**Speaking to the future**

*Nuclear waste is dangerous for millennia, so how do you keep people away for 10,000 years?*

In 1981, the US Department of Energy realised it had a major problem when it came to disposing of nuclear waste. The biohazard had slowly been accumulating for the better part of 40 years, and was likely to remain deadly to humans for at least 10,000 years. While it had been thrown into the sea at more than 50 sites in the Atlantic or Pacific, international treaties and the potential environmental impact meant this was no longer an option. Nor could the waste be simply blasted into space; if something were to go wrong, the rocket could inadvertently irradiate the atmosphere. The only option was to bury it — and that led to a big question. How, exactly, could you warn future generations where you’d put it?

The Department of Energy decided to assemble a dream-team of communications experts, archaeologists, social scientists and long-term climatologists to crack the problem. They were called the Human Interference Taskforce, and their work would spawn ideas ranging from elaborate monoliths and structures to glow-in-the-dark cats and fake religions.

**Language barriers**

The principle of sending messages into the future isn’t as straightforward as it seems. Writing, for example, changes and evolves over time; 1000 years ago, the English language as we know it today did not exist; indeed, the oldest language still spoken, Tamil, only dates back 5000 years. There is simply no way to know how future generations will communicate. And while messages can be left that are regularly updated with different languages, that doesn’t guarantee translation will work. As the [Human Interference Taskforce pointed out,](https://digital.library.unt.edu/ark%3A/67531/metadc1199078/m2/1/high_res_d/6705990.pdf) the Rosetta Stone enabled the translation of hieroglyphics – unlocking an entire language – thanks to it also including two identical messages in two known languages. But even so, it took 23 years for its symbols to be translated in full.

Pictures aren’t an option, either. While maps can be used – and distributed in their millions – to show a location, there’s no guarantee the message will be understood. For example, imagine a cartoon showing someone becoming ill after exposure to nuclear waste. If read from left to right, the warning is clear. But if read from right to left, it could appear as a miracle cure. Images also need cultural context; as the Taskforce pointed out, it’s not possible to tell from prehistoric cave paintings if the simple figures depicted are hunting, fighting or partying. Oral traditions have some evidence of lasting – Icelandic sagas from the 10th century have been found to be accurate, while we still tell the (albeit highly mythologised) story of the Trojan War, believed to date back almost 4000 years. But there’s no record of any oral tradition that comes close to the time needed for nuclear containment.

Another problem is the ‘we know better’ approach often taken by modern societies or stemming from Western colonization, where generational knowledge is ignored. In Japan, [‘tsunami stones’](https://99percentinvisible.org/article/tsunami-stones-ancient-japanese-markers-warn-builders-high-water/) have been in place for centuries, giving clear instructions not to build below them in case of tidal waves. In 2011, when the Tōhoku earthquake caused a tsunami, villages above the stones were safe; structures below the stones – including the Fukushima Diiachi Nuclear Plant – suffered catastrophic damage. In Canada, [Inuit oral traditions](https://canadaehx.com/2021/06/05/the-inuit-and-the-franklin-expedition/) had recorded exactly where Sir John Franklin’s 1845 lost expedition to navigate the Northwest Passage became trapped in the ice, and how its members had died; the British refused to believe the Inuit tales, and the expedition’s two ships, *Erebus* and *Terror*, remained undiscovered until 2014 and 2016 respectively. More recently, researchers have shown that the increased rate of wildfires in Australia [are a direct result of British colonial expansion](https://esajournals.onlinelibrary.wiley.com/doi/10.1002/fee.2395). The British put an end to indigenous cultural burning practices, a traditional method of environmental management that had stopped widespread bushfires for centuries.

Even if a warning is understood and heeded, it could easily be misinterpreted – either accidentally or by design. For example, the symbol a skull and crossbones typically represents death in Western society; in Eastern religions, it means life. And while the dynasties of Ancient Egypt left elaborate curses on tombs to threaten away potential grave-robbers, it did not deter treasure-seekers or archaeologists: if anything, they took such warnings as a sign the structure contained something of value.

Finally, all of these problems assume the message itself survives. The Human Interference Taskforce’s goal was to leave a message that lasted 10,000 years, or around 300 generations. Currently, the oldest surviving human documents are 5000 years old. Any message had to survive weathering, potential changes to the climate and be easily located by anyone who stumbled on the disposal site. And it had to be a message that was for direct interference – trying to break into the vault – and indirect activity, such as drilling in the wrong place.

The Human Interference Taskforce decided to get creative.

**Cats and the Atomic Priesthood**

The Taskforce’s recommendations were varied and sensible. They included placing the site away from human settlement and other natural resources, thus reducing its chance of discovery. They recommended various levels of defence, so that even if one message was ignored or overlooked, another might warn any trespasser. Designs were drawn up for ‘central monuments’ flanked by warning markers, a kind of giant, modern-day Stonehenge, with asphalt protected from natural weathering for several thousand years at the minimum. But these plans, the Taskforce acknowledged, didn’t focus on the key issue: how to communicate the message.

One of the group’s members was Thomas Sebeok, a semiotician – the study of signage – at Indiana University, was put in charge of coming up with possible techniques, writing a report *Communication* [*Measures to Bridge Ten Millennia*](https://www.osti.gov/servlets/purl/6705990). Sebeok’s approach was to think of radical and wide-ranging solutions, and look for reasons they wouldn’t work. For example, warnings based on light or sound might be detected, as they would only operate on a limited frequency, and there is no guarantee that humans would hear in the same way they do today. Similarly, creating a huge stink was ruled out as it was possible humans would choose to explore with robots or automatons that wouldn’t smell the odor.

Instead, Sebeok’s recommendations included relying on mythology, such as Pandora’s Box, to pass down warnings. He proposed setting up a fake religion centred around the radioactive waste sites and rituals conducted annually. “The actual truth,” Sebeok wrote, “would be entrusted exclusively to – what we might call for dramatic emphasis – an ‘atomic priesthood’, that is, a commission of knowledgeable physicists, experts in radiation sickness, anthropologists, linguists, psychologists, semioticians, and whatever additional expertise may be called for now and in the future.” In short, Sebeok was suggesting keeping the truth about radioactivity available to a select few, and building a persistent folk memory over time. The flaw, as mentioned earlier, is that the only known precedent of something similar – the famous ‘curses’ placed on the tombs of Egyptian Pharaohs – didn’t do anything to stop grave-robbing.

Other, even more outlandish proposals followed. First among them was Françoise Bastide and Paolo Fabbri’s [proposal to breed color-changing cats](https://www.semiotik.tu-berlin.de/menue/zeitschrift_fuer_semiotik/zs_hefte/bd_6_hft_3/#c185968). Felines, they suggested, had lived side-by-side with humans for thousands of years, but had no discernible purpose. What if they could be used, like a canary in a coal mine, to highlight radioactivity? “In order to make humans aware of the presence of atomic radiation,” the duo wrote, “animals can be bred that will react with discoloration of the skin when exposed. Such animal species should dwell within the ecological niche of humans, and its role as a detector of radiation should be anchored in cultural tradition by introducing a suitable name (e.g. ‘ray cat’) and suitable proverbs and myths.” If your cat changes color, it’s time to run away.

The ideas kept coming. Polish science fiction writer Stanisław Lem, the author of *Solaris*, suggested breeding ‘information plants’, whose DNA could be deciphered as a warning. But the idea assumed people would think to DNA-sequence plants before investigating the big, shiny tomb-thing, or that the plants wouldn’t mutate and cross-fertilize, degrading the message. So Lem also proposed creating satellites, which could beam down warnings to anyone listening. Philipp Sonntag, from the Social Science Center in Berlin, went even further: he proposed building an artificial moon, with the information ‘stored in its cellar’.

Unsurprisingly, none of the ideas proposed were ever acted on. But it was far from the end of science’s search for a way to talk to the future.

**This is not a place of honor**

While the outlandish ideas were shelved, the problems of marking nuclear waste repositories continued. Throughout the 1990s and 2000s, countries such as the US, UK, Germany and Sweden had to grapple with the very real problem of marking their waste sites.

In 1993, Sandia National Laboratories put together its own report, [*Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant*](https://digital.library.unt.edu/ark%3A/67531/metadc1279277/m2/1/high_res_d/10117359.pdf), which focused on preventing intruders into WIPP, a deep geological facility for storing nuclear waste in New Mexico. The waste was stored 660m below ground in a salt formation that has been stable for 250 million years. The question was what to do on the surface.

The Sandia planners looked at a host of options, including giant granite spikes, designed to scare and intimidate, in a so-called ‘landscape of thorns’, ‘spike field’, or even a ‘black hole’ – a large, square granite slab designed to be terrifying. This was part of a ‘physical language’ that humans would recognize as hostile. Ultimately, the team decided on 32, 25-foot-tall granite pillars, surrounded by an earth wall, with a giant granite room at the center of the site containing warnings in seven languages (English, Spanish, Russian, French, Chinese, Arabic and Navajo), with space for more language to be added over time. The message would also include phrases such as ‘this is not a place of honor … what is here was dangerous and repulsive to us … the danger is still present, in your time, as it was in ours. The danger is to the body, and it can kill.’ The plans are still being formalized, and will be submitted to the US Government in 2028; when you are dealing in a timescale of millennia, a few decades of careful thought doesn’t hurt.

Despite the best minds working on the problem from around the world, and a host of innovative solutions considered, humans still haven’t come up with a simple, surefire way to warn the future generations of the dangers of radioactive waste. And in Europe, the exact opposite approach is already being considered: do we really have to leave a message at all?

Finland’s Onkalo spent nuclear fuel repository is due to become operational in 2023. Built in Eurajoki on the Finnish west coast, the facility will also see waste placed deep underground, sealed in boron steel and copper capsules that should survive for 100,000 years. And yet rather than mark the site with elaborate structures, the Finnish approach is a far simpler strategy: they’re going to bury the facility, not mark it at all, and hope nobody digs there.

It’s a risky strategy; after all, it’s hard to hide such a giant mine from the world, and a single accident, even in such a remote location, could be enough to expose the waste to humans of the far future. But, the Finnish reckon, we’re overlooking a simple fact. We’re assuming that future humans won’t be smart enough to know what radioactivity is, or what a nuclear waste site could look like. And, if there was a collapse of civilization and future generations are unaware of the dangers of nuclear waste, any survivors would have far bigger problems to deal with than accidentally opening the wrong door.

Perhaps we don’t have to speak to the future after all. Perhaps it’s enough to believe that the future is smart enough to listen.

*Dr Kit Chapman is a science journalist and course leader for the MA in Journalism at Falmouth University, UK*.