THE LONG NOW FOUNDATION

Deep Time: Across the abyss

How to send messages over millennia

GIOVANNI BELZONI, a one-time circus strong-man with a penchant for hydraulic engineering, is an odd candidate for immortality. Nevertheless he will be remembered, in his way, for centuries or even millennia. Belzoni spent the early years of the 19th century exploring Egypt?s ancient monuments?and, as often as not, leaving his name carved ostentatiously into their stone. To those who think this graffiti inappropriate, Belzoni could reply that, on the contrary, there could be no better places to scratch a signature. Because the ancient structures had already survived for thousands of years, they would no doubt survive for several thousand more, preserving his name far into the future. Thus Belzoni hitch-hiked across the depths of time. Since then, those depths have proved more vasty than Belzoni and his contemporaries imagined. Biblical scholarship?most famously that of Archbishop Ussher in 1654?gave a date for creation in 4004BC or thereabouts. When, in ?As You Like It?, Rosalind described the world as ?almost 6,000 years old?, or when the poet John Burgon described the ancient city of Petra as ?half as old as time?, they meant what they said.

In the 19th century the old biblical certainties, based on long, reassuringly continuous lists of who begat whom, were challenged by a new geological view of the past featuring discontinuities and hugely slow processes that could not be compressed into the lifespans of the patriarchs. With the discovery of radioactivity at the dawn of the 20th century, it became possible to establish the true age of the earth: about 4,600 million years. At about the same time as the Milky Way was revealed to be just one galaxy among countless others, so depths of time far beyond man?s fathoming were opening up beneath his feet. Later, humanity?s own past was stretched beyond any traditional histories and chronicles when radiocarbon-dating revealed that archaic cave paintings were ten times older than Babylon. The earliest human remains are 100 times older again.

These vast depths of space and time surrounding civilisation?s ambit might seem to deny any human endeavour true significance. But as human ingenuity has revealed them, so it offers ways to cross them. Already robot explorers paddle in the nearer waters of deep space, and doubtless their successors will go further. Likewise, some people are beginning to think about how to travel across deep time?not in person, but through messages.

Kilroy was here, and here, and here

The difficulties of long-range messaging are neatly demonstrated by the Phaistos Disc, unearthed on Crete in 1908. Six inches (15cm) across, marked with a total of 241 symbols from an unknown 45-symbol alphabet, it has been dated to around 1700BC. Nobody has any idea what its purpose was, or what it says. No other example of the same script has ever been found.

Despite being incomprehensible, the Phaistos Disc does have a useful message: cultural discontinuities are not just possible, but likely. Deep-time messages, especially those aimed at geological rather than historical traverses, need to be comprehensible to an intelligent reader with no shared cultural background. Over really long periods of time you might as well be talking to aliens.

As it happens, this is something people have already tried. A message was transmitted towards a globular cluster of stars in the constellation Hercules from the massive radio telescope at Arecibo, in Puerto Rico, on November 16th, 1974; gold plaques with messages on were attached to America?s Pioneer 10 and 11 and Voyager 1 and 2, the only four man-made

objects on trajectories which leave the solar system. The Arecibo message is a repeating sequence of 1,679 binary pulses which can be turned into a rectangular array 23 bits wide by 73 deep (this pair of prime numbers is the only one which can be multiplied together to make 1,679, as smart aliens are supposed to understand). This array depicts the numbers from one to ten, the chemical elements hydrogen, carbon, nitrogen, oxygen and phosphorus, the structure of DNA, the Arecibo telescope, the solar system and a stick-figure picture of a human.

There is a lot of cleverness in this little bundle of radio waves, and in the inscriptions on the spacecraft. But with their pictures of the human form and maps of local space they all boil down to a racial ?We woz here?. And so do most of the other messages humans have sent and received across the centuries. By its very survival, the Great Pyramid has in effect transmitted the simple message of the Pharaoh Cheops? existence across 4,600 years to the present day. That desire to imprint your ego on to the future has been until now the most common motivation for sending a deep-time message. Never mind that the message contains no useful information; the prospect that it might be received is enough.

Building a huge stone pyramid or temple, though, is an extremely expensive way to send such a message. And there is an alternative. Tutankhamun is more famous today than Cheops not because his tomb was even more conspicuous, but because it was invisible, and thus escaped the notice of grave robbers. Hiding things in the ground provides at least the illusion of cheap access to deep time (and offers employment to generations of archaeologists as yet unborn).

The 20th-century enthusiasm for time capsules has made full use of this channel to the future. Alas, most time capsules?and there are now thousands of them buried around the world?are unlikely to have any meaning at all to a far-future generation. Without shared context, they can be little more than cultural graffiti: sometimes nothing more. For America?s bicentennial, 22m citizens? signatures were collected for mass burial. Quite what the historians of 2X76 (choose your value for X) were expected to do with them was never quite made clear.

Some of the latest time capsules are impressive in their ability to carry messages further into the future than ever before. Away from the slow but remorseless geology of earth you can leave messages around for millions of years. The Viking and Pathfinder probes on the surface of Mars carry tiny microdots waiting for the day that some future explorer and his extremely powerful microscope come by and take an interest. But what?s in these microdots? People?s names. The Cassini probe currently on its way to Saturn carries a DVD-Rom containing no fewer than 616,403 signatures. What could be said today that might be worth hearing in 10,000 years?

One answer is ?Danger?keep out?. Gregory Benford, a professor of physics at the University of California in Irvine and a noted science-fiction writer, was one of a panel of scientists called upon to evaluate the safety of the Waste Isolation Pilot Project, a scheme to bury 800,000 barrels of low-grade nuclear waste in a complex of underground caverns half a mile below the salt flats of Carlsbad, New Mexico. Given that the nuclear waste would be dangerous for 10,000 years, the scientists had to answer a simple-sounding question: how likely was it that the barrels would be disturbed within that time?

Warnings and responsibilities

As Dr Benford explains in a forthcoming book, ?Deep Time: How Humanity Communicates over Millennia? (Avon, 1999), the panel decided that the greatest danger was that far-future humans would disturb the site accidentally without knowing what it was. Thus the key to preventing disaster was to mark the site as dangerous in a way that would still mean something 400 generations later. The striking thing about the various plans considered is their similarity to ancient monuments. A huge stone structure such as a pyramid, for example, makes an excellent marker, difficult to remove, destroy, or deface. Each of its stone blocks could have warning messages carved into its faces, and the blocks could be irregularly shaped, to discourage their use as building materials (a common form of recycling in the past).

Eventually, a multi-levelled marker scheme was proposed that would incorporate the lessons learned from the Great Pyramid (use durable materials), Tutankhamun?s tomb (hide things of value), the Phaistos Disc (avoid culturally-specific messages) and common-sense engineering (use back-ups and redundancy). There would be forbidding earthworks, granite monoliths providing warnings in the form of pictograms, a huge granite map showing radioactive burial sites around the world, and four buried rooms providing detail about the structure of the site and exactly what it contained, again in language-independent pictogram form. The scheme is based on the idea that civilisations may rise and fall, but curiosity, reason and fear of the unknown will persist.

So far, the marker system only exists on paper. But another experiment with the very long term is moving towards a protoype. It should, if it fulfills its makers? dreams, send the message that, despite all evidence to the contrary, today?s humans are aware of the importance of long-term thinking.

The idea of building a clock that would run for 10,000 years first struck a computer scientist called Danny Hillis as an antidote to the millennium. He wanted to encourage people to think about the future in general and in depth, rather than focusing on the ever-closer and arbitrary instant when one century becomes another. Tracking the passage of time

appears to be a universal human tendency, so a clock is something which people will always understand. 10,000 years corresponds more or less to the span of humanity?s accumulated civilisations. Such a clock encourages the contemplation of durations which, if not as deep as those of geology, still undermine the concerns of normal experience. Brian Eno, a musician and artist, gave his friend Hillis?s idea a name: the Clock of the Long Now.

Before designing the clock, Mr Hillis drew up a list of general principles: longevity, transparency, maintainability and scalability. The first goes without saying for a 10,000-year project. Transparency means workings that can be understood by inspection; maintainability means using nothing that would be beyond a bronze-age culture; scalability means a design that can work on scales from the table-top to the monumental. These provided serious constraints. Longevity precludes the use of gears (they can wear down), while maintainability and transparency rule out the use of electronics, or atomic power. Tidal and geothermal power might work for a very large clock, but not for a small one (no scalability).

Eventually Mr Hillis decided that the clock should be powered by occasional winding but would have a back-up system based on the daily thermal expansion and contraction of a metal bar. Having ruled out non-transparent things like atomic decay and continental drift as ways of keeping track of time, he went for a slowly-rotating torsional pendulum, automatically corrected by measurements of the sun?s position.

As for the clock mechanism itself, Mr Hillis?s finished design is both mechanical and, appropriately given his background, digital. Called the ?bit serial mechanical adder?, it uses sets of 28 moveable levers, each of which can be in one of two positions, to store 28-digit binary numbers. Each set of levers is called an accumulator; the ?year? accumulator, for example, stores the fraction of a year that has elapsed.

Once a day, when the clock ?ticks?, an ingenious internal mechanism adds a fixed value to each accumulator. There are 365.242198 days in a year, so in the case of the year accumulator, this fixed value is 1/365.242198. After a year the value stored in the accumulator exceeds 1, and the accumulator overflows, indicating that a year has passed (the left-over fraction is still stored, so that there are no rounding errors). The concentric, rotating rings of the clock?s display move round accordingly. Every century, the clock strikes; every 1,000 years, a cuckoo pops out.

Construction of a small prototype, two and a half metres (eight feet) tall, is underway. In the end, Mr Hillis would like to build a monumental version of the clock in a desert, with two sweeping ramps wrapped around its circular face from which its vast read-out could be viewed. The technical aspects of building the clock are, however, only part of the project. How should the clock be financed? Can any way of ensuring people wind the clock endure over the millennia? Together with a group of fellow scientists and entrepreneurs, Mr Hillis has established a non-profit organisation to address these problems.

According to Stewart Brand, a writer and cultural critic who helped start it, the Long Now Foundation will be ideal for managing very long-term projects?time-lapse footage of glaciers ebbing and flowing over the centuries, for example. It might produce a ?civilisation start-up kit??a primer to act as a back-up in the event of future catastrophe. How to do so in a non-culturally-specific way presents an even greater challenge than building the clock; but there is plenty of time to work on the problem. Also under development is a ?responsibility record?, an account of debates about long-term issues (such as global warming) that could be examined later in the light of what actually transpired. Such ideas form the meat of Mr Brand?s forthcoming book, ?Clock of the Long Now: Responsibility and Time? (Basic, 1999).

In the 1960s Mr Brand was one of the first to see the power that pictures of the whole earth from space would have. Now he hopes the vistas of deep time will have a similar impact on the way people think about culture and the world?s slow rhythms of change. Whether this happens or not, though, any record of serious attempts to deal with deep time will send one important message to the future: that the people of the early 21st century aspired to more than just scribbling their names in the margins of eternity. They had something to say.

LINKS Belzoni was here. A detailed image of The Phaistos Disc is available in all its glory here along with a database of ancient scripts. The various space projects that hope to communicate with extra-terrestrials are all available on the web for earthlings to see, including the Pioneer plaque and Voyager's interstellar outreach programme, which includes selected sounds, music and images. The Waste Isolation Pilot Plant site contains fact sheets, documents and more. The early days of computing are celebrated at the Retrocomputing Museum.

To bookmark this page click here and then bookmark this unframed version.

The Long Now Foundation
Fostering Long-term Responsibility
est. 01996.