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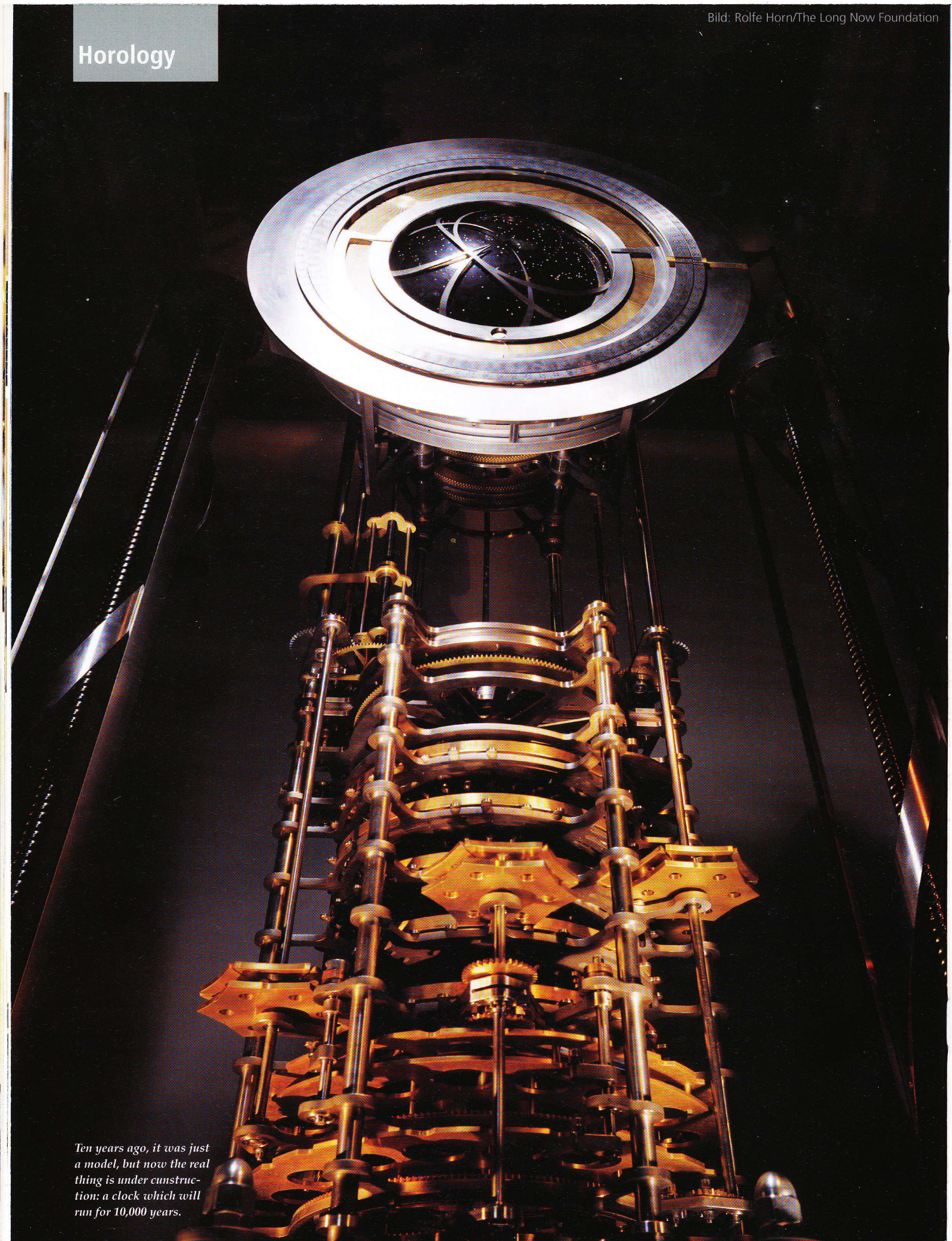


Ten years ago, it was just a model, but now the real thing is under cunstruction: a clock which will run for 10,000 years.

Ticking to **Eternity**

Building a mechanical clock to run for 10,000 years is a major engineering challenge – and a bit crazy. *Funded* ***by Amazon founder Jeff Bezos, a group of engineers is setting out to*** *craft* ***the ultimate time piece.***

The year is 12011. Two hikers cut through a stretch of cactus-filled desert outside what was once the small town of Van Horn, near the Mexican border, in West Texas. Finally, they come to an opening in the rock, the mouth of what appears to be a long, deep tunnel. After a few minutes the hikers reach a cool *chamber* dimly lit from above. A tall column of strange shiny metal gears and *rods* rises hundreds of meters above them. A black globe suspended above *depicts* the night sky, encircled by metal disks that indicate the year and the century.

A giant metal wheel sits in the middle of the platform, and the visitors each *grasp* a handle that *juts* out from its smooth edges. For the next few hours, they push and walk and push and walk in a circle. *Exhausted*, they rest on the platform and drift off to sleep. At noon the next day, they're suddenly awakened by the *ethereal* tones of *chiming bells*.

It sounds like science fiction, but this is the real vision for the 10,000-Year Clock, a monument-size mechanical clock designed to measure time for ten millennia. Danny Hillis, an electrical engineer with three degrees from MIT who pioneered parallel supercomputers and worked for Walt Disney Imagineering, dreamed up the project in 1995 to get people thinking more about the distant future. But the clock is no longer just a thought experiment. In a *cluttered* machine shop near a Starbucks in San Rafael, California, it's finally ticking to life.

This clock, the flagship project of Hillis' Long Now *Foundation*, is a wonder of mechanical engineering. Over the course of its 10,000-year life span, it will be able to power itself enough to keep time, synchronize that timekeeping with the sun, and randomly generate unique melodies on its *chimes* so that visitors will never hear the same *tune* twice. And it will do so entirely without electricity. "Think of it as the slowest computer in the world," says project manager Alexander Rose.

Eine Uhr zu konstruieren, die 10.000 Jahre lang laufen soll, ist eine gigantische ingenieurtechnische Herausforderung – und ein bisschen verrückt. Gesponsert vom Amazon Gründer Jeff Bezos hat sich jetzt eine Gruppe von Ingenieure daran gemacht, den ultimativen Zeitmesser zu bauen.

apocryphal • əpokrifl	*zweifelhaft*
beam	*Balken, Träger*
bell	*Glocke*
chamber	*Kammer, Raum*
chime • tscheim	*Glockenspiel*
chime, to • tscheim	*läuten*
clutter, to	*voll stopfen, überladen*
combat	*Kampf, Gefecht*
craft, to • krahft	*fertigen*
depict, to	*darstellen, abbilden*
eclectic • iklektik	*vielseitig, umfassend und ungewöhnlich*
eternity	*Ewigkeit*
ethereal • iθiəriəl	*himmlisch*
exhausted • igsɔßtid	*erschöpft*
forethought	*Voraussicht*
foundation	*Stiftung*
fund, to	*finanzieren, fördern*
grasp, to	*greifen, packen*
in earnest	*im Ernst, tatsächlich*
jut, to • dschat	*herausragen*
long-term	*langfristig*
oak	*Eiche*
purpose • pöpəß	*Zweck, Absicht*
résumé • resjumäi	*Lebenslauf*
rod	*Stab, Stange*
stint	*Arbeitsperiode, Pensum*
tune	*Melodie*

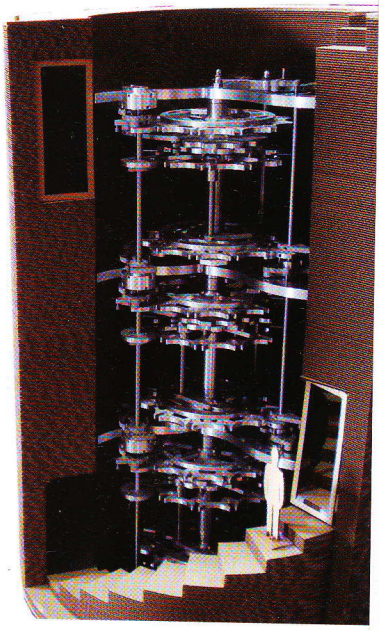
A 10,000-Year Life Span

But what's the point of building something to last 10,000 years? Hillis says he chose that time span because that's about how long human technology has been around. One inspiration came from a possibly *apocryphal* tale of a forward-looking architect. According to the myth, back in 1386, the builder of the University of Oxford's New College planted some *oak* trees. The *purpose* was to have wood that could be used to replace the oak *beams* of the college's great dining hall hundreds of years in the future.

For an engineer who had built his career on making fast machines, Hillis found this story of *forethought* striking. Building an ageless clock, Hillis suggested, was a way to bring really *long-term* thinking back. In 1997, after starting the Long Now Foundation, he began to work on the clock *in earnest* with Rose, a Carnegie Mellon-educated industrial designer whose *eclectic résumé* includes *stints* as artist in residence at Silicon Graphics and designer of championship *combat* robots.

The money turned out to be the easy part, because the clock had attracted a formidable believer: Jeff Bezos, the billionaire founder →

The scale-model shows the size of the clock compared to a human and how it will be built into a remote mountain.



Project manager Alexander Rose works on an orrery which was part of an early version of the 10,000-Year Clock.

Below: What looks like a giant marine engine is in fact the chime generator. Like a mechanical computer, it is capable of generating millions of different tunes.

of Amazon – who calls himself "the first *steward*" of the project. "It's a challenging engineering problem and so fun in its own right," he says. Bezos *bristles* at the *notion* that his investment might be perceived as frivolous. "Symbols are important," he says.

If you accept that *premise*, then you'll understand why Hillis and Rose's first concern wasn't *sketching* out the clock's innards. Instead, they were *obsessed* about how people would *experience* the clock. They wanted it to be as *engaging* as possible, "to make someone care about it in 10,000 years," Hillis says.

Hillis has spent the past seven years working with Rose and other members of the team to design what he calls the "*plotline*" of the clock. First, they wanted to ensure that visitors would be *vested* in the journey. That meant building the clock in a faraway, hard-to-reach place, somewhere requiring a real *commitment* to visit.

Discovering a Hidden Clock

But what if you were the first person to visit the clock in centuries, or even millennia? So, *for the sake of* the *wayward* traveller who just happens upon the clock by accident, the operation had to be *obvious* just from looking at it.

An electronic clock was therefore out of the question: It wasn't *sufficiently* transparent. Instead, they decided to make the clock entirely mechanical – even the digital computer that generates the melody of the clock's ten chimes.

Although much of the clockwork is similar to the workings of a standard *grandfather clock*, it differs from an ordinary analogue gear-driven clock in a few key ways. For one thing, it will be the largest clock ever built. It will tick at one-tenth the speed of a regular clock, which should help its gears, *bearings*, and other components last at least ten times as long. And rather than having a 12-hour *face*, the clock will display the positions of the stars on a black globe, surrounded by *dials* showing the year, the positions of the sun and moon, and other astronomical data.

Hillis and Rose could find no *precedents* for what they wanted to do. "Nothing else is built to last this long," Rose said. Even seemingly simple questions proved difficult to answer, such as: What should the clock be made of?

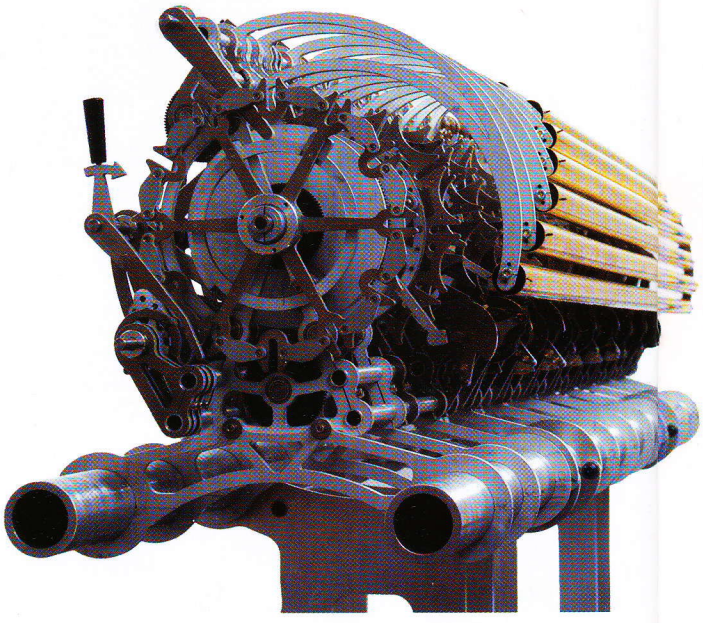
For the clock's components, the team has selected *durable* materials such as *stainless* steel, titanium, and ceramic, whose *longevity* can be *gauged* through high-temperature testing.

There was a concern, however, that over the centuries the clock's components might *weld* together if everything were made of the same material. So, most of the *pinion gears*, as well as the *pendulum* and *encasement*, will be made of titanium. Many of the bearings, meanwhile, will be made from silicon nitride, a ceramic.

The bearings will have unusually *rigorous demands* placed on them: Although they'll be protected by dust shields, they'll still have to hold up for 10 million slow speed cycles without *lubrication*. So far, the group's testing shows that the gears won't *gum up* from extended use. But 10,000 years is a long time.

Selecting the right materials is only one piece of the puzzle. There's also the matter of keeping the clock ticking and telling the correct time.

To maintain the clock's accuracy, Hillis and Rose had to figure out a way to somehow sync their clock, buried deep within a mountain, with the outside world. In earlier designs, they *considered* a solar synchronizer: A *beam* of sunlight would pass through a *slot* in the top of the clock at noon, heating up and contracting a piece of nickel titanium shape-memory wire; the wire would act as a mechanical *trigger*, resetting any error that had crept into the timekeeping since the previous day.



http://longnow.org/clock
www.10000yearclock.net
Die beiden Webseiten der Long Now Foundation zu der 10,000 Year Clock mit Bildern und Infos zu dem Projekt, den Prototypen und den aktuellen Arbeiten. Außerdem eine komplette Bauanleitung für den ersten Prototypen!

It's a clever idea, one of many the team has *devised*. In total, they have ten U.S. patents on the clock, including the *winding* tower, the clock face, and the solar-triggering mechanism. "We're probably the only ones patenting weird clock *esoterica*," Rose says.

Breathing With Time

The problem with memory wire, as with the use of electronics, was the lack of transparency. Instead, the sun could be *exploited* in two different ways. "The most promising design we're looking at uses two tanks of air: one near the *surface* of the mountain where the sun can heat it up and another that is kept cool inside the mountain," says Rose. The movement of air will drive a *piston* or a *bellows*, which will *ratchet up* the clock's 4.5-metric-ton weights. The weights will then have enough potential energy to keep the 136-kilogram pendulum swinging for the next day.

To recalibrate the clock, the current plan is to use a titanium box that pops out one normally concave side when the air inside heats and expands at around solar noon. This will trigger a correction in the pendulum if it's swinging too quickly or too slowly.

Using these mechanisms, the clock will be able to *keep track* of the time. But displaying the current time, the team decided, will require visitors to wind up the clock – yet another way to give the visitors' experience meaning.

Although the project was originally *slated* to finish in 2001, these days there is no official *schedule* for completion, and the team *estimates* at least a few more years of construction lie ahead before the clock will be completed and opened to the public.

For all the creative *deliberation*, hard work, and long-term planning, there's one thought that continues to *haunt* these engineers. "My biggest fear is that people will destroy it on purpose," Rose says.

"We're building it to withstand being broken," he says. But even a broken clock will change the way people think, Rose adds. He recalls a recent *encounter* with a skeptic, who *predicted* that the machine would eventually be *rendered* inoperable "when the blood of future human *sacrifices* stops up the gears."

"That might be," Rose told the man. "But before you walked into this room, you weren't thinking 3,000 years ahead. So it's already worked. Simply because you and I have had this conversation, it has *achieved* its *goal* – and it's not even built yet." ■ *David Kushner*

A detail of the clock's giant Geneva wheels.

achieve, to	erreichen
beam	Strahl
bearing • beəring	Lager
bellow	Blasebalg
bristle, to	sich sträuben
commitment	Einsatz, Engagement
consider, to	betrachten, erwägen
deliberation	Erwägung, Überlegung
demand	Anforderung, Vorgabe
devise, to	erdenken, ausarbeiten
dial • deiəl	Skala
durable • djuərəbl	dauerhaft, haltbar
encasement	Verkleidung
encounter	Begegnung, Treffen
engaging	einnehmend, bezaubernd
esoterica	Esoterik
estimate, to	schätzen, beurteilen
experience, to	erleben
exploit, to	ausnutzen, verwerten
face	hier: Ziffernblatt
for the sake of	um einer Sache willen
gauge, to • gäidsch	abmessen, abschätzen
goal	Ziel
grandfather clock	Standuhr
gum up, to	verkleben, verharzen
haunt, to	verfolgen, heimsuchen
keep track, to	nachgehen, verfolgen
longevity • londschevəti	Langlebigkeit
lubrication	Schmierung
notion	Ansicht, Vorstellung
obsessed	besessen
obvious	offensichtlich, deutlich
pendulum	Pendel
pinion gear	Ritzel, Zahnradgetriebe
piston	Kolben
plotline	Handlungsstrang
precedent • preßidənt	Beispielfall, Präzedenzfall
predict, to	vorhersagen
premise • premiß	Voraussetzung
ratchet up, to • rätschit	anheben, hochkurbeln
render, to	machen
rigorous • rigərəß	streng, hart
sacrifice	Opfer
schedule • schedjuhl	Terminplan, Zeitplan
sketch, to	skizzieren, entwerfen
slated, to be	vorgesehen sein
slot	Schlitz, Spalt
stainless	rostfrei
steward	Verwalter
sufficiently	ausreichend, genügend
surface	Oberfläche
trigger	Auslöser
vested	hier: persönlich involviert
wayward	unberechenbar, eigenwillig
weld, to	schweißen
wind, to • weind	aufziehen

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