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How Gregor Antes' basement laboratory changed money as we know it

Banknotes equipped with images that change when tipped, called kinegrams, foil counterfeiters all over the world. Their inventor turned his parents' house into a laboratory as a young man. And at the age of 82, he's finally getting around to completing his doctorate.

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First the manual labor, then the science: Gregor Antes (left) and his friend Guido Melliger haul a concrete polishing machine into Antes' parents' house.

Antes

From a villa in the university quarter of Zurich, the view from the attic apartment sweeps over the city and the lake and lingers on the snow-covered mountains. My host draws my attention to the house next door. Albert Einstein once lived there with his first wife Mileva Marić. But there is no time to think about that well-known physicist: We'll be spending the next few hours in a darkened, soundproofed room in the basement. «I've spent more of my life down here than in the bright penthouse,» my host says.

The first thing that catches my eye is a huge 3D television screen perched on a massive concrete foundation. In front of it sit a row of comfortable cinema seats, flanked by several speakers. If it weren't for the rest of the room's contents, you would think you were in the private screening room of a cineaste. Hidden behind a curtain, a lathe, milling machine, and electronic measuring equipment are jammed into a small workshop. And what are the holograms and the banknotes on the walls doing down here?

More than a fun gimmick

Welcome to Gregor Antes' laboratory. Antes' name is probably unfamiliar to most people. And yet almost all of us have an Antes invention in our wallets, one that he came up with in the 1980s. «Kinegrams» is what the trained physicist called the shiny silver tilting images that now adorn banknotes, identity cards and visas. What looks at first glance like a nice gimmick has made the world a considerably safer place. That's because, together with other security features, the kinegrams reliably protect banknotes and ID cards against counterfeiting.

There kinegrams' design puts few limits on artistic freedom. On Swiss banknotes, digits move from left to right or vice versa. A rock crystal sparkles on the Swiss identity card. And on euro banknotes, the euro symbol becomes a numerical value if you tilt it. All kinegrams have one thing in common: They change their appearance depending on the amount of light shinging on them, or the viewing angle. This tilting effect is caused by microscopically small structures which diffract light.

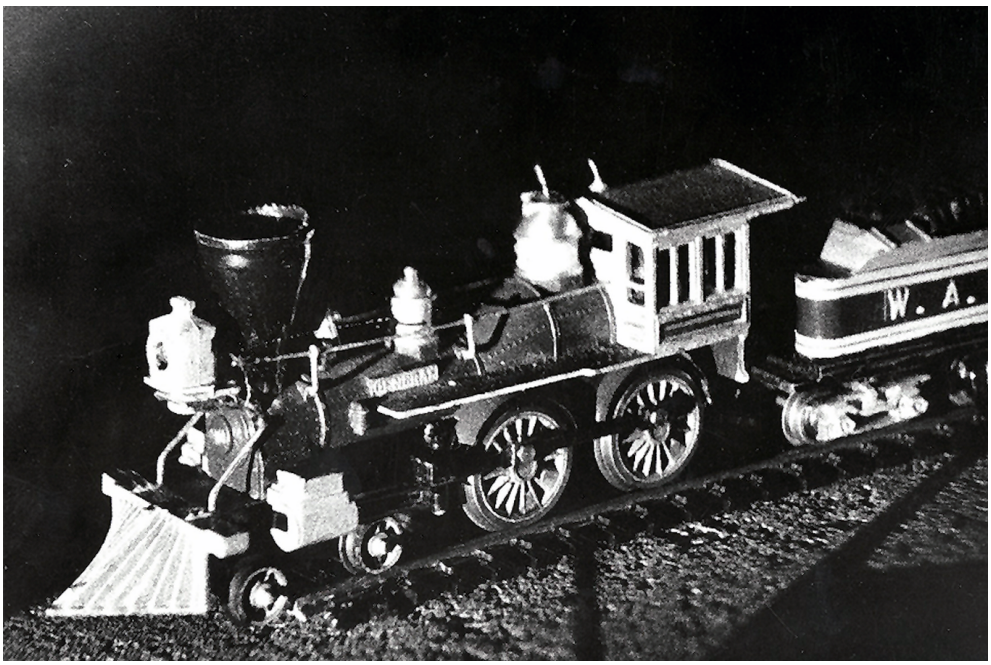
No desire to be a doctor

Few would have predicted a career as an inventor for Antes. His parents would have liked him to study medicine after high school, just like his father and uncle. But that didn't appeal to him, Antes says: «An appendix is an appendix, and a fetus is a fetus. I wanted to grasp things and create them myself.»

Antes was particularly enthusiastic about electronics and physics. Even before graduating from high school, the young man attended lectures by the renowned physicist Paul Scherrer. That left a lasting impression. Antes studied experimental physics at the ETH Zurich, graduating in 1965 with a thesis on plasma physics.

After that, he faced a problem that plagues many a graduate: What next? The young man was not fundamentally averse to a career in industry. However, he did not want to end up as a small cog in a big research machine. Antes was looking for a meaningful line of inquiry, one worth devoting a considerable part of his life to.

It was during this time of searching and questioning that Antes first heard about holography. The method for recording and reconstructing light waves was developed in 1947 by the Hungarian physicist Dennis Gabor. But it was not until the invention of the laser in 1960 that it became possible to produce qualitatively appealing holograms. Antes found the objects, which appeared to float freely in space, fascinating. He was ultimately able to convince the head of the Photographic Institute at ETH Zurich, the physicist Wolfgang Berg, to invite Gabor to a colloquium.



One of the first high-quality holograms was captured on a glass plate in 1963 using laser light. The train appears three-dimensional when the glass plate is irradiated with laser light.

Smithsonian National Museum of American History

After the lecture, Berg was also convinced of holography's importance as a field of study. Antes had essentially created his own doctoral position. But the Photographic Institute lacked practically everything he needed for his experiments, including adequate premises. In time of need, Antes took refuge in his parents' house, which was only a few minutes'

walk from the university. After tearing down some walls, there was enough space in the basement to set up a laboratory to his specifications.

Together with his childhood friend Guido Melliger, Antes built a vibration-free platform for the sensitive optical equipment. The two men reinforced several tons of concrete, and then ground them into a flat block. Six inflatable truck hoses were used to cushion the vibrations caused by road traffic. The lasers, beam splitters, and monochromators that Antes needed for his experiments back then have long since disappeared. But the concrete foundation still stands.



Gregor Antes polishes the concrete base for his holography platform flat with a grinding machine.

Antes



Antes created Switzerland’s first holograms in his basement laboratory.

Antes

Switzerland's first holograms were created in the basement laboratory. Antes quickly became a recognized expert in the field of holography. This did not go unnoticed by the «Neue Zürcher Zeitung.» In 1967, Antes used several pages in the newspaper's technology supplement to describe what holography was all about, and the process’ many applications. Among other things, he explained how holography can be used to encode information visually. At the time, he could not have guessed that this topic would never let him go.

A change to the industry

Word also spread in industry about the potential of optics with coherent laser light. The physicist Jean-Frédéric Moser of Landis & Gyr offered Antes the opportunity to set up a laboratory for coherent optics at what was then the world's largest producer of electricity meters. Antes agreed. He hoped to be able to finish his doctoral thesis at the same time. That

was overly optimistic. The work at Landis & Gyr absorbed more and more of his time and attention.

Landis & Gyr was in touch with the Swiss National Bank thanks to an earlier project, and Antes was asked to develop practically invisible security features for banknotes based on diffraction-optical microstructures, as well as the corresponding devices to read them. Together with the banknote manufacturer Orell Füssli, a series of banknotes was printed, but never entered circulation. The reserve series was produced only for emergencies. For Landis & Gyr, this was an excellent opportunity to gain experience in the world of banknotes and security features, says Antes.

This experience would soon pay off: In the early 1980s, the first high-quality color copiers came onto the market. Alarm bells began ringing at the central banks. The fear of counterfeiting sparked an urgent effort to make banknotes more secure. The hidden security features Antes had developed for the reserve banknote series were a possibility, but they could only be detected with a special reader. The central banks wanted authenticity features that were difficult to imitate but easy to verify.

More exclusive than holograms

Antes and his staff threw themselves into the work. The obvious idea of adding holograms to banknotes was rejected, Antes recalls. At that time, a growing number of companies offered holograms which were used as part of brand-name product packaging. Central banks demanded something more exclusive. After countless attempts, a solution was found that looked promising. Using improvised means, Antes and his

collaborators built an apparatus that made it possible to synthesize images with customized motion effects.

Kinegrams are basically microscopic peaks and valleys that are imprinted on a film. When light falls on such a microstructure, the light waves are diffracted, and a characteristic diffraction pattern is formed. The art is to make an image with the desired motion effect out of many diffraction patterns. This was done with Antes' apparatus. It selected from a pool of periodic, aperiodic, symmetrical and asymmetrical microstructures, and seamlessly assembled these basic elements into an microscopic mosaic. That way, tailor-made images could be generated that were much more complex than a hologram.

The invention was patented in Antes' name. In the following years, 16 further patents were added. They didn't make him rich: As is common in the industry, he assigned the rights to his employer for the token price of $1.

The breakthrough

However, it was not banknotes that helped the kinegrams break through. On the contrary, the tilting pictures premiered on Saudi Arabian passports. It was not until 1988 that the Austrian National Bank launched the world's first banknote with a kinegram. A colorful likeness of Mozart, who alternately looked to the left or to the right when the note was tilted, glittered on the 5,000 shilling note. After that, other national banks abandoned their hesitancy.

The first banknote with a kinegram came from Austria: Here, an enlarged section of the 5000 schilling banknote.

Original image: Imago

In Switzerland, it took a little longer. It was not until 1995 that the Swiss produced the first banknote with a kinegram. The note in question was a 50-franc Series 8 note. Later, the other denominations followed suit. Kinegrams had finally arrived in the home country of their inventor.

The end of a long-term relationship

By then, Antes and Landis & Gyr had parted ways. In 1987, the traditional family business was taken over by the Swiss industrialist Stephan Schmidheiny, who sold his majority share to Elektrowatt in 1995. The change of ownership has been bad for the company, Antes says. Family entrepreneurs were repeatedly replaced by outside managers. Under these conditions, it was tough to carry out research on topics that were not part of the company's core business.

Antes experienced that firsthand: Although he was still full of ideas, his role in the company was limited. He was offered the opportunity to execute his ideas with external companies. But

that didn't do justice to his years of experience, Antes said. In 1993, he decided to resign. His passion project — outfitting Swiss banknotes with kinegrams — was already on the home straight at this point. That made it easier for him to say goodbye.

Even without its guiding light, Landis & Gyr continued producing kinegrams. In 1998, the division was spun off under the name OVD Kinegram, and a year later was taken over by the German company Kurz, which Landis & Gyr had been working with for a long time. Antes' conclusion: «It's ironic that this little appendix of Landis & Gyr, of all things, has survived and grown successfully to this day.»

After his resignation, Antes went into business for himself. He worked as a sound engineer and CD producer, among other things. And he spent more time in his Zurich laboratory. Even during his time at Landis & Gyr, he never completely gave up «tinkering.» But now he finally found time to dedicate to it. He developed a multi-channel acoustic surround recording technique, that makes the listener feel as though they're floating above the orchestra. In another project, Antes and his childhood friend Guido Melliger constructed a computer that was wired, via 800 cables, to the organ of the Engelberg monastery. The «robot organist» digitally recorded a professional organist, and then played the organ itself.

Even at the age of 82, the inveterate inventor has not run out of ideas. And there are other tasks waiting in the wings: Antes wants to spruce up his website. And he would like to finally finish his doctoral thesis on three-dimensional image projections, which his kinegrams forced him to set aside. He

is not concerned with late doctoral honors. But he wants to finally get some closure on a period of his life that began with holograms more than 50 years ago.

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