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Retrocomputing Beta

How long will floppy disks maintain data integrity?

Asked 4 years ago Active 2 years, 8 months ago Viewed 14k times



This was on CNN today:

46

[The U.S. is still using floppy disks to run its nuclear program](#)



Which led me to read through this article:



[Think the floppy disk is dead? Think again! Here's why it still stands between us and a Nuclear Apocalypse](#)

5

In particular, this excerpt got me thinking:



Last year, a broadcast of 60 Minutes surprised many viewers with the discovery that 8-inch floppy disks were still the preferred method of removable storage for the computers in a U.S. Air Force nuclear silo.

Even the newest 8" floppy disks *must* be around 25 years old (at least). Honestly, I don't remember floppies being the most-stable storage media to begin with. I can't imagine the old 8" disks have a very good service life. And I remember being able to only reformat a bad disk a few times before it was useless.

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Can you take these disks off the shelf 30 years later and still expect to read their data?

floppy-disk

data-preservation

edited May 29 '16 at 10:26



sendmoreinfo

642 5 15

asked May 26 '16 at 16:17



Aaron

2,136 2 12 26

- 22 Well the good news is if the disk fails they can't launch the nukes. One day we might all owe our lives to a bad 8" floppy. – [mnem](#) May 26 '16 at 16:27
- 12 These weren't 8" floppys you got at Radio Shack to go with your TRS-80. These are *mil-spec* floppys! These floppys are individually hand-built with military grade plastic substrate, the individual iron filings hand-inspected, then glued to the substrate and inspected using ISO-9001 procedures. The titanium floppy jackets (perhaps "floppy" is a misnomer) were milled on certified CNC machines. These were your \$640 toilet seats, your \$436 hammers, your gold-plated built-to-last cost-plus floppys! (But, no, you can't expect them to work after 30 years.) – [davidbak](#) May 26 '16 at 20:49 ✎
- 8 More to the point, the US Military probably wouldn't mind paying the \$100 a disk or whatever it would cost for someone to produce brand new ones as needed. It would still be cheaper than alternatives. Just doing a feasibility study to replace the drives would cost more. – [Ross Ridge](#) May 26 '16 at 23:26
- 2 Easy solution: just get yourself one standard-issue 1970s-floppy-drive-to-USB-stick converter like the U.S. Strategic Homeland Intervention, Enforcement, and Logistics Division uses to communicate with old neural network systems! – [tonysdg](#) May 27 '16 at 0:32
- 6 @davidbak MIL-SPEC is generally more about environmental tolerances or security features than build quality (though, it does tend to mean more durability and a longer life under normal conditions), but more importantly, I expect that by this point, they're using whatever works, whether it was built to MIL-SPEC or not. ([And yes, you can still find and buy 8 inch floppies these days, not that there's much demand.](#)) – [HopelessN00b](#) May 28 '16 at 18:52 ✎

8 Answers

Active

Oldest

Votes



There are a few factors:

22



1. Quality of media.
2. Storage environment (i.e. climate controlled versus humid attic).
3. How many hours of use did the disk experience.



Assuming little-to-no use, it probably comes down mostly to quality of the floppy disk media which tends to vary across manufacturers

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While 5.25" disks seem to have held up over the years, I can say that 3.5" disks were obviously cost reduced and of much lower quality. Some that I have in my collection that were sold as "high quality" back in the early 90's are questionable today at best while a repurposed America Online 3.5" from the same period is almost certainly not going to still hold its original contents.

In general, I think it is hard to come up with an answer for this since nobody really seemed to perform studies on this back in the day; probably because nobody assumed the technology would still be in use 30 years later. However, I will state that you can visibly see if a disk is "dead" physically by looking for small dark spots on the medium (not referring to mold but natural oxidation). If you see that, I'd say you've got time to image the disk before throwing it away and then perhaps cleaning your drive head.

answered May 26 '16 at 17:50



bjb

11.2k

26

90

1 "High quality" simple meant high density (1440K vs the standard 800K). – [Mr Lister](#) May 28 '16 at 13:44

9 @MrLister it doesn't sound likely to me. Quality and density are two independent concepts. Do you have any sources to back that up? – [blubberdiblub](#) May 28 '16 at 16:26

4 The higher the data density, the faster it will degrade. Imagine storing data as the magnetic direction of a few hundred atoms. Compare that with a few million atoms. Which one will survive random polarity changes of a few atoms for longer? In a way, the low density disks have a huge redundancy factor. The original 8" disks were very low density compared to the latest 3.5" disks. – [CJ Dennis](#) Aug 18 '17 at 3:47



Can you take these disks off the shelf 30 years later and still expect to read their data?

26



Yes.



Although we all experienced floppies fragility, the magnetic media in fact is one of the longest-living we can practically manufacture. Typical streamer tapes are often guaranteed for 30 years. Of course, under very strict handling and storage conditions - but the point is that no other popular writable media can come even close to 30 years figure. Home and office floppies fail due to mishandling, physical damage, being put too close to speaker, getting dirty, etc - all those failure modes are well known and easily preventable with procedures.

The usage of one of the oldest, 8" floppies is also not surprising here. They have pretty small capacity compared to their size - the largest ever are barely 1.2MB. This gives them tremendous advantage in reliability, as with wide and sparse tracks there is huge

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Even the newest 8" floppy disks must be around 25 years old (at least).

Do not underestimate the power of a large, government organization. Eg in Poland one agency put on a tender for 130000 3.5" floppies in... 2008. \$40k budget. Brand-new ones, manufactured in same year, of course. It's expectable that Navy alone kept one factory afloat for all those years.

And last but not least: You've assumed that they wrote those disk 30 years ago and never touched them since. I believe that's not reasonable assumption. In long-term data storage there are procedures to cyclically read and re-write data on new storage.

/edit: On a second thought, this is just another example of an old tech being continuously used in professional environment despite newer tech being widespread among consumers. NASA using magnetic-core memory in 80's, cars using relays instead of solid-state to control starter motor, Amtrak using rotary converters, etc, etc. The main point is not about absolute reliability, it's about better understanding of failure modes. When you have good understanding of failure modes, you can simply overengineer that particular aspect or put in procedures to circumvent the problem. Being able to predict it with good certainty is all that it takes to achieve the best possible reliability.

edited Jun 3 '16 at 15:11

answered Jun 3 '16 at 14:50



Agent_L

379 2 7

-
- 1 Now, using an 'older' technology isn't just about understanding it better, or even being available at that time. More important it's not only proven to work in the environment it is used, but the environment is made to work with that part as part of a common spec. This includes way more than just the primary function. A technology that can be a fine replacement in an office environment, mit not work as well in like a steam engine cab. It took decades to make transistorized control reliable enough to compete for something 'simple' ad wipers in a car. – Raffzahn Sep 20 '17 at 11:30
-

Further, beside the seemingly main feature a technology always offer other features. Like the rotary converters do not only rectify or change frequency, but also deliver exactly the same behaviour as a power station of the same technology. And controls and traction motors are as well of that technology. Putting power electronics in the middle isn't just about handling that amount of current. Similar the starter relay. It switches the starter on but its mechanic also can not *cross the streams*. Quite important for safety, as currents of a shortened battery can easy lead to a car fire. – Raffzahn Sep 20 '17 at 11:53

- 1 @Raffzahn I think I don't quite understand what you mean. Reliability is not absolute. Old Amtrak power converters have been hugely overdesigned in certain aspects, and that's how they can handle overloads that fry solid-state. Their behaviour is not important to modern solid state locos which are brand new in comparison, not designed for that. Starter relay is not inherently resistant to shorting out the battery, it's the understanding of how contacts stick that made them designed and wired in a way that can not cross the streams. – Agent_L Sep 20 '17 at 16:03
-

I'm not convinced that cherry picking is the right way to look at a large scale system as a railway installation is. But this isn't exactly the place to discuss this. Same for starter motors, but you should take a chance and have a closer look at some point. – Raffzahn Sep 21 '17 at 6:58

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▲ The short answer is that they will retain data integrity as long as they do. Floppy disks have a number of enemies: Moisture, corrosion, mildew, deformation of the physical media, degradation of adhesives and other materials, magnetic fields, etc.

15



If a floppy disk is treated like a precious document and stored in a UV-proof, temperature and humidity controlled environment, free from harmful magnetic fields, and if the bonding agent that keeps the magnetic material attached to the disk surface doesn't fail, the disks may last for decades yet to come even if they are 8" floppies from the 1970s.



However, I've seen floppy disks fail just a couple of months after opening the package. It's a fragile media.

The best advice is to preserve the contents of any floppy you come across if the data contained within is at all worth preservation. Multiple redundant copies remains the surest way to keep data safe into the future.

The US nuclear program has a problem in that the data on those 8" floppies may not exist elsewhere, and we cannot know how long the media or the drives will last. Moving parts eventually fail too, after all. Theoretically the US government could commission new drives and new media at considerable expense. You and I probably cannot do that. But better it would be I think for them to prepare for a day when that fragile media no longer exists.

answered May 26 '16 at 21:45

[Joseph Carter](#)

989 5 18

With the age of those floppies, the expense of commissioning new drives and media is probably minimal - I wouldn't be surprised if the entire library of 8.5" floppies could be copied onto a single 64GB micro SD card - about \$20. – [Dan Henderson](#) May 26 '16 at 22:50

3 "The US nuclear program has a problem in that the data on those 8" floppies may not exist elsewhere" - well then they should make some backups, shouldn't they? – [user253751](#) May 27 '16 at 3:25

The expense would be manufacture of new 8" disks and drives. It's true that one modern flash device could hold the entire library of 8" floppies ever made, but the military would not be using them. That'd take all new testing and certification, and some group would sue them for "developing new nuclear weapons technology" (SD card flash drive) because it violates some treaty or something ... Messy. Or, dump a few million into factory tooling to make 50 year old disks/drives. They **do** spend \$10k dollars on a hammer or \$6k for a toilet seat. It's made according to MILSPEC! ;) – [Joseph Carter](#) May 27 '16 at 6:24

1 Seriously though, they're going to replace these things. It just might require some careful effort to do it without causing all kinds of problems along the way. – [Joseph Carter](#) May 27 '16 at 6:32

1 The writable CDs have shorter lifespan than floppies? – [nsandersen](#) Jun 3 '16 at 17:06



From something I read just the other day on the news:

10



"We regularly read floppy disks from 40 years ago and they are as good as new," he said. [someone at The National Museum of Computing at Bletchley Park]



"Magnetic tape has a real issue because when it is on the reels you have a lot of different layers so you have 'print through'," he said. "This involves the shadow of data on one section of tape being superimposed on the layer above and below. The interference means data quickly gets harder to read."

Source: [BBC article](#)

Certainly from my own experience, well stored 3.5 inch floppy disks are readable after 20 years, if not more.

answered May 27 '16 at 8:54



Andy

419 2 4

- 2 My C64 5.25" disks collection (from 1984 to 1991) which I transferred on a harddisk in 2012 was readable nearly as good as they were 25 years before. Just those disks which had already problems in the old days weren't reliable readable. Just a few disks fell through (those cheap ones with their failing I had expected at that time already). But overall, even low quality disks didn't failed completely. The disks were stored in a living room (not too cold or moistly, in a dark box). I was astounded about the success of this project. – [Johann Klasek](#) May 31 '16 at 12:19
- 1 "print through" is an issue with analog audio and video tape. I don't believe it to be a problem with modern digital, due to the very high coercivity of the media (which makes it very difficult for magnetic domains to be "flipped") and to the error correction schemes that are used. i can see it being a problem for reading older-tech mag tapes. But I'd worry more about oxide shedding. – [Jamie Hanrahan](#) Sep 25 '17 at 14:06



9



When recently imaging my old Amiga disks, dating from 1989 until about 1993, approximately 80% of them read first time without error, another 10% needed a few retries to get all the data off, 9% had unrecoverable sectors, and 1% appeared to be completely unformatted. (The latter were not virgin blank disks, since they were labelled with their contents.)

This is for 3.5" DD disks. Other sizes and densities will of course vary, with 3.5" HD disks being famously awful.



answered May 26 '16 at 19:50




pndc

7,299 2 30 44

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disks. On magnetic storage, you cannot maintain the same direction of magnetisation for very long, that's why the raw bits need to be changed after a while and that's also why the encodings (like MFM and GCR) exist. And on HD disks, the bits need to change within a shorter physical length than on DD disks (that's what the substrate is designed for) and that's why they are not interchangeable without sacrificing reliability. – [blubberdiblub](#) May 28 '16 at 16:30 

Out of curiosity, why would there be a problem using HD disks at lower density? Thank you. – [nsandersen](#) Jun 3 '16 at 16:31

The biggest problem is if the disks were ever formatted for high density. You can't remove that higher density data, and writing the disk at a lower density isn't going to completely overwrite the lower density data either. Ideally you format a disk once for the number of tracks and sectors it will always have. If you don't, you'll never be able to completely undo previous formatting. This causes problems in the long term with data integrity and higher density drives are likely to get REALLY confused with the disks. – [Joseph Carter](#) Jun 4 '16 at 11:29

@nsandersen en.wikipedia.org/wiki/IBM_Personal_Computer/AT#Problems – [a CVn](#) Jun 10 '16 at 17:34 

- 1 @nsandersen: Data written to magnetic media will tend to "spread" a little bit; the spread will be larger with materials that can be written with a weaker magnetic field than with materials that require a stronger one. High-density media require a stronger magnetic field to write them than did lower-density media; some drives designed for low-density media don't supply enough write current to flip the magnetic states on higher-density media. – [supercat](#) Jul 26 '16 at 22:36



4



I know I'm responding to an old post here but I thought I would share my recent experiences. I recently purchased a TEAC 5.25" floppy drive off eBay for the purpose of going through a bunch of old 5.25" disk that I have (some were mine originally, others come from a bunch I bought at a thrift store a long time ago). I've gone through about two dozen double density disks (some single sided, most double sided but all formatted as double sided it seems) and all of them have been readable so far. These disks date back to between 1983 and 1988. It seems like double density disks can be very reliable for long periods if properly taken care of. I don't know how high density disks compare...I haven't run across any of those yet.

answered Aug 9 '17 at 18:46



[Jeremiah](#)

41 1

- 6 There's no problem with answering old questions! Please read the [tour](#) to get an idea of how the site works - we're not like other sites. Welcome to Retrocomputing Stack Exchange. – [wizzwizz4](#) ♦ Aug 9 '17 at 19:35



2

With floppies the density of data write is a big difference. My experience is the more dense data is written the lower the lifetime.

I still got around ~100 of 5.25" DD 3M floppies which last I check (after 15 years of non usage) were still in tact (I did a full backup to

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be still in tact even after 30 years. Also even faulty Floppy is good as new after proper low level reformat (not the MS-DOS crappy one) if no mechanical damage is present.

As written in the other answers Floppies are the most reliable removable storage in longterm. Here empiric experience of mine:

medium	reliable_storage

MG tapes	10 years (reusable)
5.25" DD	15+ years (reusable)
3.5" DD	10+ years (reusable)
5.25" HD	5.0 years (reusable)
3.5" HD	1.0 year (reusable)
CD W	10 years (fully destroyed metalic layer)
DVD W	0.5 year

So guessing/extrapolating to 8" SD 30+ Years is a real possibility

The closer the tracks are together the sooner they noticeably interact similarly to tapes. Yes of coarse the higher density uses much a bigger B punch so they should be less susceptible to background magnetic fields but the experience tells us a different story.

Well yes we have **USB** Flash now which can store data for a long time (if not rewritten) but the reliability of the electronics involved is questionable. As for any modern electronics the lifetime goes to hell. I remember electric devices that last for 40+ years. Even my ZX clone from 1989 is still functional. And the modern ones are up to 2-5 years tops...

edited Sep 20 '17 at 11:12

answered Sep 20 '17 at 9:02



Spektre


5,087 9 25

Another format which might fit in your table is WORM (Write-Once Read-Many) magneto-optical platters. They are marketed for long-term archival storage. In the early 1990s my company built systems which featured this storage capability onto 12" hard-shell platters. Using some sort of accelerated aging technique, the manufacturers spec'd them for at least a 90-year (maybe even 99) data lifetime. IIRC, magneto-optical disks were written by a laser burning small permanent dents into the media. These were readable via magnetic means. – RichF Sep 22 '17 at 2:25

@RichF never heard of such device :). btw advertised and real lifetime are very different numbers because a lot of factors (mainly we got our discs somewhere in the shelf instead of a temp/humidity controled no light/radiation and fields safe. for example writeable DVDs where planned for 20 years (If I remember correctly) but usually only after 6 months the data start to get lost. That is why they are used usually for lossy compressed video and sound where some portion of error does not hurt as much. – Spektre Sep 22 '17 at 6:05

@RichF seems like the punched tape is unbeatable but the data density is too low ... – Spektre Sep 22 '17 at 6:07



@Ed999 that was why a standard programmers tool was scissors and glue along with the hole puncher :) simply you cut down wrong chunk and glue in a new patched one :) but yes finding and repairing code was probably a nightmare ... – [Spektre](#) Jan 22 '18 at 12:50 



Even for disks which have self-erased due to entropy, high temperature storage, or poor chemistry resistance to self-demagnetization, these disks are not necessarily defective.

2



If the magnetic coating has not itself degraded or detached from the plastic, then a self-erased disk can still be used again by low-level reformatting of the entire disk, which lays down new magnetic patterns that defines new data boundaries for tracks and sectors.



(Due to differences in head width and signal strength for low and high density drives, a full erasure with a powerful "bulk erasure" magnet is preferred before low-level reformatting to remove any such old patterns.)

This "refreshing" of the magnetic domains was a feature of an old PC DOS hard drive maintenance software for early MFM/RLL/IDE hard drives, called SpinRite by Steve Gibson. It could read weak sectors, attempt statistical recovery through multiple rereading, and then rewrite each sector to refresh the magnetic patterns.

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EDIT: I should mention that really old hard drives used stepper motors to position the read/write heads. A stepper always turns a precise number of degrees for each step, which would be used to position the heads for each track. But due to the loose mechanical nature of these hard drives, there was some "slop" in the head positioning. Taking an old hard drive and tipping it 90 degrees on its side could lead to read/write errors unless it was low-level formatted for that new physical orientation.

Also external physical impacts could cause the heads to "skip" to a new location, which the stepper can not detect and then leads to the drive being confused about where it is reading or writing. If this track-skipping occurs during a write, it can lead to catastrophic data corruption.

,

An improvement over this was the use of optical encoders and the voice-coil servo positioner. There was a clear glass or plastic band with tiny black stripes printed on it, attached to the head positioning arm, and passing over a light sensor.

If the drive head were to be struck and head misalignment occurred, it would immediately detect the misalignment due to the motion of the optical encoder, then stop whatever it was doing and reposition the heads back over the correct track again.

This worked well, but there is a limit on how precise the optical encoder can be, as tracks became ever smaller and smaller as

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At some point there was a transition to a new way of positioning the heads, using special magnetic markers read by the heads to tell them exactly where they are now on the platters. These position markers are printed onto the platters at the factory using special external equipment, and it is not possible to reconstruct the markers once the drive has left the factory. This positioning method is used by all modern hard drives.

Early drives using this method would dedicate an entire platter surface to the servo data, but for modern drives, the permanent servo positioning data is mixed in among the regular read-write areas of each platter, and the drive electronics make sure to never overwrite that servo data.

At this point it became impossible to do true low-level formatting because if the markers are removed, the drive has no idea where anything is on the platters and it becomes useless.

Also, this is why modern hard drives can not be "degaussed" using a powerful external magnetizer, as this removes the head-positioning servo data and the drive can no longer find where tracks are located.

edited Sep 21 '17 at 7:38

answered Mar 14 '17 at 16:51



[Dale Mahalko](#)

3,073 6 28

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- 1 I even remember IDE low level format in the BIOS ... or the HD_format utility for HD FDDs for MS-DOS performing true low level format (not just logic rewrite of sectors like MS-DOS format did). I do not remember how the MFM discs were handled it was too long ago – [Spektre](#) Sep 20 '17 at 11:07
-
- 1 For anyone who has a practical use for the information, I was still using the recovery software SpinRite by Steve Gibson as recently as 8 years ago, and getting good results with it, to maintain an old PC running Windows 98SE (which I only stopped using when the motherboard wore out, not through a disk problem). – [Ed999](#) Jan 22 '18 at 12:22
-