VRC Middle School – Reverse Engineering Challenge

Title of Submission:
Looking inside a Hard Drive

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Chapter 1: Why did we choose a hard drive?

- We decided to reverse engineer a mechanical hard drive, specifically a Western Digital **LBA 234375000, but most of the principles are applicable to other mechanical hard drives.**
- We chose a hard drive as we thought that a hard drive, while now being replaced by SSDs, was a very important piece of technology which helped to change the computing industry, allowing people to store more data than before, which in turn led to the development of major programs.
- A hard drive works by storing data magnetically, on platters and all of the mechanisms in a hard drive have been carefully engineered for speed.

NB: Hard drives when taken apart like this will not work, due to the dust building up on the platter. This is why there is such a careful seal on the top cover.

Chapter 2:
Day by Day Logs

Day 1 – Taking the Basics Apart

Members Present

Fig 1 – The hard drive with the stickers peeled off and the label pealed back

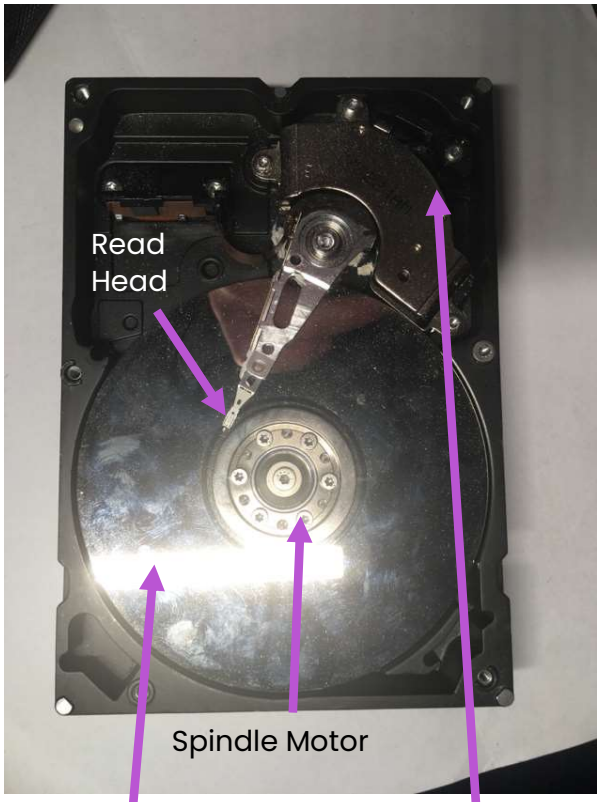


Fig 2 – The internals of the hard drive

We started by removing all the security stickers so that we could undo the screws that hold the hard drive together (Fig 1). After this, we were greeted with the sight of the platters (Fig 2). After a bit of research, we were able to conclude what each of these parts do.

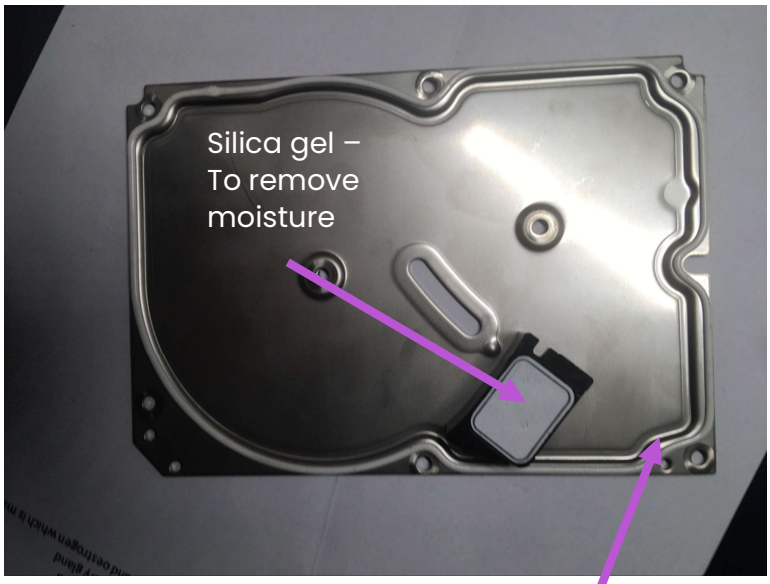


Fig 3 – The back cover of the hard drive

Day 2 – Further Disassembly

Members Present

Fig 5 –The assembly that restricts the range of motion of read head

Fig 4 – One of the large magnets used in the voice coil (this moves the read head)

Fig 6 – The back of the hard drive

Fig 7 – The back of the hard drive

Fig 8 and 9 – Edge connectors

In order to remove the drive head, we had to remove one of the coil magnets (Fig. 4/5). We then realised that the last screw holding the drive head in was under the PCB, so we removed that (Fig. 6/7). Isaac thought that the connector to transmit data to the clean part of the hard drive was very interesting, as it allows replacement of the PCB without having to risk dust getting into the hard drive.

Day 3 – Drive heads and Platters

Members Present

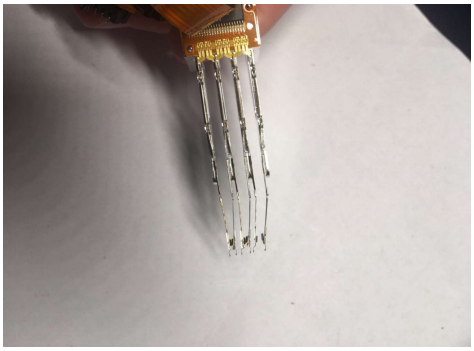


Fig 10 and 11 – The actual 6 drive heads and the control arm

Fig 12 – Just the platters and motor in the drive housing

Fig 13 – Just the drive platter – you can see that it is really reflective, due to the coating.

Fig 13 – The mandrel that the drive was held on – this was a really tight fit

Fig 14 – Another really well machined spacer

Today Isaac planned to finish disassembling the hard drives by taking out the drive heads and removing the platters.

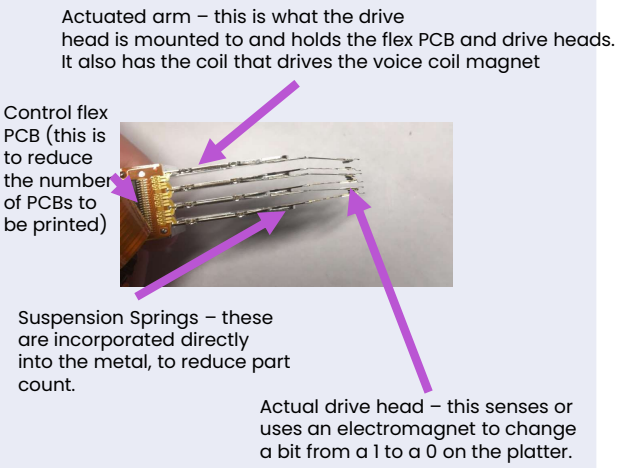
The drive head was delicate, and Isaac ended up bending it as he removed it, which is why hard drive repair and data recovery is so difficult – a speck of dust between the read head and the platter can lose lots of data.

Chapter 3: Evaluation

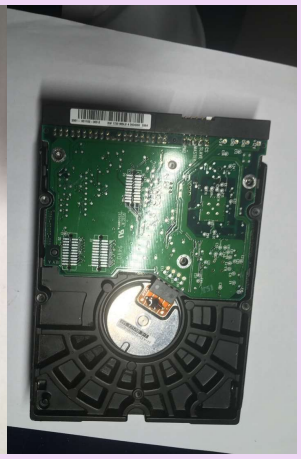
This project taught us a lot about how many moving parts there are in a hard drive, and how much thought goes into keeping hard drives operating reliably, while keeping them easy to repair. An example of this was the fact that the main board is on the outside of the hard drive, and the use of pogo pins to transmit data and power to the inside so the PCB could be replaced without going into a clean room to open the hard drive. These well thought out parts made us think about how many iterations of something it takes to make it work with that level of precision.

It also taught us a lot about safety when taking things apart. We made sure to always wear safety googles, because parts of the hard drive had strong magnets, which can be dangerous and make small objects go flying.

Chapter 4: Parts List & Functions

Part	Function	Photo
The Drive Housing	This houses and mounts all of the components.	 
The Drive Platter	This is where the actual data is written to, magnetically.	
The Platter Spacer	This spaces out the 3 drive platters, by sitting in between them. It is precisely machined to fit.	
The Platter Motor	This spins the platter incredibly fast, to allow data to be written everywhere.	
The Mandrel	This is what holds the platter to the BLDC motor seen above.	
The Drive Head	This reads and writes data to the hard drive, by using an electro-magnet to magnetize or demagnetize a specific area of a hard drive platter. This is also the most delicate part of the hard drive, were evens tiny amounts of mis-alignment can ruin the hard drive.	
The Drive Head Pivot	This mounts under the voice coil magnet. It is the pivot that the drive head arm spins around.	

Chapter 4: Parts Lists & Functions

Part	Function	Photo
The Voice Coil Magnet	This is a form of a linear actuator to move the head around its pivot. It uses strong magnets (which is what the voice coil magnets are).	 
Voice Coil "Magnet Restrictor Part"	We were not sure of the technical name of this part, but it restricts the range of motion of the voice coil to where the platter is.	
Control PCB	This controls everything, and takes the signals from each subsystem, before converting them into an IDE port, and power port. This lets the drive get power and talk to the computer.	 
Top Plate	This seals the main components of the hard drive in a box.	 
Silica Gel Box	This absorbs moisture - it is glued to the top plate. We need to absorb moisture from the drive in order to prevent internal corrosion.