VINEGAR SYNDROME (1)

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Attack of the Vinegar Syndrome
An in-depth examination of the insidious virus that is eating away at America's cinematic heritage.

By Les Paul Robley

Unbeknownst to many, our American film heritage is deteriorating with each passing year at an alarming rate. Film archivists have estimated that a whopping 75% of all U.S. silent films have been lost through deterioration or improper storage
procedures, and that 50% of all films made prior to 1950 are gone. In addition, many much more recent works lie in vaults, wasting away to the point where the negatives have become corrupted.

If steps are not taken to reverse this trend, some of the cinema's seminal works may be lost forever. The purpose of this article is to offer an in-depth explanation of the degradation process, in the hopes that detailed information on the seriousness of the problem will encourage studios and filmmakers alike to take measures to preserve and protect our collective film history - and future works - from further harm.

When cellulose triacetate base safety film was introduced in 1948 to replace the highly flammable nitrate stock, everyone thought it would outlast its deteriorating predecessor by leaps and bounds. Collectors of IB (Imbibation) Technicolor three-color strip dye-transfer prints believed 9 that they had invested in something that would outlive them in terms of non-fading color and image excellence. Unfortunately, this not the case as both cellulose nitrate and acetate have a built-in inclination to degrade. Some nitrate films have even lasted longer than safety film prints.

The first reports of triacetate degradation were discovered by the Eastman Kodak Company in the Fifties. Film from the government of India had been stored in a hot, humid environment which adversely affected the chemical stability of the plastic
film support. Subsequent laboratory experiments by Kodak in high-temperature incubation ovens confirmed that improper storage of safety prints would yield cellulose contamination.

The dilemma was outlined by Anthony Slide in his book Nitrate Won't Wait: Film Preservation in the United States. He writes: "For a number of years, archivists have been noticing the pungent order of acetic acid emanating from some safety films, evidence of the film stock's deterioration. Because of the smell, the phenomenon has come to be known as 'the vinegar syndrome'... In 1991, [Kodak] revealed that safety film deterioration 'derives from the same chemical mechanism (hydrolysis) and the same triggering factors in the environment (heat and humidity) that nitrate decomposition does.' Without the hoopla and publicity surrounding nitrate film decomposition, it transpires that safety film has also been decomposing with the same finality."

Kodak disclosed to the press that "'vinegar syndrome' is a common term used to describe the chemical reaction occurring during the natural deterioration of triacetate film base in a sealed container."

According to Kodak, when cellulose triacetate begins to degrade, acetate ions react with moisture to form
acetic acid, producing the characteristic odor. In layman's terms, one 1000-foot (10-minute) roll of 35mm motion picture film can generate the equivalent of 250 teaspoonfuls of household vinegar! The acid attacks the film base and accelerates image color dye fading.

All freshly manufactured acetate film carries with it some level of acidity by the very nature of its composition. Hydrolysis is the reaction by which moisture in the film (water) cause it to decompose as the acetyl groups in the cellulose molecules become detached. Temperature and humidity both play important roles in regard to this liberation of free acetic acid. The room humidity controls how much water will be absorbed by the film, and the temperature affects not only color dye stability,
but also the speed with which the chemical reaction takes place.

Excessive heat causes the shrinking and expanding of the base in conjunction with the less-affected emulsion layer, causing the latter to flake or crack. High humidity not only invites vinegar syndrome, but also Promotes mold-growth on the
gelatin emulsion. As the base shrinks, the emulsion gives way and the film becomes warped to the point where it cannot travel through a projector or printer. Seriously buckled film not only releases a sharp vinegar odor, but exudes plasticizers out of the plastic base. These resemble shiny slivers or crystals which have oozed out of the base onto the reel or emulsion surface of the
film.

Another, easily recognizable physical indication that alerts one to a badly decomposed print is when the film refuses to wind tight on a reel, or lies "unhappily" across your splicer. The effect when viewed from the side on a shipping reel is like a hexagonal "spoking pattern whereby the film will not lie flat when wound in a certain emulsion-in-or-out orientation. By the time this happens, the film is unusable and is ready for the rubbish bin. So far, no one has discovered a way to reverse this process and bring the suffering print back to a salvageable level so it will run efficiently through a machine. But one can save a
film that is in an early stage of vinegar syndrome and prevent it from getting any worse. Prevention is the name of the game, and a film with only a slight smell" can still offer years of use and entertainment.

The vinegar problem was reviewed in 1990 by Kodak research scientists Dr. A. Tulsi Ram and N.S. Alien in various scientific papers claiming that the reaction was acid-catalyzed, meaning that once the degradation began, it fed on itself at ever-increasing rates. This led to the popular theory that an infected film can affect other healthy prints. When the acetic acid (vinegar) leaches out of the plastic film base, it either evaporates into the air, or it can be absorbed by the surrounding storage container. The effects of this process can be seen in the rusted enclosures of metal film cans encasing vinegar prints, or the embrittled paper surrounding them in shipping cases. The acidic fumes are very volatile and can be measured using A-D (acid-detecting) strips inside the fiber cases, polyethylene bags or cardboard microfilm boxes which formerly contained fairly
degraded stock, long after the film itself had been removed. If the degraded film is contained in such isolation for a long period of time, the acid can become trapped. Being autocatalytic, this greatly accelerates the degradation process.

Similarly, "healthy" fresh film has been found in some cases to absorb acidity from deteriorating prints kept in close proximity. This, in turn, is thought to accelerate the rate of degradation in the fresh film. While there remains some argument as to the extent to which the absorption of acidic vapor motivates the degradation of fresh film, it is believed by most archivists that segregation of the diseased print is the safest policy in protecting a film collection.

While it is not always possible (or pleasurable) to sniff every print in one's collection (the vinegar odor is strong and can lead to health problems, namely throat and skin irritations), one can assume that all collections of old safety film carry with them some degree of vinegar sickness; knowing which ones are at a
higher acidic level than others can prevent the spread of the disease. Storing film in a well-ventilated area, as some archives do, can help lower the level of acetic acid in the storage area. The Image Permanence Institute of Rochester, New York (IPI) sells a Storage Wheel (along with their A-D Strips) which is based on the worst-case-scenario -- the acid-trapping factor of film stored inside a tightly-closed container. The wheel details the effects of temperature and relative humidity (RH levels) on fresh acetate film, as well as film which has already degraded beyond a 0.5 free acidity level, the deadly autocatalytic point of film on the road to vinegar syndrome.

Based on results achieved with this system, IPI claims that new film stored at 50% RH in 70' Fahrenheit (normal comfortable room conditions) will take approximately 40 years to reach 0.5 acidity. The colder and dryer the environment, the longer the film will last. For example, film stored at 55`F, 40% RH may not suffer the onset of vinegar syndrome for 150 years. Films kept in very cold conditions (below 50` at moderate RH levels of 20 to 3070) can be expected to last for centuries. In fact, merely a 10` decrease in storage temperature may increase your film's existence by a factor of two. Even though water is a primary reactant with regards to vinegar syndrome, storing films below 20% RH is not recommended, as the dry conditions can lead to brittleness in the base of the stock. Without some moisture, the film might break apart when handled or run through a projector. Too much dryness also increases film curl and warpage.

There is a twist, however. Some film collectors who have stored film in their warm household closets have movies they know to be more than 40 years old, but which show no apparent signs of deterioration. Also, many film archivists know of films that are 40 years old but still in good condition. But it's important to remember that the IPI chart is simply a means of prediction, and that collectors do not always know how a film has been stored before they have appropriated the print. IPI assures us that the 40-year prediction is merely an approximation of the years to the onset of measurable deterioration, and not the number of years that the film will be able to last through a projector. The wheel acts as a guide with which to analyze, relatively speaking, how much better or worse one storage environment is in comparison to another.

Since nothing lasts forever, the converting of film information to a digital environment for long-term archival storage may not be such a bad idea. In the long run, opponents of videotape and laserdiscs - mediums which have also shown problems in quality and durability, what with tape disintegration and disc sides unbonding - may be grateful for electronic storage mediums. Even if video afforded a suitably high resolution, the physical characteristics of the tape itself indicate that the image will deteriorate quicker than a film image. Thus far, black-and-white color separations have provided

the best means of preserving original color negatives, but Problems with registration of the three elements come into play if the three films shrink by different amounts during storage.

Of course, new technology may not always be the panacea that it first appears to be. For example, low-fade LPP color stock was once ushered in to greatly improve the cyan limiting dye-factor in earlier 5383 or 5381 Eastman color print films. The improved cyan dye was expected to last up to 50 times longer than that of a conventional magenta-stable Eastman print. But even prints manufactured just 12 years ago have begun showing some loss of cyan density in the black area of the transparent image. In a properly timed print with good contrast, the black area should be composed of equal densities of the three dye layers. The extent to which the cyan layer has a lower density than the more stable magenta layer in a faded print represents the amount of fading which has occurred in each layer over the years.

With regards to dye stability, nothing seems to have outlasted the old Technicolor Imbibation process of three-strip dye-transfer printing. The popular story among film collectors is that Technicolor labs phased out IB. printing in Hollywood because the trend in print orders gravitated towards smaller numbers of release prints, making the complex Imbibation process less economically feasible. Star Wars was probably the last big feature made in IB by England's Technicolor Labs, a company which used the process a few years longer than America before selling it to the Chinese in the late Seventies. China embraced the process because it made their Communist country less dependent upon foreign suppliers of color film stocks. The Chinese were able to manufacture the raw stocks required for Imbibation printing, but the resultant dye-transfer release prints suffered in image quality due to poor lab conditions, prompting the discontinuation of the process in 1994. At any rate, the very nature of the IB process made it less likely to achieve the degree of sharpness that is possible with the integral tri-pack films used in modern processing techniques.

Despite the superiority of dye stability in IB Tech prints, Jim Harwood, vault supervisor of the Kodak's PRO-TEK film preservation facility in Hollywood, points out that these films have been found to be more prone to vinegar syndrome than those using standard Eastman color processing, mainly because higher amounts of certain acids are used in the final wash. In addition, IB prints made with the Fifties' four-track stereo process, such as Oklahoma!, pose a double threat. In these older 35mm mag prints, the magnetic stripe used for the additional sound channels acts as a catalyst in accelerating the vinegar syndrome. The iron oxide (like rust) speeds up the chemical reaction, causing these acetyl groups to split apart even more, releasing the acetic acid and subsequent vinegar odor. Keeping the film in a confined place, such as a lab can or shipping case, accelerates the process further, to the point where the reaction begins to feed on itself, exhibiting the autocatalytic behavior described earlier.

Collectors often wonder why Technicolor does not revive the older IB process, making it less susceptible to vinegar onset using today's technology -- particularly in view of its superior dye stability. But as mentioned earlier, there was a time when the dye-transfer process was no longer considered to be commercially viable. The older printing machines were very labor intensive, and it sometimes required eight men to operate one printer. For the technique to work in the present, the printers would have to be completely redesigned to be competitive with today's faster printing process, and would demand the expertise of individuals who retired from the film industry long ago. Also, single print orders by low-budget producers would make the process less advantageous due to the amount of work involved in setting up one printer. For the process to become feasible again, only big pictures commanding large print orders would have the clout necessary to dictate a renaissance in the IB

process. Still, there may yet be hope for IB's future. There has been talk of it being revived for use in selected road show runs of newly restored classics.

All this being said, what can low-budget producers or film collectors do to make sure that the items in which they have invested last at least through their lifetimes? For now, the best advice for collectors of old IB Tech product, which may or may not carry the dreaded "smell," is maintaining a proper, climate-controlled storage environment. Temperature plays a key role in slowing down the chemical reactions within the film. If cold storage proves economically impractical, a constant 70" temperature is still better than one which fluctuates continually.

"The absolute worst thing for long-term film storage is a fluctuating environment," reiterates Jim Harwood. "I have been in facilities where the temperature has varied wildly by 20 degrees on a daily basis."

For this reason, outdoor tin storage sheds, uninsulated garages, attics and public storage facilities are definite no-no's when it comes to preserving a valuable film collection. Even though a 70" office environment isn't great for color storage, it does less harm than one which fluctuates continually. As mentioned before, temperature equilibrium for film changes quickly (sometimes in a matter of hours), causing the film base to shrink or expand. The slight temperature changes found in an ordinary household should not result in any physical damage to the film. However, the conditions maintained in some PRO-TEK vaults can be as low as a constant 34"F, 25% RH. According to IPI's acid wheel, this will effectively slow the doubling of acidity in a print which already has a 0.5 acidity level for roughly 500 years.

It's also best to avoid treating or rejuvenating prints with a scratch-removal process. Treated prints seem more prone to vinegar syndrome than untreated ones. Since IB prints are a valuable commodity on the collector's market, many have been treated with a substance using the same index of refraction as the film to "fill-in" the scratches and thereby maintain a scratch-free appearance. (Base scratches on a positive release print normally refract the light, which makes them look black on the screen. Some emulsion scratches fill with dirt, and after ultrasonic cleaning and scratch-removal, turn white when projected.) One SR process used polished ground glass to effectively sand down the film base, after which it was treated with chemicals.

"Some film rejuvenation of IB Tech material, for example, can accelerate the autocatalytic process," warns Harwood. "Apparently, some of these [so-called] rejuvenation techniques chemically add something to the base that just doesn't mix. I had heard of one process with a bit of acetone in it. All of these various companies that do scratch-removal use different combinations of chemicals, which is one reason for thinking that certain types of treatments will cause [problems.] I don't know if anything scientific has been done on it, but I do know of collectors who have taken a reel of film in for scratch-removal, and then found, years later, that it's the one reel which has vinegar problems. From an archival standpoint, no one in the archival industry likes to treat original negative or preservation elements with any form of rejuvenation, because they don't know what the long-term effect will be."

How does one know if a film has been treated? The nose knows, and often the easiest way to find out is to sniff it and see if you can detect any odor. But what if the degradation process is underway, and it hasn't yet gone vinegar? Or the rejuvenation smell has long since vanished? It is often impossible to

pinpoint an odor within a massive collection harboring many different solvent smells. Plus, one can become desensitized after breathing the odor for prolonged periods, or risk hazards to one's health.

One fanatical collector I met in Europe actuary uses his dog to sniff for treated prints, much like customs agents in airports use canines to sniff for narcotics. Another in Holland swears that one can use a magnifying glass or microscope to look along the edge of the soundtrack and pinpoint whether there is a coating on top of the picture area, since the process is normally limited to the image area projected on screen. Many collectors complain that they have encountered the most problems with vinegar from prints made in the Fifties, an era in which the earliest examples of Kodak triacetate safety film were made commercially available. Being an old stock, perhaps it's showing all the signs of decomposition. (The obsolete diacetate stock is even older and has its own set of acidic problems.) It's also possible that these stocks were once treated at one of many questionable West Coast rejuvenation facilities.

The problem is hardly exclusive to the West Coast, however. Many Fifties-era prints, both color and black-and-white, have experienced vinegar syndrome, which occurs with all types of film stock -- Kodak, DuPont, Fuji, and so on. The one certainty is that all improperly stored acetate films will eventually succumb. A SMPTE Journal of May 1992 concludes that "the chemical stability of different cellulose ester-base films is generally quite similar. There have been reported cases where films from a particular manufacturer, or which were made during a certain time period, have poorer stability. However, there is no evidence to suggest that diacetate, triacetate, or mixed esters have inherently different stabilities because of their chemical differences."

If treating a film can affect a print adversely, what about coating it with film cleaning solutions, such as Vitafilm or trichloroethane? "There have been no known cases that I have heard of involving the commercially available cleaning solutions containing trichlor, which we use here at PRO-TEK," says Harwood. "Trichlor is very volatile and it evaporates very quickly, so it doesn't soak into the base of the film. It's more of a surface cleaner. Vitafilm tended to get into the film base somewhat, but I've known collectors who have experienced no problems after treating their prints with it. The only problem I've heard relating to Vitafilm was that it sometimes caused the IB dyes to run."

Vitafilm is no longer available, and trichloroethane (also known as methyl chloroform), used for years in film labs, will also no longer be an option. Due to potential ozone depletion, the world's environmental science community recommended a cease in the manufacturing of this solvent after 1995. Some suppliers can still be found, but access to the solvent will soon dry up. Instead, the film community will have to look for other nontoxic solutions, or rely on the PTRs (particle transfer rollers) and web cleaners used in local cinemas to clean theatrical release prints.

One collector thought that encasing a vinegar print In 3M's Photogard process might stop it from emitting the acetic gas. (Photogard is an expensive process that coats a protective layer around the film to prevent it from being scratched.) But just the opposite occurred. "Labs would routinely put it on their dupe negatives and release prints," admits Harwood, "but, from an archival standpoint, it's not used if at all possible on unique masters or original negatives. It's almost like encasing the film, or laminating it, and what [this particular collector did] was to trap in the off-gassing that was occurring within the print. He was suffocating the film. But as to whether or not it causes vinegar syndrome, I don't think Kodak has done any tests on it."

Remember that vinegar syndrome is autocatalytic; safety film needs to breathe. It's meant to be run, not Placed on a shelf like a book. This is why archives tend to spend their time rewinding prints from heads to tails and vice versa at least every six months. Kodak recommends that a reel of print film be maintained in an emulsion-in orientation (tails-up for most 35mm theatrical release prints) from the time it was originally processed. They claim that the projected image is greatly improved, as there is less focus drift or tendency toward flutter. But some disagree with this, believing it is best to occasionally reverse the wind to allow the film to curl naturally.

Some archives prefer a large, well-ventilated space for storing film material. The rolls are kept on cores in cardboard containers which allow the film to breathe and any acetic vapor to escape into the air. Last July's SMPTE Journal on the "Stability of Cellulose Ester-Base Photographic Film "-demonstrated that film will show greater stability if the acid is allowed to escape. When film was incubated while free-hanging in a 90`C, 50% RH oven, lower acidity values were obtained. This allowed easy evaporation of the acetic acid, thereby reducing the autocatalytic effect. When freely exposed to air for a week, film with an acidity level of 5.4 dropped to 1.7. This simple test illustrated that the higher air-to-film ratio afforded easier escape of the acid from the print, slowing degradation.

Others argue against the idea of open-air storage. The big problem with this method is that it leaves the film susceptible to external elements that might come along - water damage, chemical contamination by air pollutants such as ozone and nitrogen dioxide, smog, carbon monoxide, fire, etc. In companion tests, Kodak discovered that open-air storage of film can lead to attack by atmospheric contaminants that damage both the film base and the dyes that form the image. But the IPI Storage Guide for Acetate Film counters that "pollutants originating from storage enclosure materials have a very strong effect on silver and dye images, although they are not usually a significant factor in chemical deterioration of film bases." The guide points out that "real-life storage may involve more opportunity for the acid to escape; if that is the case, it will take longer for vinegar syndrome to occur.

Since a real-life scenario for motion picture film usually involves a changing environment rather than a steady one, the Institute has evolved a "Time Out of Storage Table" detailing the effect of changing climatic conditions on acetate film. The table reveals that removing a print from a vault for 30 days for exhibition can decrease the time in years it will take for the print to reach 0.5 acidity. Although dyes fade when exposed to bright light, the brief amount of time when the film is projected inside a hot film gate - even when it is shown hundreds of times - is probably not a significant factor.

The guide recommends that film be stored inside containers that are "chemically inert" toward the components of film. It points out that much damage has been done by reactive, poor-quality papers, adhesives and cardboard. Tin shipping reels and rusted metal shippers should be avoided for the storing of film. The metal reels bend easily, thus scraping the film on feed or take-up, and the metallic bits can flake into the print, damaging the emulsion irreversibly. Rusted metal can also act as a catalyst in the furthering of vinegar syndrome. Alien and Edge, in their Photographic Science papers, observed that still film degrades faster in a tin-plated iron container than in an aluminum, polyethylene or glass receptacle. Plastic reels and cases don't share these problems, but the jury is still out on whether or not the material can react harmfully with the film. Certainly plastic burns very easily in a fire. FPC, the "sales arm" for Kodak, sells metal film cans which have been treated with an inert, non-reactive paint designed exclusively for the storage of contaminated film. They also sell -- and use, in the PRO-TEK vaults - molecular sieves.

Explains Ken Knaus of FPC: "Molecular sieves were recently developed by Kodak scientists and represent a real breakthrough for film preservation. They are like small chemical sponges which minimizes the effects of vinegar syndrome. The sieves, which are inserted into the film cans, absorb moisture and other contaminants released during the natural aging of the film. This new technology will significantly extend the life of films."

Molecular sieves belong to a class of compounds known as zeolites, some of which can selectively absorb water, acetic acid and methylene chloride. The sieves resemble silica gel packets shipped with cameras and electronic equipment. When placed in water, they absorb moisture and become very warm. Five to six packets are generally placed with every 2,000-foot roll of 35mm motion picture film, and each will last for several years, depending on storage conditions. For Kodak's research, a specified sieve compound in polypropylene packets was placed within sealed film storage cans and tested using accelerated aging techniques.

"We can significantly slow the degeneration of motion picture film by controlling temperature, moisture, acids and vapors from the atmosphere surrounding the film," adds Harry D. Heuer, manager of special markets for Kodak Motion Picture and Television Imaging. "The molecular sieve is the tool used in conjunction with current recommended storage practices to achieve that control."

Whether or not the sieves will actually help a print already infected with vinegar damage is too early to predict. But Kodak is quick to point out that sieve technology provides added protection and is not a replacement for industry-accepted archival storage recommendations.

But one thing upon which everyone seems to agree is that storing a harsh-smelling print inside a closed container alongside fresh film is like signing the new film's death certificate. The autocatalytic behavior will likely cause faster deterioration in the good film. Sandwich experiments conducted in the same SMPTE Journal indicated that "undegraded cellulose triacetate base film will absorb acetic acid from adjacent degraded film, and that physical contact is not necessary for absorption to occur." It's Probably better to isolate the vinegar film in a cool, open-air environment where it can release the odor without causing harm to other prints, or discomfort to people. The technical paper went on to suggest that film vaults be designed to either absorb acetic acid, or allow its free release. Continual air monitoring to detect the presence of film-base decomposition by-products may be one way to achieve this. unfortunately, IPI's A-D Strips do not function well as room monitors, because the acid detectors change color over time by the absorption of carbon dioxide in the air, forming carbonic acid and giving a false reading of acidity. Even fresh film will turn the strips blue-green, since all acetate film has a measurable acidity level immediately upon manufacture.

Freezing the film is one way to seriously halt the phenomenon (as well as to stop dye fading). In an August 1985 SMPTE Journal, "Freeze/Thaw Cycling of Motion-Picture Films," the paper maintains that the act of thawing and re-freezing film does not harm it. However, there is still concern within the preservation community regarding the freezing of film, since frost buildup and condensation upon improper removal can lead to damage.

A former editor of American Cinematographer, Richard Patterson, detailed the recommended procedure for the storing of color film in the July and August 1981 issues of the magazine. He points

out that sealing the film inside a moisture-proof polyethylene bag in a relatively dry environment eliminates the need for humidity control in a vault or storage facility. Concern over the possibility of chemical reaction taking place between the bag and the film is discussed, as well as the use of moisture-proof tape to seal film cans (which can likewise be purchased from FPC.)

There are also those who claim to have answers for the whole vinegar syndrome problem. One collector suggested the technique of running the infected film through a rag doused with one of the fast-evaporating commercial brand cleaners, then heating the film surface with a blow-dryer while slowly rewinding it. This, he believes, will evaporate the moisture trapped in the base which causes it to offgas. The late Tom Ogburn had a method called Filmbrite which he claimed flattened a degraded print to the point where it might run through a machine. Another treated his film with a homemade concoction of camphor and citrus oil derivative that has allegedly put a halt to the smell and the degradation attributed to it for a couple of years. The citrus works as an anti-acidic, and airing out the print for three days did seem to get rid of the smell. But as to the trustworthiness of these techniques, time will ultimately tell whether they are just projections in the dark.

Perhaps when a film is in the early stages of vinegar syndrome, one of these methods might be useful. But when it reaches a state of 5.0 or 10 acidity level and is completely wrinkled, these techniques become questionable. Most archivists believe that nothing can reverse the syndrome. Once it has started, one can only slow it down by cold storage, low humidity and the various tools Kodak offers. These may merely be remedies, and the real cure may be some ways off.

Recalls Harwood, "During the early days of 16mm, when diacetate was introduced, many home-movie companies, such as Kodascope and Universal Show-At-Home, would place chunks of camphor in the can to help keep the film pliable and not let it dry out. There might be something in this..."

Thankfully, polyester-based mylar film is not affected by vinegar syndrome. Since it does not have an acetate base, it cannot leach acid out of its stock. Mylar is more chemically stable than acetate or nitrate and is said to last up to ten times longer than these films under the same storage conditions. Estimates of over 1,000 years of satisfactory life were gathered from incubation studies of one to two years' duration by the Image Permanence Institute. But polyester base has its own set of problems. The softer emulsion makes it more susceptible to scratches, and its tough base prevents easy tearing, making conventional splicing difficult and a potential hazard for expensive projector, printer or camera equipment.

"The best way to not have to go through expensive restorations is to store your negative in a cool, dry environment," concludes Harwood. "If the humidity is low enough, this method will retard vinegar syndrome as well. Our facility here offers climate-controlled vaults of 34 degrees Fahrenheit and 25 percent RH. Fifty features on 16mm will cost about $40 a month. Fifty on 35mm [averaging six reels per feature] will cost around $120 a month. This may seem a small price to pay 50 years from now, when it comes time to do color separations."

"Digital reconstruction of damaged motion picture films will be possible in the near future," says Bob Bender, strategic planning director for advanced technology products at Kodak. Tools on Kodak's Cineon digital film system provide capabilities for scanning film into a digital format for manipulation at an image computing workstation. The digital pictures can be recorded onto a high-resolution

intermediate film without compromising-the image quality of the original. The countless digital composites involved in visual effects applications, such as the plate backgrounds in Under Siege II: Dark Territory, Heat and Kodak's own Cineon demonstration at NAB, Believing is Seeing, have demonstrated many times over that this process really works.

Bender believes this technology can be applied to the restoration of valuable films. Once the film has been digitized, scratches and other artifacts can be repaired by an image computing workstation, in the same way that dust was lifted from eels during the restoration of Disney's Snow White and the Seven Dwarfs [see AC Sept.'93]. Also, missing image data could be "cloned" from an un-damaged frame to produce a seamless restoration, just as wire and rig removal is done in visual effects applications. The corrected digital pictures could then be recorded onto a high-resolution intermediate film, without a trace of vinegar syndrome.

Film Preservation: A Practical Guide
Key steps and suggestions on how best to protect valuable prints.

by Karen Kalish

A discussion on film storage is not sexy, but neither is the deterioration of a film in which you've invested your heart and soul. Whether you're a cinematographer, director, lighting designer, editor or a specialist in any other area, a little piece of you goes into every film that you work on.

The intention of this article is to focus on storage – the preventive medicine for film preservation -- and to provide a brief rundown of fundamental facts relevant to film storage; a few cost effective, "financially-friendly" preservation strategies; and key sources of information.

"Cinematographers who concern themselves with creating their works on film should also be versed in what happens to that work as it is stored over time," says Fred Murphy, vice president of operations for the Paramount Television Group. "This way, they can knowledgeably discuss with those responsible for maintaining their negatives, the most advantageous storage financially available, even if only on a frugal budget."

"Not everyone has millions of dollars to build and operate a sophisticated preservation facility," Murphy concedes. "As a major studio, we have sound business reasons to invest that magnitude of money in our assets. An individual or small company shouldn't throw in the towel, however, thinking there's nothing they can do toward preservation on a small or non-existent budget. Asset protection can in fact be tailored to the nature or budget of the collection. Many people believe you must go 'whole hog' to preserve your material, or it isn't worth even trying. That's simply not true."

According to The Library of Congress/National Film Preservation Board's 1994 report, "Redefining Preservation: A National Plan," new research in film deterioration shows that small, incremental changes in storage conditions, such as decreases in temperature and humidity, can result in considerable life extension for film collections. Even degraded film will last longer under cooler and drier conditions.

In the years to come, film will be reproduced and distributed by a variety of new technologies, some now available (at high costs) and some yet unrealized. The key to future access is to preserve the original long enough to be converted, restored, and distributed in these new ways. Original films have the maximum image and sound quality and will be the best platform from which to create access copies in the future. It is important to emphasize that digital restoration techniques will soon be a part of, but not a substitute for, the preservation of original film materials.

Determining the Archival Quality of Your Negatives

A 15-minute test can determine if your black-and-white print films and sound negatives are of archival quality. If they are found not to be of archival quality, they can be made archival by rewashing.

Contact:
Tom McCormick, N.T. Audio, 1833 Centinela Ave, Santa Monica, CA 90404, (310) 828-1098.

Detecting Vinegar Syndrome; Storage Guidelines

The Image Permanence Institute has developed A-D Strips, which can be used to objectively and accurately determine the presence of vinegar syndrome. Their IPI Storage Guide for Acetate Film, a four-part publication, includes a calculating wheel which relates film storage to how long film will last, and explains the relationship between temperature, relative humidity and vinegar syndrome. Together, the Guide and the A-D Strips make a kind of "do-it-your-self film preservation kit." One is a diagnostic tool, the other explains what is going wrong with film and tells how to extend its life through better storage. The IPI Storage Guide costs $25.00 and includes detailed information on vinegar syndrome. The A-D Strips cost $29.95 per package; each package includes 250 detector strips and instructions for use.

Contact:
Image Permanence Institute, 70 Lomb Memorial Drive, Rochester, NY 14623-5604, (716) 475-5199, Fax: (716)475-7230.

Fighting Vinegar Syndrome with Molecular Sieves

Molecular sieves act like chemical sponges, minimizing the effects of vinegar syndrome by lowering the moisture and absorbing the damaging acid contaminants. To help prevent the vinegar syndrome, films should be stored in clean, rust-free metal containers. (The reason the cans must be rust free is because oxide, or rust, is a catalyst for the vinegar syndrome.) The sieves cost 25 cents each; depending on the size of your film cans, three to six are suggested.

To obtain additional information, or the actual sieves, contact FPC, 6677 Santa Monica Blvd., Hollywood, CA 90038, (800) 814-1333.

Soundtracks with Vinegar Syndrome

The following process for handling vinegar syndrome on soundtracks, as detailed by Universal's Sound Facility, begins when the tracks are removed from their cans or boxes and placed in a "stinkerator." This device is a large metal box with film racks inside; after it is sealed shut, fresh air is drawn in and across the contaminated film and evacuated to the outside. The film is then inspected routinely for moisture and decomposition content, and removed from this metal box when dry. A gentle Kimwipe cleaning, splice and perf inspection and repair follow. After re-labeling and re-boxing, the material is transferred to both analog and digital protection masters. The original infected units are saved, but isolated from all other uninfected track units.

Two facilities that are equipped to handle soundtracks with vinegar syndrome are:

Chace Productions, 201 S. Victory Blvd. Burbank, CA 91502, (818-842-8346)
And
Film Technology, 726 Cole Avenue, Hollywood, CA 90038, (213-464-3456)

For information on how to care for picture elements afflicted with vinegar syndrome, see listing of "Labs That Specialize in Preservation" later in this article.

Treating Shrunken Film

A specialized treatment can restore shrunken film to "on pitch" measurements, thereby allowing duplication of the film by means of a continuous printer or the transfer of the film to videotape. The cost for the treatment is 10 cents per foot for films that are 10-12 years old, and approximately 25 cents per foot for older films with vinegar syndrome.

Contact: Amold Sheiman, Restoration House Film Group, 12 Village Drive, Belleville, Ontario,K8P 4J8 Canada. (613) 966-4076.

Storage Tips for Those with Severe Budgetary Restraints

While the Paramount Television Group is not inhibited by restrictive budgets when it comes to preservation practices, Phil Murphy is well aware that most film collectors may not have the fiscal resources to maintain state-of-the-art storage facilities. However, his empathy for preservationists with severe budgetary restraints has led him to offer the following suggestions and guidelines with regard to the proper care of optical materials.

"The worst condition of all is to leave a roll of film in an attic or a warehouse with no temperature or humidity control, [where it can be] affected by eliminate and weather of the environment," says Murphy. "Subjecting the material to such extreme changes in conditions over a long period of time is damaging. If the best conditions you have available are warm and humid, but at least consistent, you're better off than if the conditions change from good to bad to good in cycles. Offices may offer reasonably good conditions while they're occupied, but most buildings turn off air-conditioning on nights and weekends, which may result in large temperature fluctuations for the film. Stable poor conditions are better than wildly fluctuating conditions."

The next best thing, says Murphy, is to maintain the consistency at lower temperature and lower relative humidity. "If you're an independent producer with a small collection and a frugal budget, buy a used refrigerator with a frost-free freezer. Should you choose to go this route, there's information later in this article on how to contact the Smithsonian Institution for their simple method of packaging film for this low-cost method of preservation."

Considerable improvement can be made via some simple preventative measures mentioned in the National Plan, namely: lowering thermostats, shutting off heating vents and relocating collection materials within a structure.

This plan also concurs with Murphy's suggestions that household freezers can be a very successful storage approach for some small collections. (They also provide protection from fire and flood.) Listed below are some guidelines for the use of refrigeration.

Cold-Storage Packaging for Conventional Freezers

The Smithsonian's Critical Moisture Indicator (CMI) packaging method for conventional freezers has only recently been developed in their lab, and the technology is being implemented in a number of cold-storage applications at The Smithsonian Institution. The simplest and least expensive embodiment of the CMI method utilizes the common metal film can, low-density polyethylene stretch wrap, the critical moisture indicator, and silica gel packs. The total packaging material minus the film can costs less than one dollar per 1000-foot roll of 35mm negative, and the package can be easily assembled in about one minute.

For details, contact:
Mark H. McCormick-Goodhart, CAL/MSC, MRC 534 Smithsonian Institution, Washington, D.C. 20560. (301) 238-3700 ext. 114. Fax (301) 238-3709.

Freezers
In addition to low-cost household freezers, mini walk-in freezers are also available, with prices starting at $3,100.

Contact:
Norlake Scientific, Second and Elm Streets, P.O. Box 248, Hudson, Wisconsin 54016, (800)477-5253.

Please note that nitrate requires a flammable material storage freezer or an explosion-proof freezer. It's also important to note that the freezer method is still a little controversial within the preservation community, because if instructions are not properly followed, damage to the film can occur. Questions about this method can be answered by Rick Utley at PRO-TEK (213-468-4450), David Wexler at Hollywood Vaults (800-569-5336), or Mark McCormick-Goodhart at the Smithsonian (301-238-3700).

OTHER STORAGE OPTIONS

Depositing Films with Archives

Archives not only make films available for research, study, and appreciation, but also provide secure storage - often in low-temperature, low-humidity environments designed expressly to protect film. Many filmmakers, from D.W. Griffith to Andy Warhol, are known today largely though works that came into the safekeeping of these institutions. For active filmmakers, archives often make special arrangements to allow continued access to their material under conditions that ensure their preservation.

These details are described in a section of The National Plan titled "Depositing Films with Archives: Guide to the Legal Issues." Eric Schwartz, one of the individuals who drafted this document, can be reached at:

Proskauer Rose Getz & Mendelsohn, LLP, 1233 20th Street NW, Suite 800, Washington, DC 20036-2396, (202) 416-6817.

The Ideal Environments: Full-service or Self-service Vaulting

Both full-service and self-service vaulting options offer current protection techniques and technologies for optimum safe keeping and preservation. The difference between the two is that full-service vaults provide many services that include pickup and delivery, inspection, retrieval and shipping. Full-service vaults are only accessible during business hours and do not allow direct access to the vault stacks. Self-service vaults do provide clients with access to their individual unit within the vault 24 hours a day, seven days a week and offer direct control over the inventory system, stored material, plus complete confidentiality. By putting your negatives in a vault, you are ensuring the protection of the negative and don't need to buy insurance. If you do have insurance, often times you can get a cheaper rate by telling the insurance underwriter that the material is properly vaulted.

At the self-service Hollywood Vaults, the cost of a double vault is less than 25 cents per can per month.

Contact: David Wexler, 742 N. Seward Street, Hollywood, CA 90037-3504, (800) 569-5336.

At the full-service PRO-TEK Vaults, a 1000-foot can costs 35 to 37 cents per month.

Contact: Rick Utley, 1017 Las Palmas Avenue, Hollywood, CA 90028, (213) 468-4450.

Film Labs That Specialize in Preservation

When you are ready to take additional steps, the following facilities also offer help with preservation:

Cinetech, 1900 West Burbank Blvd. Burbank, CA 91505 (818) 840-1130.

Film Technology, 726 Cole Avenue, Hollywood, CA 90038, (213)464-3456.

John F. Alien, Inc. 116 North Ave, Park Ridge, NJ 07656, (201) 391-3299. (In Northeast PA, John E. Alien/Cinema Arts, 717-676-4145.)

WRS Motion Picture Labs, 1000 Napor Blvd. Pittsburgh, PA 15205, (412)937-7700.

YCM, 2312 West Burbank Blvd. Burbank, CA 91506, (818) 843-5300.

ACTIVE ORGANIZATIONS AND FOUNDATIONS

Association of Moving-Image Archivists

The AMIA promotes moving-image archival activities, especially preservation, through meetings, workshops and direct assistance. Their newsletter lists their networking events, educational opportunities and information on the preservation of both film and tape. At the group's 1995 Toronto Conference, laboratories from across the United States and Canada participated in a forum where they shared their preservation experience.

Association of Moving Image Archivists
c/o National Center for Film and Video Preservation
The American Film Institute
P.O. Box 27999
2021 North Western Avenue
Los Angeles, CA 90027
(213)856-7637.

Mary Pickford Foundation
Keith Lawrence, who is managing director of the Mary Pickford Foundation as well as an AMIA member, is currently helping the AMIA to establish and coordinate a scholarship fund for continuing education in preservation. Lawrence's goal is to help make libraries accessible to the public; he's very open to teaching individuals how to make money off the libraries they have. The foundation also gives colleges and universities monies for scholarships.

Mary Pickford Foundation
9171 Wilshire Blvd.
Suite 512,
Beverly Hills, CA 90210
(310) 276-3523.

New York Women in Film & Television
New York Women in Film & Television founded the Women's Film Preservation Fund in 1994 in association with the Museum of Modern Art and American Movie Classics. This is the first step by women within the industry to raise funds for archival restoration. (The organization also has male members, two of which, director Robert Benton and actor Dustin Hoffman, are on the Honorary Board.) The mission of this fund is to preserve films on which women played a major creative role. The group's first preservation project was completed last spring, and was shown at the 1995 Hamptons International Film Festival. Last June, their first fundraising event generated enough money to allow for a second project.

New York Women in Film & Television
274 Madison Avenue

Suite 1202, New York, NY 10016-0701
(212)679-0870.

International Documentary Association
The IDA is devoted solely to Promoting non-fiction film and video and supporting the efforts of documentarians. A preservation seminar was held at the 1995 International Documentary Congress; preservation discussions are also offered during the year. The IDA Documentary Center at the AMPAS Film Archive, the only center devoted exclusively to the collection, preservation and study of documentary film, was established jointly by the IDA and the Academy of Motion Picture Arts and Sciences.

IDA
1551 S. Robertson, #201
Los Angeles, CA 90035
(310) 284-8422.

A Few Words on Videotape Preservation

William T. Murphy will soon be coordinating "A National Study of the State of Preservation of American Television and Video Materials" for The Motion Picture Broadcasting and Recorded Sound Division of the Library of Congress. The format will be similar to the study completed in 1993 for American film.Fact-finding hearings were held in March. Completion is expected by end of 1996.

For more information contact: Steve Leggett, project assistant, or William T. Murphy, project coordinator,(202)707-5912.

For Videotape Information: VidiPax, a videotape restoration service bureau specializing in old, damaged and obsolete videotapes, provides a toll free help line, (800) 653-8434 (the group's web site, www. panix. com/~vidipax, offers articles on video restoration and preservation, and provides links to other preservation resources).

VidiPax, 920 Broadway, New York, NY 10010, (president: Jim Lindner)

Vidipax's West Coast affiliate has a list of "Do's and Don'ts of Video Tape Care." Contact Jim Wheeler via email: JimWheeler@aol.com.

Additional Published Information

"Redefining Film Preservation: A National Plan" includes information on film storage and depositing films with archives.

Film Preservation 1993 - Vol. 1 includes information on the Technicolor and Eastman color printing processes, film bases, and the fundamentals of preservation.)

Complimentary copies are available from: Steve Leggett, Motion Picture & Broadcasting Division Library of Congress Washington, D.C., fax (202) 707-2371.

Publications from the Society of American Archivists

This organization is known for supplying publications that focus on archiving and preservation. Their Publications Catalogue lists over 100 titles.

Society of American Archivists, 600 S. Federal, Suite 504, Chicago Illinois 60605, (312) 922-0140.

National Film Preservation Board Information on the Internet

Gopher site address: gopher://marvel.loc.gov:70/00/research/reading.room/motion.picuture/nfpb.

World Wide Web homepage: http:// Icweb.loc.gov/ film.

Handling Nitrate

YCM Labs has put together a list of suggestions for handling nitrate that is sent to their clients. To obtain this list write: YCM Labs, 2312 W. Burbank Ave, Burbank CA 91506.

A FEW CLOSING WORDS

To Cinematographers:
"Because restoration is done without consultation with the cameraman, it is all the more important to try to be faithful to what they were trying to do. I have been shocked by the poor timing (grading as we call it) in some recent work. And today's cameramen ought to pay attention to restoration -- because their future reputation depends on it!"

Kevin Brownlow (Film historian, restoration producer of Abel Gance's 1927 Napoleon).

"We must remember that it is not just old films we have to worry about, we should think about preservation right now, for our recent films. This is serious!"

Film editor Thelma Schoonmaker, ACE (Raging Bull, Goodfellas, Casino)

"If you find out that one of the films you've worked on is being restored, try to be there for some indelible transfer, ask if you can be present -- offer to participate, to watch the timing. I offer my time if it's in New York, and if my airfare was paid to go to L.A., I'd offer my time there. It's hard for other people to guess what the intent of the cinematographer was."

Gordon Willis,ASC (The Godfather, Annie Hall)