EPISODE #313

Digital Forever? Bit Rot and the Return of Physical Media

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EPISODE SYNOPSIS

In this episode of My Weird Prompts, Corn and Herman tackle the unsettling reality of "bit rot" and the fragility of modern high-speed storage. While we have chased gigabyte-per-second speeds with NVMe drives, we have inadvertently created storage that can lose data in months if left unpowered. The duo explores why tech giants still rely on "ancient" magnetic tape and how "digital petroglyphs" like the M-Disc are making a comeback for long-term archiving. From the air-gapped security of LTO-10 to the futuristic promise of encoding data in quartz glass and DNA, this discussion reveals that the cloud is far more physical—and more vulnerable—than we think. If you have ever worried about your digital legacy surviving the next century, this deep dive into cold storage and format rot is essential listening.

DANIEL'S PROMPT

Daniel

In the context of modern data storage, I'm curious about the continued relevance of offline archiving technologies like LTO tape and M-Disc. In the age of cloud storage, what are the primary use cases for these? We often see issues like bit rot in newer storage like NVMe when it's not kept active, making digital permanence a challenge. Interestingly, the "write once, read many" limitation of older media has become a feature in cloud platforms like S3 for things like digital evidence and financial records. Why are people still building and using tape libraries in 2026 instead of migrating everything to the cloud? Is there a future for these offline technologies, and if tape reaches the end of its life cycle, what comes next for offline data storage?

TRANSCRIPT

Corn

Hey everyone, welcome back to My Weird Prompts. I'm Corn, and I was just thinking this morning about how much of our lives we trust to these invisible, ethereal services. We talk about the cloud like it's this magical, weightless dimension where our photos and documents live forever, but as we often find out, the cloud is just someone else's computer.

Herman

And usually, that computer is a lot more interesting and a lot more physical than people realize. I'm Herman Poppleberry, and I've been waiting for us to dive into this particular rabbit hole. Our housemate Daniel sent us an audio clip about this very thing. He was looking into his old backups and stumbled upon M-Disc and LTO tape, and it got him wondering why, in January of twenty twenty-six, we are still messing around with physical, offline media when we have fiber optic speeds and unlimited cloud buckets.

Corn

It is a great question because it feels counter-intuitive. We have moved toward everything being instant and accessible, yet the world of high-stakes data storage is actually moving in the opposite direction in some ways. Daniel mentioned bit rot, which is something I think a lot of people have heard of but don't quite realize how aggressive it can be, especially with the newer, faster storage we use every day.

Herman

Exactly. We've spent the last decade chasing speed. We went from spinning hard drives to SATA SSDs, and now we are all on N V M E drives that can move gigabytes per second. But there is a trade-off. In the world of physics, there is rarely a free lunch. The way we store data on an N V M E drive is by trapping electrons in these tiny little cells of flash memory. But those electrons want to escape. They are like kids in a classroom right before the bell rings. If you don't give that drive power and let the controller refresh those cells, those electrons eventually leak out through a process called charge leakage. That is bit rot in a nutshell.

Corn

Right, and the scarier part is that as we've made these drives denser to get more terabytes into a smaller space, the cells have gotten smaller and more fragile. A drive from ten years ago might hold its data for a few years without power, but some of these modern high-density Q L C drives might start seeing errors in as little as six months to a year if they are just sitting in a drawer in a warm room. It is the ultimate irony. Our fastest storage is also our most forgetful.

Herman

It really is. And that is why Daniel's mention of LTO tape and M-Disc is so relevant. These are what we call cold storage or offline archiving. The goal isn't to read the data in milliseconds. The goal is to make sure that when your great-grandchildren want to see your digital legacy in eighty years, the ones and zeros are actually still there.

Corn

So let's talk about LTO tape first, because I think that is the one that confuses people the most. When I tell friends that the biggest companies in the world, including the ones running the cloud, are still using magnetic tape, they think I'm joking. They think of cassette tapes from the nineteen eighties. But LTO-ten, which is the current standard we are seeing here in twenty twenty-six, is a completely different beast.

Herman

Oh, it is an engineering marvel. We are talking about thirty-six terabytes of native capacity on a single cartridge. If you use compression, you can get up to ninety terabytes on one tape. And the reason people still use it is simple: cost and durability. Once you write that data to a tape, it requires zero electricity to maintain. You put it on a shelf in a climate-controlled room, and it is rated to last thirty years or more. Compare that to a server rack full of hard drives that are spinning twenty-four seven, consuming power, generating heat, and mechanical parts wearing out every five years. In terms of total cost of ownership, tape is roughly one-sixth the cost of disk storage for long-term archives.

Corn

And there is the security aspect, too. We've talked about this in previous episodes, especially when we touched on engineering spy gear back in episode two eighty-one. The air gap is the ultimate firewall. If your backup is on a tape sitting in a plastic case on a shelf, no hacker in the world can encrypt it with ransomware. They can't delete it remotely. It is physically disconnected from the network. In an era where cyberattacks are getting more sophisticated, that physical air gap is becoming a premium feature.

Herman

That is a huge point. And it leads into what Daniel was saying about the cloud providers themselves. When you use something like Amazon S three Glacier Deep Archive, you aren't paying for a hard drive in a server. You are essentially paying for a robot in a massive warehouse to go pick up a tape, put it in a drive, and read your data when you request it. That is why it takes twelve hours to get your files back. You are waiting for a mechanical arm to do its job. So, when people ask why we aren't migrating everything to the cloud, the answer is that for a lot of that data, it already is on tape. The cloud is just an interface for a tape library.

Corn

It's funny how the more things change, the more they stay the same, just at a larger scale. But what about the other technology Daniel mentioned, the M-Disc? That one feels more like a consumer-level thing, but it has some fascinating claims behind it. I remember seeing advertisements saying it could last one thousand years. Is that just marketing fluff, or is there some real science there?

Herman

It is actually quite legitimate, though the one thousand year claim is obviously an estimate based on accelerated aging tests. A standard recordable D V D or Blu-ray uses an organic dye layer. When the laser hits it, it chemically changes that dye to represent a bit. The problem is that organic dyes break down over time, especially if they are exposed to light or heat. M-Disc replaced that dye with an inorganic, stone-like layer made of glassy carbon and metals. It is literally like engraving information into a rock, just at a microscopic scale.

Corn

So, it's basically digital petroglyphs. I love that. It goes back to what we were saying about digital permanence. If you have your wedding photos on an M-Disc, you don't have to worry about the magnetic fields of a hard drive failing or the flash memory leaking electrons. As long as you have a disc drive that can read it, the physical pits in that stone layer will still be there. But that brings up the big problem with all of these technologies, doesn't it? The hardware to read them.

Herman

Exactly. That is the Achilles' heel of archiving. You can have the most durable media in the universe, but if you don't have the drive to read it, it's just a very expensive coaster. We see this all the time with people finding old floppy discs or Zip drives. The data might be perfectly intact, but finding a working drive and a computer that can interface with it is a nightmare. With LTO tape, the industry tries to mitigate this. Usually, an LTO drive can read one generation back and write to one generation back. So an LTO-ten drive can read LTO-nine. But it can't read LTO-seven. So if you are a big company, you have to have a migration strategy. Every ten years, you have to move your data from the old tapes to the new tapes.

Corn

Which sounds like a lot of work, but I guess when you are talking about petabytes of data, it's just part of the cost of doing business. It's better than losing the data entirely. But I want to go back to something Daniel mentioned about W O R M, or Write Once Read Many. He said it's becoming a feature in the cloud, like in S three buckets. Why would we want a storage system that prevents us from changing or deleting things?

Herman

It sounds like a bug, right? But in the world of compliance and legal evidence, it is a massive feature. Think about financial records or body cam footage for police. If a company is under investigation, they need to prove that their emails from five years ago haven't been tampered with. If the storage is physically incapable of being overwritten, like an M-Disc or a tape set to W O R M mode, it carries a much higher level of trust in court. The cloud providers realized this, so they created software-defined W O R M, often called Object Lock. You can set a policy on a folder that says, anything put in here cannot be deleted or modified for seven years, not even by the administrator with root access.

Corn

That is a powerful tool for accountability. But it also highlights the difference between data and information. We are getting very good at storing the data, the ones and zeros, but we are still struggling with the information part, the ability to actually use it. If I save a file today in a proprietary format and try to open it in fifty years, even if the tape is perfect, will the software exist to understand it?

Herman

That is the second half of the bit rot problem. We call it format rot. And it is arguably a bigger threat than the physical degradation of the media. This is why archivers always recommend using open, well-documented formats. Save your photos as T I F F or high-quality J P E G, not some weird proprietary R A W format from a camera company that might go out of business. Save your text as plain text or P D F-A, which is the archival version of P D F. The goal is to make the data as dumb as possible so that future engineers can reverse-engineer how to read it.

Corn

I like that. Make the data dumb. It's a good mantra for longevity. So, looking at where we are now in twenty twenty-six, what does the future look like? Daniel asked if we've reached the end of the life cycle for tape. Is there something coming next that will finally replace the need for spinning magnets or stone-etched discs?

Herman

There are a few very exciting things on the horizon, or even just starting to be deployed in labs. The one I'm most excited about is Project Silica from Microsoft. They are using femtosecond lasers to encode data inside small blocks of quartz glass. It is similar to M-Disc in the sense that it is a physical change to a very stable material, but the density is much higher. We are talking about several terabytes of data in a piece of glass the size of a drink coaster. And glass is incredibly resilient. You can boil it, bake it, scour it with steel wool, and the data remains intact. It doesn't need climate control, and it could potentially last for ten thousand years.

Corn

I remember reading about that. They even stored the original Superman movie on a piece of glass as a proof of concept, right? It feels very sci-fi, like the memory crystals you see in movies. But glass is still a physical object that needs to be filed and retrieved. What about D N A storage? That was the big buzzword a few years ago. Is that still a thing?

Herman

It is, but it is still very expensive and very slow. The idea is to encode digital data into the base pairs of synthetic D N A: A, C, G, and T. D N A is the ultimate storage medium. It is incredibly dense. You could theoretically store all the world's data in a few grams of D N A. And we know it lasts. We've sequenced D N A from mammoths that are tens of thousands of years old. The problem is the write and read speeds. Synthesizing D N A and then sequencing it back to digital data takes a long time and costs a lot of money. Right now, it's only being used for things that are truly meant to last for centuries without ever being touched, like the Global Gene Bank archives.

Corn

So, for the average person or even the average business in twenty twenty-six, we aren't quite at the D N A or glass stage yet. We are still in this hybrid world where we use the cloud for our daily work, but we should probably be thinking about what happens if that cloud account gets locked or the company goes under. It makes me think about my own backups. I have everything on a couple of external S S Ds, but based on what you said about bit rot, I might be in trouble if I don't plug them in every few months.

Herman

You absolutely might be. If those S S Ds use Q L C, or Quad-Level Cell flash, which is very common for high-capacity cheap drives, the margins for error are razor-thin. If I were you, I would at least consider a multi-tiered approach. Use the cloud for convenience, keep an external hard drive—a spinning one—for a local copy, and then for the stuff you truly can't afford to lose, like family photos or important documents, look into M-Disc. You can buy an M-Disc compatible Blu-ray burner for less than one hundred dollars, and the discs themselves are affordable now. It is a small price to pay for peace of mind.

Corn

It's a bit of a return to the physical world, which I find strangely comforting. In a world where everything is a subscription and nothing is truly yours, having a physical disc or a tape that you own and that will exist regardless of an internet connection is a powerful thing. It's like having a physical library versus a Kindle subscription.

Herman

Exactly. And that is why tape libraries are still being built in twenty twenty-six. In fact, the demand for tape is higher than it has been in years. As A I models require more and more data for training, companies are realizing they need to keep everything, forever. They can't afford to store petabytes of training data on expensive, power-hungry hard drives. So they dump it onto tape. The tape is dead predictions have been wrong for thirty years, and I suspect they will be wrong for thirty more.

Corn

It's the ultimate old reliable. But let's look at the downsides for a second. If I'm a small business and I decide to go the tape route, the entry cost is still pretty high, isn't it? An LTO-ten drive isn't exactly cheap.

Herman

No, it's not. You are looking at several thousand dollars for a single drive. That is the big barrier. Tape is designed for the enterprise level. For a small business or an individual, it rarely makes sense to own the hardware. That is where services like A W S Glacier or Azure Archive come in. They give you the benefits of tape storage without the upfront cost of the machinery. You are essentially renting a tiny corner of their massive tape library.

Corn

So the cloud in this case is a middleman that makes enterprise technology accessible. But it still leaves you dependent on that middleman. I wonder if we'll see a return to more consumer-friendly archiving. Maybe a resurgence of optical media, or perhaps some new form of long-term flash that is designed for stability rather than speed.

Herman

There is some work being done on Write Once flash memory, where the cells are physically altered so they can't leak charge, but it hasn't hit the mainstream yet. Most of the research money is still going into making things faster and smaller for our phones and laptops. Archiving is the unglamorous side of the tech world. It's not flashy, it doesn't have a high frame rate, and it doesn't do A I. It just sits there. But when everything else fails, it's the only thing that matters.

Corn

It's like the foundation of a house. You don't think about it when you're looking at the nice curtains or the smart appliances, but if it's not there, the whole thing eventually collapses. I think that is the takeaway from Daniel's prompt. We are living in an era of incredible digital abundance, but it is also an era of incredible digital fragility. We are producing more data than any generation in history, but we might be the generation that leaves the least behind if we aren't careful.

Herman

That is the Digital Dark Age theory. The idea is that future historians will know more about the Romans because they wrote on stone and parchment than they will know about us because our data was stored on decaying magnetic platters and leaking flash cells. It's a sobering thought. We think we are the most documented civilization ever, but our records are written in disappearing ink.

Corn

So, what can our listeners do? If they are sitting at home and they have ten years of digital life on a laptop, what is the first step to ensuring digital permanence?

Herman

Step one is the three-two-one rule. It's a classic for a reason. Three copies of your data, on two different types of media, with one copy off-site. So, your laptop is one copy. An external hard drive is the second copy, that is a different type of media. And a cloud backup is the third copy, and it's off-site. If you want to be a gold star archiver, make that second copy an M-Disc or a high-quality optical disc instead of another hard drive.

Corn

And don't forget to check your backups. I think people set these things up and then forget about them for five years. You should be scrubbing your data, which basically means running a check to make sure the files can still be read and that no bits have flipped. Most good backup software does this automatically, but it's worth verifying.

Herman

And every time you get a new computer, that is the time to think about your long-term storage. Is the connection still compatible? Are the file formats still supported? It's a chore, I know. It's like cleaning out the attic. But in this case, the attic is your entire life's history.

Corn

It really is. I'm looking at my desk right now and realizing I have a stack of old S D cards from cameras I haven't used in years. I should probably get those onto something more permanent before those electrons start their Great Escape.

Herman

Do it this weekend, Corn. I'll help you. We can make a day of it. We'll find some of those old photos from when we first moved to Jerusalem. I bet there are some gems in there.

Corn

That sounds like a plan. And I think it's a good reminder for everyone listening. Technology is amazing, but it's not magic. It's physics. And physics always wins in the end unless you put in the work to fight back.

Herman

Well said. And hey, if you've been finding these deep dives into the guts of our digital world helpful, we'd really appreciate it if you could leave us a review on your podcast app. Whether you're on Spotify or Apple Podcasts, those ratings really help other curious people find the show.

Corn

Yeah, it makes a huge difference for us. And if you have your own weird prompts or questions about how the world works, head over to myweirdprompts.com and send them our way. We love hearing what's on your mind, even if it's as obscure as magnetic tape in the age of A I.

Herman

Especially if it's as obscure as magnetic tape. Those are my favorite ones.

Corn

Thanks again to Daniel for sending this one in. It's definitely given me some homework for the weekend.

Herman

And thanks to all of you for listening to My Weird Prompts. We'll be back next week with another deep dive into the strange and wonderful world of technology and beyond.

Corn

Until then, keep questioning, keep backing up, and we'll talk to you soon.

Herman

Goodbye everyone!

Corn

See ya.

Herman

You know, I was just thinking, if we did use D N A storage, we could technically store the entire history of this podcast in a single drop of water.

Corn

That is both cool and slightly unsettling. Would it be holy water if the episodes are good?

Herman

Only if we back up the episode on the theology of A I first.

Corn

Fair point. Alright, let's go find those S D cards.

Herman

On it! I think I saw some in the drawer in the kitchen.

Corn

Oh no, not the junk drawer. That's a different kind of archiving disaster.

Herman

Wish me luck, I'm going in!

Corn

This has been My Weird Prompts. You can find us on Spotify and at myweirdprompts.com. Thanks for listening.

Herman

Catch you later!

Corn

I wonder if there's any data on those old floppy discs we found in the basement.

Herman

Don't even start, Corn. We don't have a drive for those.

Corn

Not yet, we don't. I saw one on an auction site yesterday.

Herman

You're a dangerous man, Corn Poppleberry.

Corn

It's for the sake of history, Herman! The history!

Herman

Alright, alright. Let's just start with the S D cards. One disaster at a time.

Corn

Deal.

Herman

Seriously though, the quartz glass thing? I want one. Imagine a bookshelf of glass coasters that contains every book ever written.

Corn

It would certainly make moving house easier. Although, knowing us, we'd probably drop the one that has our birth certificates on it.

Herman

That's why you make two! Redundancy is the soul of archiving.

Corn

Redundancy is the soul of archiving. I'm going to put that on a t-shirt.

Herman

Make sure it's a high-quality cotton. We want that shirt to last at least fifty years.

Corn

Organic fibers, Herman. They'll rot. I need a stone-etched t-shirt.

Herman

Now you're just being difficult.

Corn

Just being thorough. See you guys next week!