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Thought I'd give you a brief history of film preservation using the example of the Imperial War Museum.

The Imperial War Museum was one of the first organisations in the world to address the question of how to preserve a film collection, having in 1920 taken on the responsibility for some 250,000 feet of official 'War Cinematograph film'. The museum's 'advisor on cinematographic matters' at the time, Edward Foxen Cooper, quickly recognised the two essential ingredients of a film preservation policy: storage and duplication. The former is of course a vital factor for archives of any kind. The latter has particular significance for film, a medium which could not exist without the technology which allows one copy to be made from another.

What Foxen Cooper realised was that in order to preserve the museum's films for an archivally significant length of time, not only would he have to secure adequate storage for them, but he would also have to make new protection masters of the films which could be set aside for long term keeping in case the vulnerable (and even by 1920, rather damaged) originals, all on dangerously inflammable and unstable nitrate film stock, deteriorated beyond use. Really good storage for the films was not in fact achieved until the 1980s, which may have been just as well: Kodak's recommendations from 1920 suggested that films should be kept cool "the lower the temperature the better" (good!) but in a moist atmosphere (bad!). Among Kodak's other recommendations for keeping old films was the following very significant statement:

"Film stock is composed chiefly of nitre cotton and this substance, while apparently stable is subject to very slow change. The rate of change at normal temperature is so slow that no effect would result if it continued for many years at this rate, but under certain circumstances the rate may increase so that decomposition may set in. Once decomposition has started no treatment swill stop it, and copying is the only remedy."

The assumption that the life expectancy of nitrate was 20 to 50 years was the basis for the Imperial War Museum's, and virtually every other archive's, preservation policy for the next 60 years or so: on the assumption that nitrate film was both short-lived and dangerous, we were only too happy to make duplicate masters and then destroy the originals as soon as they showed the slightest sign of deterioration, often the slightest sign frequently from an accelerated ageing test devised to predict lifetime. This process came to be known as "Preservation". In any other discipline, preserving your materials by destroying them might raise a few eyebrows.

No matter, we ploughed on, making safety masters of our most important WWI material in the 1930s and then finishing the job in the 1960s, before continuing with the WWII material, gradually losing our enthusiasm for throwing out the originals unless they had clearly decomposed beyond rescue.

You will have deduced by now that the old copy and destroy approach to film archiving is now generally discredited. There are a number of reasons:
1. Better understanding of the materials. First, the life expectancy (LE) of nitrate is not in fact the traditional 20 – 50 years. The Image Permanence Institute in Rochester, US, have suggested a LE of 15 - 500 years. This may not be terribly helpful - unless you can ascertain whether you have a 15 year reel or a 500 year reel! The IPI have also demonstrated that the old ageing test is not a particularly good indicator of LE. There are better predictive tests, but at present too complex for routine use. However, what is clear is that any surviving nitrate now in existence (which must be at least 50) is likely to last many more years providing it is kept in good conditions.

Secondly, acetate safety film, the stuff we've been making all our master copies on until recently, has been shown to have an equally poor LE (arguably even shorter). In the wrong conditions, acetate has been found to develop serious vinegar syndrome – the decomposition reaction produces acetic acid – in as little as 8 years. Fortunately in the right conditions, archivally significant lifetimes of several hundreds of years should be achieved.
Thirdly, there is now a greater appreciation of just how defective a process photochemical copying is. Photochemistry allows "perfect" prints from negatives (that's what it's designed for), but not much else – certainly not perfect copies of projection prints. We've always known this, but now we have digital scanning at "film" resolution (the sort of thing used for Hollywood special effects). This does offer the possibility of almost perfect clones of film prints, but the technology is at present hugely expensive, and the digital file sizes are huge and difficult to handle. And even the best digital scanning cannot capture all the information on a 35mm film negative. The technology is of course continually improving and becoming cheaper and more practical. All of which means that digital copying will one day be the perfect solution, but it's not there yet.

The point of all this is that whatever kind of copy we make of a film today, we will definitely be able to make a better one in 10 years time (assuming the film has not decomposed in the meantime). "Copy and destroy" has therefore been replaced by "above all, save the originals".
So if you are looking for advice on how to preserve your film collection, and someone says copy them and destroy the originals, you should treat them with some scepticism.
In truth, there will always be situations where copy and destroy is an acceptable approach – where the original has decomposed beyond rescue (as is often the case with nitrate reels), and for certain types of collection: for instance for broadcast archives holding vast quantities of 16mm newsfilm which was only ever intended for TV broadcast it is possible to argue that it is acceptable to destroy the originals after producing digital copies.

But how *do* you conserve your originals with any confidence?
The three elements are identification, condition checking and environmental control. Films come in a wide variety of formats and types which have different storage requirements.

The principle ISO standards are these:
ISO 10356: Cinematography – Storage and Handling of Nitrate-Base Motion-Picture Films:
Long term storage:

2 °C
20 to 30 % RH

ISO 18911: Processed Safety Photographic Films – Storage:
Long term storage of B&W Acetate:

2 °C
20 to 50 % RH

(Or 5 °C
20 to 40 % RH
Or 7 °C
20 to 30 % RH)

ISO 18911: Processed Safety Photographic Films – Storage:
Long term storage of Colour (chromogenic) Film:

-10 °C
20 to 50% RH
(Or -3 °C
20 to 40 % RH
Or 2 °C
20 to 30 % RH)

You need to know what you've got before you can decide what kind of storage you can get away with, and since these specifications are for film in good condition, you need to know what state your film is in – if it is already well down the road of decomposition, then the storage conditions may have to be more stringent.
Nitrate film of course has its own particular safety needs which limit the amount you can put in any one vault: these are the Imperial War Museum's nitrate vaults, safely situated in the country away from habitation, and kept in good – if not quite ideal – conditions.

B/W acetate film must be kept cool and dry to avoid the onset of vinegar decomposition: this is a reaction which is autocatalytic, ie the acetic acid it produces makes the reaction go faster, so it is important to prevent it starting in the first place. There is a simple acid level test using indicator paper strips which is a good way of determining the condition and the LE of acetate reels.

Colour film is a major, major problem. Many common types of colour film are very prone to fading. If you have a collection of colour film from the 1950s onwards, you have a big problem. Yes, rhe ISO standard really does say minus 10 °C . This is the only thing you can do to save these films – freeze them. It's no good pretending that there is an alternative. If you are serious about saving these films for the future, you have to invest in deep freeze storage, and this is far from straightforward. Colour films like to be frozen but they don't like to be damp. So you either have to have fully humidity controlled freezers (a tricky engineering problem), or you have to precondition and seal the films before freezing them, which is what we do at the Imperial War Museum.

Of course, saving the originals is of absolutely no use if no one gets to see the films. Traditionally our collection has always been accessed through film viewing prints: increasingly this is a disadvantage – they require specialist viewing equipment, they are vulnerable to damage and they cannot be streamed over the internet. On the other hand, they will (if properly looked after) last for many, many years.

What about video? Indeed, what about digitisation? I hope I've already answered the question of using electronic media for film preservation – as I said, even at the highest quality level, we are still some way short of capturing the theoretical maximum amount of data from a film, although it is true that for most purposes you can get satisfactory results from scanning a film at what is known as "2K" resolution (2000 pixels across the picture). Transferring film to TV broadcast resolution video (whether on tape or as a digital file) entails a significant loss of data for most films. Most film archives will agree that this is not acceptable if the aim is to produce a permanent replacement for the original.

But is video acceptable as an access medium? Here you need to consider what kind of access we need to offer. Are you a feature film archive, offering prints for screening in cinemas? Or, at the other extreme, a broadcast archive, providing material for TV broadcast. Do you need to provide rapid access? Do you have customers willing to pay handsomely? Is all of your archive is in regular use, or do you have a core of popular items.You need to answer these questions because electronic media come in a variety of flavours, all of which have a very short (in archival terms) lifetime. Beta SP, Digi Beta, VHS, DVCAM, DVD all represent a compromise in quality, some more than others, and all of them have a very limited lifetime – Perhaps DVD might hang on for a while yet, but you can be sure that in 15-20 years time, all your videotapes will be junk. Why? Because the formats will be obsolete, and when your last player is worn out you will only be able to play them using a specialist video restoration firm. For an archive such as ours, where some of the more exotic (but nevertheless important) items may only get an outing once every 20 years, making videotape access copies of such material is pointless – the tape is likely to be obsolete before the first user comes along.

Part of the PrestoSpace project is an system to efficiently produce digital file copies audiovisual media; this is undoubtedly the future for moving image archive access, the difference here being that when the format becomes obsolescent, it can be automatically

migrated to a replacement format. I am not going to say too much about that, but it would be a mistake to think that this is a cheap and easy approach – the production and management of a large number of big files, assuming you take the necessary precautions to ensure that they don't suddenly vanish when there's a disk crash, is a major (and a never-ending) undertaking which makes the business of storing old films in air-conditioned vaults seem simplicity itself.

Finally, here is an illustration of the perils of not storing your films properly. This is a 16mm colour print of the British atom bomb trials in Australia in 1956. Due to Eastmancolor film's extreme susceptibility to fading in poor storage, there is virtually no colour left in this print. Luckily we were able to track down the cutting copy of the film which, although not complete, was relatively unfaded, and after a lot of painstaking and expensive digital work and reassembly, we have managed to produce a restored version. The point of this is, of course, that the money spent on restoring this film would have paid for good storage for our entire collection for many years: it is always going to be far cheaper to store your films properly that to rejuvenate them when bad storage has damaged them.