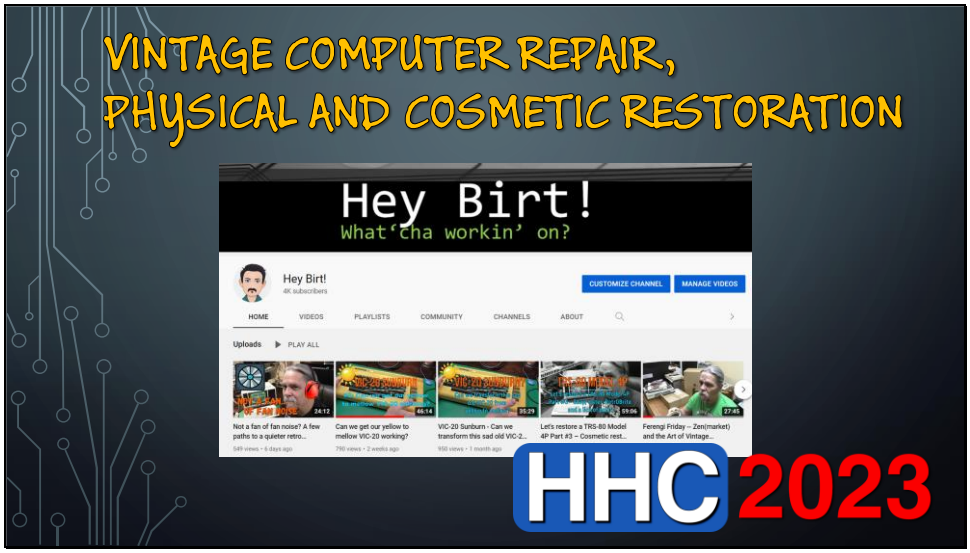
Slide 1



My name is Jeff, from the Ozark Mountains in Missouri, USA. I make YouTube videos and begin every video like this because when I started, I did not know what else to say. I have lived in Missouri my adult life, but the rest of the story as Paul Harvey would say, is that I grew up just up in central Ohio.

I started making videos because it pains me to see people struggling when repairing vintage computers, so I try and pass on what I have learned over the years and hope it helps others.

Slide 2

Today we are going to talk about the physical and cosmetic aspects of restoring vintage computer gear.

It seemed to make the most sense to cover these topics in the order in which they will most likely be applied when we are working on our machines, this is the same general order as when working on about anything: Clean it, fix it, refinish it.

Slide 3

This may seem like and odd question but…I suspect most of you will have the same answer.

Slide 4

I suspect most of you will answer ‘soap and water’. The type of soap varies from task to task, but soap and water are typically where we begin. Not wanting to be accused of stating the obvious here, but I make this point as I have seen comments like ‘I rinsed it with a garden hose and wiped with alcohol’. Sadly, then their later cosmetic restoration efforts don’t work well because the parts simply are not clean.

Slide 5

If we step back and look a wider view of cleaning, we are using a liquid solvent which mixes with the substance we wish to remove allowing us to wipe away the solution that is formed. Solvents that might come to mind are acetone, alcohol, etc. Water is also a solvent. Soap is an emulsifier which allows oil and water to mix. Soap may seem boring, but it is a great example of everyday household chemistry.

There are lot of various types of soaps or cleaners. I like to start with a very mild cleaner like dish soap or Formula 409. These are the least likely to react poorly with most surfaces. As needs dictate stronger cleaners re used. Mild to wild.

Slide 6

Examples - We only need simple tools, soap, water, a bucket, brush, rags. For stubborn spots some pumice hand cleaner and/or magic eraser (melamine sponge) comes in handy. I'm working on large pieces here so a large bucket outside was a good choice.

Everything is abrasive, even rags, and can cause minor scratching. More abrasive cleaners will do so faster. Be as gentle as you can while still getting your parts clean.

I have used plastic polish to restore luster to areas that took a lot of effort with Magic Eraser.

Slide 7

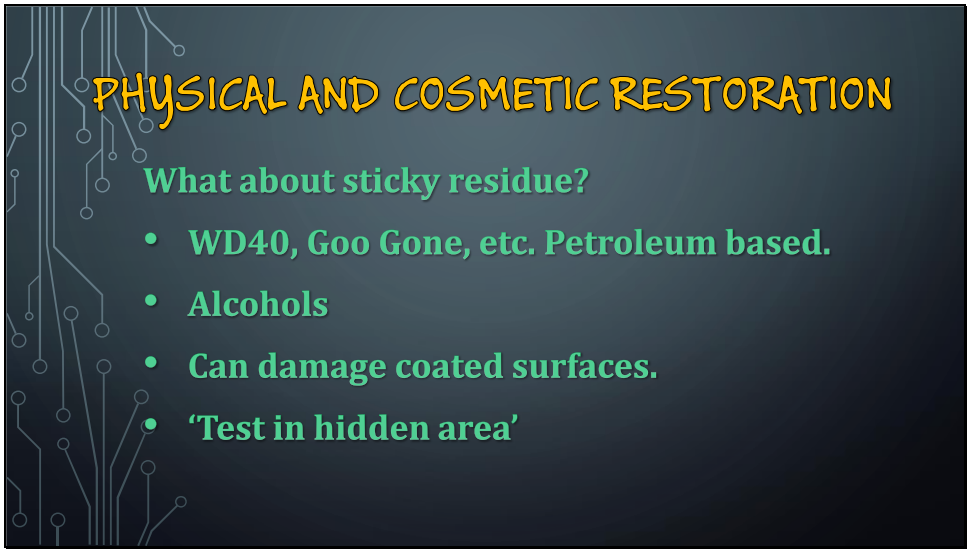
I like letting things soak in soapy water, especially things like keys which seem get pretty grubby. This makes them easy to clean. Smaller items call for smaller buckets, a cup is perfect for calculator /pocket computer keys. I'll take a key out of the soapy water, scrub with a toothbrush and then place it in an empty buck for later rinsing.

Of course after soap, water and scrubbing you want to rinse with clean water.

Slide 8

You can even wash circuit boards. I use distilled water for washing and rinsing here due to calcium in local water. Watch out for relays, etc. that are not sealed we don't want to get water inside them. Of course, let the board throughly dry before use. A final rinse with 99% alcohol can speed up the drying process.

Slide 9



There always seems to be some sort of sticky goo on machines & power cords. Solvents like WD40, goo gone, alcohol can be very helpful in removing these. Be careful as they can also discolor coated surfaces or even remove some paints. WD40 is usually pretty safe even if not the most effective or fastest acting. I have found alcohol and silver paint do not work well together so 'test in a hidden area' as they say.

I typically start with soap and water and then clean the goo off. This means another round of soap and water where the goo was. I have had a few things that were so sticky that it worked better to git rid of all the goo I could, before soap/water. Sometimes you wind up doing both steps multiple times.

WARNING! Alcohol can damage some types of clear/translucent plastics and some types of rubber. It can cause crazing/cracking on clear/translucent plastic and hardening of some rubbers used for things like paper feed rollers.

Slide 10

Examples - Used WD40 to clean up glue residue left after removing the rubber strip on this TRS-80 Model 4P keyboard.

The TRS-80 PC-1 printer/cassette interface on the right (Sharp CE-121) had copious amounts of electrical tape and other goo all over. I called it the ‘the pig pen’ as both interface and computer were filthy. Found some betting slips in the velour lined case from Florida which a friend suspected might be from dog racing. I wondered if the original owner used the pocket computer for calculating odds?

Slide 11

It is very common to find corrosion from leaking batteries in portable equipment or desktop machines with backup cells. We also find this on circuit boards from leaking electrolytic capacitors.

The first step to cleaning is mechanical abrasion, i.e. scraping the crust off. If needed, we can use a mild acid or base to neutralize the residue.

Slide 12

A fiberglass pen comes in very handy for cleaning PCB corrosion, battery terminals, etc. Sometimes a wire wheel on a Dremel type tool can come in handy too. Sandpaper and ScotchBrite are also good to have to hand.

Slide 13

When we want to neutralize the remaining corrosive chemical residue. Most of the dry cell batteries you will come across will be alkaline, like alkaline AA cells. We'll want to use a mild acid like vinegar or citric acid to neutralize the residue and remove the corrosion. I like citric acid it comes as granules; a pound is about $9. Mix with ~1.25L of distilled water for a 40% solution. No smell, food safe.

Electrolytic capacitors have an acidic electrolyte. A mild alkaline solution like dilute baking soda, concentrated cleaners (purple power), etc. Ammonia is also alkaline but can react poorly with copper.

Slide 14

Examples - This is a sight we are all too familiar with. Batteries left in a device for years making a big mess.

If mild, corroded springs can be cleaned with abrasion and then citric acid. If you can't easily separate from machine mix ~10% glycerin to thicken acid and brush on. We can get a variety of replacement springs from AliExpress or can salvage them from a generic battery holder if they need to be replaced.

GTDBO!

Slide 15

This is a metal plate from inside a Sharp CE-150 cassette/printer interface for PC-1500/PC-2. After scraping the worst of the corrosion off, a solution of ~10% glycerin to citric acid was brushed on plate. Glycerin keep it from running but reduced effectiveness some too. That way I did not need enough solution to soak whole plate.

Slide 16

Plate was then painted grey. More on refinishing later.

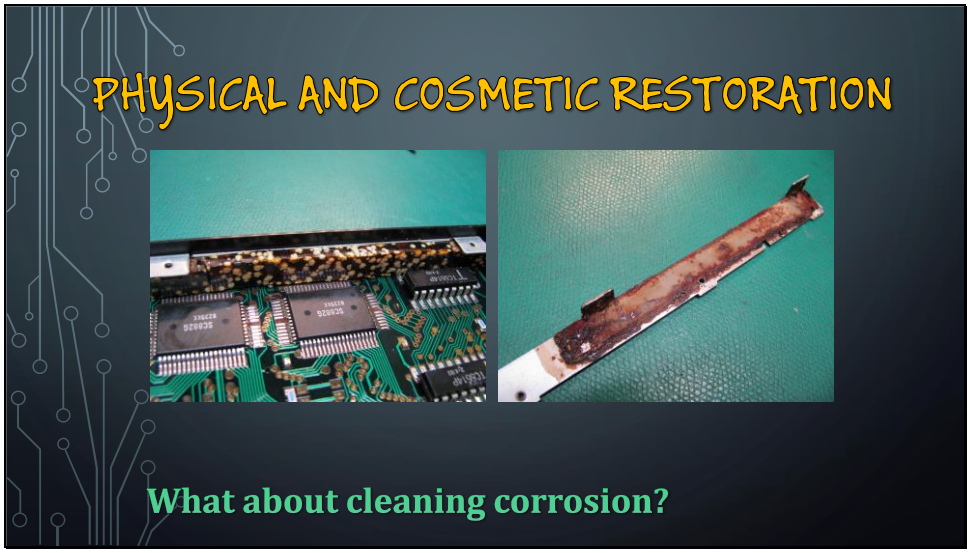
Slide 17

Leaking NiCad pack also attacks paint as we can see on this silver paint on exterior of sane CE-150. This was neutralized by wiping with citric acid and lightly buffed with a Magic Eraser, and it looked a lot better but not perfect.

Slide 18

Corrosion will also wick into wires. This whole ribbon cable was ruined, luckily clear plastic allowed problem to be seen. This also happens with battery pack leads. It is not unusual for corrosion to wick up a battery lead 100mm or more. I almost always replace battery pack leads if there is any sign of corrosion.

Slide 19



Corrosion can come from unexpected placed. For example, some TRS-80 PC-2/Sharp PC-1500 had this ‘moldy block of goo’ option. It seems to have been to brace the edge of PCB where LCD is. As this block molds it rusts metal plate.

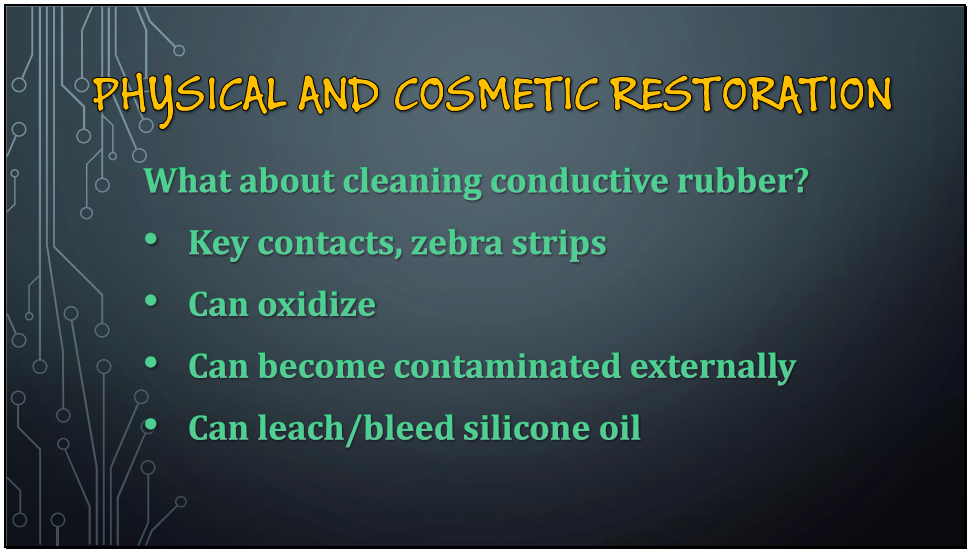
Luckily the plate is easily removed with three screws, so the moldy block can be removed, and the plate scraped treated and with citric acid.

Slide 20

Sometimes you can see corrosion from leaking electrolytic capacitors like this picture on the left. It may not look too bad but if you scrape along the trace away from source you often find breaks. The crud that was left looked like a trace but was not conductive.

You may need to scrape/brush joints before desoldering due to oxides that have formed. In this example the area was scraped with small flat blade screwdriver, then buffed with fiberglass pen, and cleaned with alcohol. For really bad areas I'll apply some concentrated alkaline cleaner to neutralize the acid. Then flush with water and alcohol.

Slide 21



Conductive silicone rubber is used in things like switch contacts and zebra strips for LCDs.

This rubber can oxidize when left open to atmosphere as in a switch contact. It can also become contaminated with grease/oil from external sources or internal sources.

Slide 22

Oddly, silicone can also leach or bleed silicone oil and contaminate itself. This can happen as a result of certain manufacturing conditions it may not be evident but in extreme cases can look like the rubber is sweating.

The black key switches on right high a high resistance due to being oxidized. The white one on the far right was contaminated externally with silicone grease.

Slide 23

I did a lot of research to figure out how to rejuvenate conductive rubber. I used contaminated Mitsumi key switches as I had many on hand and made a test fixture to allow for constant contact area and pressure so as to get a repeatable and reliable resistance reading. It is also, a handy tool for testing them in general.

There are industrial cleaners for this, unavailable to hobbyists. What we can do is soak the rubber in mild alkaline solution like ammonia, or concentrated cleaners like Purple Power. Soak time for ammonia 1-4 days for very high resistance contacts. A friend in Germany suggested (sodium hydroxide) lye+water, (1tsp+200ml) which works faster/better. Soak time 4-6 hours, rinse, maybe soak in alcohol to draw out water. Test.

Slide 24

Zebra strips are a layer cake of conductive and insulative silicone rubber and are conductive in the Z-axis only. Commonly used for LCDs and add on modules. Testing conductivity is a bit trickier. Can do so at home by using two scrap copper clad FR4 sheets with zebra strip clamped in between. You want to keep the conductive surface area and pressure equal. This lets you calculate ohms per unit area.

This cleaning process described also works for zebra strips for LCDs. Sometimes they have been in a compressed state for so long they won't 'spring back' and make a good contact again.

Slide 25

It can be a bear to get LCD glass lined up on larger panels. To help with this I printed some C-clamps to make this easier to clamp, test, reposition before twisting clamps on back.

Side note: If LCD has been used for long period of time with poor contact it can damage the glass itself.

Slide 26

For small keypads like remotes the conductive rubber ‘painted’ on. You can clean it and recoat with a conductive paint. This MG Chemicals product was the best kit I found but is now out of production. You can buy all the parts that were in it though.

Clean the keypad, apply thin coat of Super Glue on conductive rubber, this sticks well to the pad. After glue is cured cover it with a light coat of conductive paint. The paint sticks well to the glue. Let dry overnight. I did the keypad on the left about 3 years ago and it still works well today.

Slide 27

We'll shift from cleaning to physical repairs now and start with a simple but useful idea.

Many rubber feet on our old gear are just small discs of rubber. Rather than need to find the odd rubber foot of some random diameter from time to time you can get a small hollow punch set and a small strip of ~1.5mm thick rubber and make your own. I use the thin 3M double sided tape or E6000 glue to attach the new feet. It is easy to do, and you can make what you need on demand.

Slide 28

Plastic is a broad category of materials, there are many different types with very different properties. It's like cake; if I say cake, you have an idea of what I mean although there are many types of cake made with different ingredients. They all have different tastes, textures, etc. The cake that is, not the plastic! ☺

For example, nylon is almost impossible to glue, some plastics are very heat resistant. We can have different failure types on different plasltics which leads to different repair techniques.

Slide 29

We can divide glues in two broad categories: solvents and mechanical bonding. A solvent based glue uses a solvent like acetone which softens/melts the base plastic. We are chemically dissolving two pieces of plastic and mixing together the soft melted parts. This is sort of like welding in that you are modifying the base material. Examples of these glues are ABS/PVC pipe cement and glues made for acrylics as well as the model glue we used as kids. New model glue is junk, BTW.

Glues like Epoxies, Structural Adhesives, CA form mechanical bond. They flow into and stick to surface imperfections. The base material is not altered. This is sort of like soldering, where solder acts like glue but the base metal does not become molten. With these types of glues abrading the surface slightly with sandpaper provides nooks and crannies for the glue and creates a stronger bond.

Slide 30

Examples - We can have different failure types like stripped threads, cracked screw posts, or a chunks broken out of a case.

Slide 31

A brief aside while talking about stripped threads in plastic.

Plastic and sheet metal screws are NOT the same. Generally, screws for plastic have a blunt tip. They are coarser with a shallower root and designed to not split plastic.

Slide 32

There are pointed screws for plastic, but they are of similar design to the blunt type. These are used so the point can aide in centering the screw in the hole. Note the finer pitch and deeper grooves of the sheet metal screw.

TOP TIP: When reinstalling a screw into plastic turn it backwards with slight downward pressure. You will feel/hear a slight click as the screw drops into the existing threads. Now reverse direction and tighten the screw. This prevents cutting new threads into the plastic each time the screw is installed.

Slide 33

You can sleeve split posts with plastic, metal tubing, etc. The epoxied on sleeves make for a very durable repair. If the hole is stripped, you can fill stripped it with epoxy and redrill. You can 3D print sleeves for more complex shapes as shown on the right. PCB mounting post in white was machined form ABS plastic with a large base for gluing.

When gluing ABS to ABS a solvent glue, like ABS pipe cement or acetone can be used. For same or differing plastics structural adhesive like Devcon 22045 Plastic Welder or J-B Weld 50133 Plastic Bonder work well. I found the Devcon a little better but smells it worse and does not last as long in tube once opened as the JB Weld. Both are fine for our purposes.

Slide 34

This was a very busted up C64 case. Large cracks were solvent welded with acetone. A small syringe can be helpful for applying just a drop of glue.
Be careful of blooming, which is where the acetone seeps through the crack and spread out on the other side of the case altering the color. The inside surface sanded for a better bond and then mending plates were glued over the cracks to add strength.

In the right-hand two pictures I'm using a hot 'staple', a bit of non corroding wire melted into the plastic to act as a stich. They make tools for this that use stainless steel staples. I did not such a tool at the time. After buying one have only needed to use it on truck bed liner.

Slide 35

Cases often have clips that hold them together, replacements can be 3D printed to match complex shapes. You have to be careful of clearances and account for reduced strength of 3d printed parts. These clips are printed on their side, so the weaker layer lines are vertical. In this orientation the stress, which is vertical, in use won't cause delamination along layer lines.

Slide 36

What about when pieces are missing of a complex shape?

This is a TRS-80 cassette deck they sold to accompany pocket computers. It had been dropped and the plastic retaining the heavy motor was shattered. I glued in the remaining pieces use acetone to solvent weld. Then the area was built up with baking soda and superglue in alternating layers. Mixing baking soda and super glue causes an exothermic chemical reaction which results in a hard, somewhat machinable material.

Slide 37

This is a messy process as you can see. A syringe needle used here to keep screw hole open. The area carved to shape with Dremel tool and files then the hole was tapped with self tapping screw.

As an experiment I covered with Sharpie marker to make it look a bit nicer. A bit messy but works great does not require special equipment.

Slide 38

When we get into metal work often the tools required get larger and more expensive.

A few tips: Tin, brass and copper can be soldered. Structural adhesives also bond well to metals and can be a great way to fasten metals together.

Slide 39

Examples - Metal work can range from removing corrosion and refinishing, to fixing a loose corner of a cover, or even manufacturing replacement parts.

On the left we have the metal plate which was corroded by a battery leak and clean up and repainted.

Another problem we often have is the corner of a metal face plate starting to lift in a corner. I have found that these can be stuck down with thin double-sided tape. I like this 3M tape as it seems to be similar to the type of adhesive used originally for things like faceplates and rubber feet.

Slide 40

Example - And you can get into more extreme repairs which requires more tools ☺

This is a Microcassette deck from a Convergant Workslate. There were used in all sort of answering machines back in the day. This one is a bit unique in that it uses a stereo head.

The little nub on bottom of pinch roller arm sheared off and I wanted to find a way to repair it.

Slide 41

I’m using a small benchtop Taig micro lathe here. A blank arbor drilled and tapped to accept a small screw for machining. Threads removed to reduce shaft to diameter of broken nub of pinch roller arm.

The part we are after here is the threads which are in the arbor and about 2mm of smooth shaft sticking out.

Slide 42

The pinch roller arm was then drilled and tapped to accept the screw. The screw installed w/thread locker then the head of screw cut off leaving only our nub.

This fixed the mechanism mechcanically but could not get computer to properly work.

Slide 43

On the left is the ubiquitous Alps printer/plotter mechanisms which was used in dozens of printers over the years. These all have the same problem, the pinion gears on the stepper motors are always cracked. There were reports of mixed success with 3d printed parts, these tiny parts are hard to print. It is hard to get the ID correct.

After a lot of searching found manufacturer who could reproduce these gears in brass in smallish (1,000) quantities at good price.

Today there are several companies offering various prototype services online: 3D printing, CNC machining, sheet metal work, even low run injection molding. This opens up many possibilities.

Slide 44

3D printing has taken the hobbyist realm by storm over the past 10-15 years. The equipment has gotten better and more affordable allowing us to create very complex parts at home.

There are two main types of 3d printers in the range of hobbyists:
3D printers that use a roll of plastic filament: FDM
3D printers that use a UV curing resin: UV light can come from UV light source through LCD or laser.

Some companies also offer 3d printing services where powered plastic or metal is fused together with a laser.

Slide 45

These repair parts were printed on a limited quality FDM printer. They are perfectly functional though.

Slide 46

These cases were made with a better quality FDM printer and are examples of making new parts for vintage gear.

On the left we have a Backpack drive, a SD card ‘disk drive’ with a serial interface which works on many vintage computers. On the right we have a 16K RAM expansion for an Epson HX-20.

Slide 47

Back to our old friend the Alps printer/plotter mechanism. The second most common failure is a broken Y-axis (paper feed) anti-backlash gear set. The hub cracks similar to the pinion gear and the spring perches can also break. If just the hub is cracked, you can sort of patch it with 3mm hose clamp with ears cut off. I used a Dremel tool to cut the ears off. The resulting spring loop is installed on the hub and provides enough of a squeeze to hold it too the shaft. That is what we seen in the picture on the left.

The right most two images are replacement gears on cheap resin printer. To give you an idea of scale the gear is about 12mm in diameter and the text is 1mm tall, 0.1mm deep.

The resin printer provides a lot more detail, they are much more messy, more expensive to operate, and the selection of resin/properties is not great. The resin selection has been getting better over the years though. I got lucky with resin I happened to choose for this project. The other resins I tried later did not provide the detail needed.

These resin printed gears are more brittle than the original nylon and might not last forever, but it beats having a broken printer.

Slide 48

The subject of refinishing sometimes can evoke a strong emotional response.

I have equipment I have left untouched with stickers, etc. as it was parts of its history. I have refinished other equipment. It is yours do as you see fit. My intent is to impart factual information to allow you to make an informed decision.

Slide 49

Let's broach this subject with something less controversial, that is polishing plastic.

Slide 50

Example – Polishing a LCD screen cover

Novus is my favorite brand of plastic polish. When polishing clear plastic, you might not be able to take all scratches out, but you can make it a lot better.

I'm using blue painter's tape to mask off where the polish should not go. Polishing is simple, clean the plastic, apply a dab of polish, wipe polish on all areas of plastic using light pressure and small circular motions. When it starts to dry stop polishing and buff off with a clean rag. Repeat as needed.

Follow up with Brillianize or Novus #1. Brillianize leaves an antistatic type coating.

Slide 51

Example - Here we have some key caps that faded on side sun hit them. Darker colors tend to not Retr0Brite well, what to do?

Slide 52

I used same process as for polishing plastic headlight covers on cars. Scuff the surface with a very fine sandpaper, polish at LOW speed with Novus 3->2, repeat. I'm using a stack of Dremel polishing pads here in a battery powered drill. The drill run on slow speed works well for this. The Dremel is too fast and will melt the plastic.

These keycaps are double shot injected, the test on the top is not a paint or decal so the tops of them could be polished too. Of course, if you try this on plastic with paint/decals on it you will ruin said paint/decals.

Slide 53

On the left is polished key and on the right is a faded key. I then like to coat keys with 303 Protectant and let it ‘soak in’, i.e. wet the surface. Then wipe off and buff with dry rag.

Slide 54

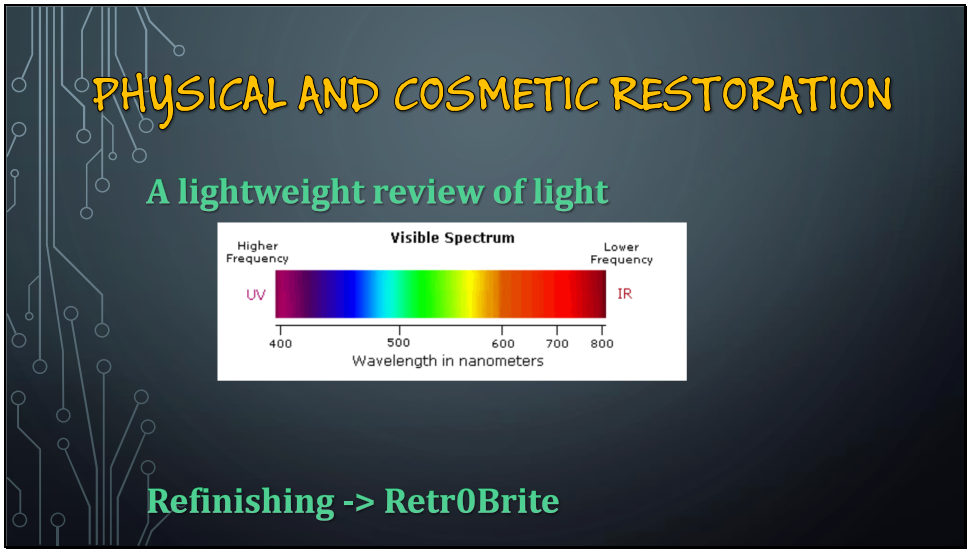
Nothing has generated as much controversy, speculation or myths than Retr0Brite.

“It destroys plastic!!” “It will yellow again in a few months!!”, “Your hair will fall out!”

I thought it was a crazy idea when I heard of it. Using UV to remove the yellow from plastics, that silly as everyone knows UV destroys plastic. Not being one to believe in myths I wanted to learn how it actually worked which started months of study and experimentation.

NOTE: Before any refinishing the parts need to be clean, very clean.

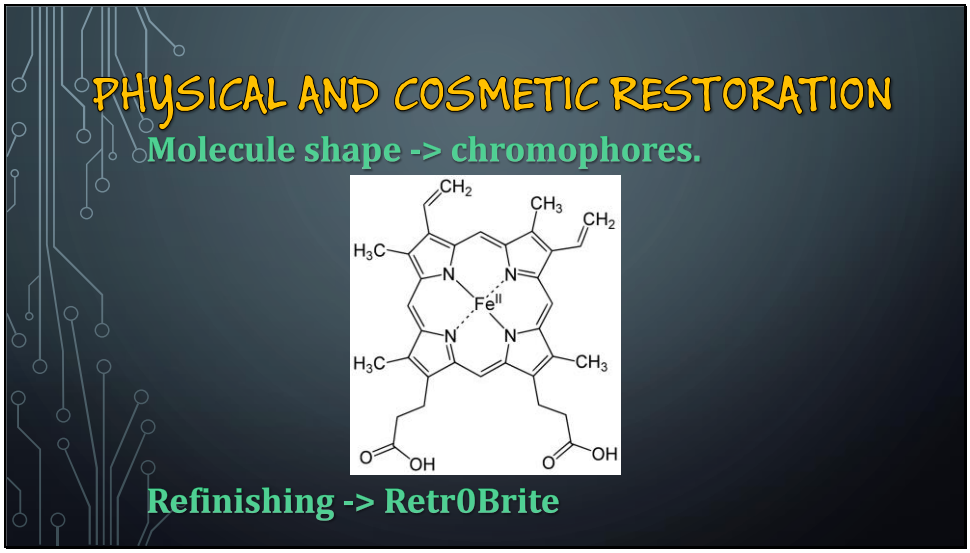
Slide 55



Before delving into what the Retr0Brite process does let's refresh our memories about light itself. White light made up of many different wavelengths/colors. When this white light hits an object, some of the wavelengths are absorbed and some are reflected. We see those wavelengths which are reflected, thus if an object reflects mostly blue light, then we would identify it as being blue. Its a bit more complicated, but this is a fairly accurate description that is adequate for our purposes.

On the subject of yellowing plastics UV light is of particular importance. We break UV into three wavelength bands:
UVC 100-280mn is absorbed by upper atmosphere which is good as it is dangerous, used for killing germs
UVB 280-315nm some does get through atmosphere. Erases EPROMs, causes sunburn, causes sun bleaching, is blocked by window glass. Can't get sunburn inside.
UVA 315-400nm your classic blacklight. UVA will pass through window glass

Slide 56



The arrangement or shape of a molecule, that is how the atomic bonds form between atoms, effect the color we see. These feature are called chromophores.

Plastic that has yellowed has had the atomic bonds of the chromophores changed in manner that shifts the reflected spectrum toward yellow.

Slide 57

Yellowing process is a naturally occurring chemical reaction. It takes place in the dark too. The reaction alters some atomic bonds changing the chromophore's shape, shifting color toward yellow. There is nothing that can be done to stop it. However, certain conditions can cause it to happen more quickly, and some things can also be done to slow the reaction down. Adding energy increases chemical reactions. Energy can come in form of heat or light. Shorter wavelength light, i.e. UV has a higher energy.

Slightly different plastic mixtures yellow differently, Nintendo on left is original same exposure and environment but parts have yellowed differently.

Slide 58

For example, some fire retardants containing bromine have been shown to cause a marginally faster reaction/yellowing. Somehow the connection was made that since bromine is yellow it must be the bromine making the plastic yellow as it 'leaches' out of the plastic. The myth was born 'it's bromine's fault'.

Fact: Bromine evaporates instantly at room temps. If any 'leached out' it would immediately evaporate. Raw plastic with no bromine also yellows. Bromine is not the cause.

On the right here is a VIC-20 case the worst example I have seen. It was almost the color of cheddar cheese.

Slide 59

The Retr0Brite process involves using hydrogen peroxide and the addition of energy to shift the chromophore bonds back toward blue. Energy can be added in the form of heat and/or UV light. This increases the rate of the chemical reaction and speeds the process up. Part of my research was to measure the effect of temperature, H2O2 concentration and treatment time on the whitening process.

Slide 60

I prefer immersion in a tank heated with seedling heat mats surrounding it as it is controllable and repeatable. Bottles in tank shown here are filled with water and just used to take up space so less H2O2 is needed. Some folks use a UV 'grow lamp'. Light is directional so you need a reflective box. Some folks will set container outside in bright sunlight. Some people also just use sun bleaching with no H2O2.

Spoiler alert, Retr0Brite is just a bleaching process. Some folks might then ask, "Is bleaching plastic harmful to it?". I like to reckon this to bleaching your socks. Does bleaching your socks destroy them? If I let me socks soak in bleach for years on end, perhaps we could show some type of detrimental effect. Bleaching my socks every few washings will have no noticeable effect. They will be worn out by use, not bleach. The key here is considering the treatment time in hours compared to the yellowing time in decades.

Slide 61

Case study, pardon the pun.

This case was the worst example of yellowing I have seen. It also had cigarette burns, etc. I decided to try an extreme Rer0Brite session of one week, at 40C with a 6% H2O2 concentration, to see if it would turn this sad old case into mush.

From left to right: Original, day 1, day 2

Slide 62

Day 3, day 4, day 5

Slide 63

Day 6, day 7

The case looks much better. All the physical damage to case it had when I started is still there. The only spots that got worse were the cracks in the grill opening up a little more. These cracks are the result of heat from the internal heatsink. In hindsight it may have helped to repair these cracks first.

Slide 64

Conclusion - It looks a lot better than it did. All physical defects present when I started were still there.

There is a European museum paper on subject of the RetroBrite process. They tried it on different plastics taking detailed photographs and thought it ‘may’ contribute to some surface changes. I suspect that as in my case though surface defects were hidden by the dark yellow color and made more plainly visible once treated.

In either case, I am not a museum. I use my computers, I do not wear gloves when handling them, etc. Our objectives are not the same and that is OK.

Slide 65

Some folks also have strong options about painting vintage equipment. Again, I have some thing I have left untouched and other things I have painted.

Why would we want to repaint something. One use case I have is 'Retroflage', that is to make newer parts match a vintage machine. If you have a badly broken case, it might need filler in cracks to replace the crumbles that went missing, a good paint job can hide this. Some folks enjoy personalizing they equipment with wild colors, this is not my thing but whatever floats your goat.

I'll repeat it again, cleanliness is important here. Clean the part very well with soap and water then wipe it down with 99% alcohol to remove any last trace of grease/oil.

Slide 66

Examples - This is one of my main uses for painting - RetroFlage, making a light grey Gotek and 3.5” adapter blend in with black vintage drive bay. I also kept the LED display as it looks more period correct that an OLED display.

Slide 67

When painting you want to use a good quality paint, with light coats. Check the can so see what time intervals it recommends for recoating. If you are not familiar with spray apinting practice on something else first.

Top Tip: to remove paint from plastic without harming the plastic you can use DOT 3 brake fluid. Rags soaked in DOT3 placed on painted surface will soften pain after several hours. This is safe for most plastics, but ‘test in a hidden area’ as the warning says.

Slide 68

I hope this talk has provided some ideas and food for thought. If you have any questions I'll do my best to answer them.