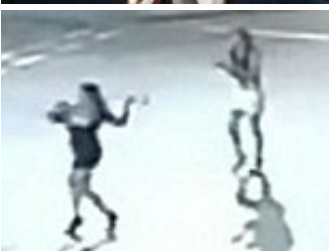
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"Five genetic 'letters' from the genetic code - A,C,G and T - were used...." Um, I count four, not five. Plus there are only four different nucleotides anyway. Unless I missed the major breakthrough discovery of the missing fifth invisible one that can't be named.

- [mike\\_h](#) , Basingstoke, United Kingdom, 23/1/2013 20:59

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Wasn't it Christopher Marlowe that was credited with writing most of Shakespeares plays?

- [Kareng](#) , Widnes, United Kingdom, 23/1/2013 20:53

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Very clever and very scary! Where will this end I wonder...? Perhaps with "genetically modified" humans whose complete memories can be read by the powers that be - the stuff of science fiction!

- [loopyloo](#) , England - not very green or pleasant these days..., 23/1/2013 20:34

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Good news. I've forgotten everything from my 17 years of education and find the idea of downloading it all into a newly installed inbuilt brain chip far more appealing than the notion of spending another 17 years relearning it.

- [Brace Brace Brace](#) , BorrrislandsUtterlyStupid, United Kingdom, 23/1/2013 20:30

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Why would you want to store the works of Shakespeare , he probably didn't even write half the guff.

- [Mr Tambourine Man](#) , Desolation Row, UK., 23/1/2013 20:18

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ouch.....£8000 per MB? .....i won't be downloading anytime soon .... thats some rental price!

- [Taurean77](#) , Washington, United Kingdom, 23/1/2013 20:14

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"A DNA archive also requires no constant supply of electric power, as do hard disks." No, they don't. You can switch them off, and they don't lose their data. You are confusing volatile and non-volatile memory. HDD non-volatile, RAM - volatile.

- [ApostropheRUs](#) , GrammarLand, 23/1/2013 20:10

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DNA ... National Dyslexic Association

- [Hyphen8-ed](#) , HarlowCanYouGo, United Kingdom, 23/1/2013 20:04

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Will scientists ever think of anything original? Amazing that nature outperformed our best storage devices. And her devices grow themselves from an invisible speck, make new ones, and have copying machinery, fuel production motors, and 100 trillion sets of storage in one sealed unit. A unit that never wonders how it came to be!

- [iain](#) , bedford, United Kingdom, 23/1/2013 19:57

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Wow wow wow, Man has been searching for his creator in the corners of Earth & now space. The secret may be hidden inside every one of us. Now, where is that DNA reader?

- [PeterA](#) , London UK, 23/1/2013 19:40

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