

# There is No Such Thing as Digital Restoration

Film archives have taken to churning out digital restorations with enthusiasm, but how many of these really qualify as restorations? It is possible to devise a numerical tool for measuring the degree of restoration for any film, but, in its simplest form, this might be seen as encouraging unlimited improvement to the picture and sound. A simple rule is therefore necessary to define the acceptable limit to digital manipulation.

## 1

It has become a common refrain that digital technology is forcing film archives to redefine their role, and even to question their very existence. Converging technology is certainly helping to encourage a trend in which film archives are being absorbed into all-encompassing heritage institutions which offer digital access to everything. Nonetheless, the issues facing film archives, whether in or out of such entities, are much the same as they always have been – acquisition, preservation and access – and while digital technology may broaden the scope of these activities, there is nothing very special about digital technology itself. Why then is there so much excitement over ›digital restorations‹ if digital technology is just another tool in the box?

In order to explore this, let us go as tourists on a visit to the world of film restoration: we step off the bus in the main square of Restoration Town, and the first thing we see is Abel Gance's NAPOLÉON (1927), a truly monumental, if slightly ramshackle, edifice. There is always a big crowd to admire it, and we feel sure that this is the real thing – a restoration. Over on the

other side of the square is another vast structure, METROPOLIS (1925-27) – undoubtedly a true restoration too. These two structures, where the end result has been painstakingly assembled from elements recovered from around the world, generally epitomise what most people think of as film restorations.

Let us now move away from the town centre, and down this little avenue to the home of the Imperial War Museums (IWM) Film Archive. Here the picture is a little confusing: there has certainly been something happening, but are these things restorations, or are they something else? To answer this question, we shall for the moment step out of our metaphorical conceit, and travel back to the year 1978.

In this year, IWM sent off to the film laboratory the original nitrate masters of the film WESTERN APPROACHES (1944), a groundbreaking drama-documentary, largely filmed using a huge Technicolor three-strip camera, plus sound recording equipment, plus lighting, plus crew and cast, all crammed into two tiny wooden lifeboats in the Irish Sea. IWM had recently acquired these masters and, as part of our nitrate film preservation programme, we were making new acetate protection masters, a new colour negative and a new print. Given that they hadn't printed much nitrate in recent years, the laboratory, Technicolor in London, who had worked on the film when it was first produced, did a good job, and we were satisfied that our duty of preservation had been fulfilled: we now had preservation masters and a fine new print for exhibition.

In the accepted wisdom of the time, what we had carried out was something called ›preservation‹: we had taken the original nitrate negative of a film, and using the best technology available, made a safety master copy, and a new print – exactly what we did with every other nitrate film in the collection. It never occurred to anyone to call this a restoration – because it wasn't.

Or was it? In 1994 an exhibitor managed to damage our print. Because we had done our preservation work properly, it was a simple matter of sending the colour negative made fifteen years earlier back to Technicolor for a new print. In these intervening years, restoration had become quite the fashionable thing, and so not to be left out, we booked the new print into the London Film Festival, invited along Pat Jackson the director, gave the film a grand introduction, and proudly called it a ›restoration‹. Was it? No, of course not. Even generously turning a blind eye to the fifteen year hiatus between doing the real work and launching this release, it was still no more than, well, a new print.

32 How dishonest were we? Let us step back into Restoration Town, and have a closer look around. There certainly do seem to have been a number of these constructions erected around this time, very often Technicolor films, with a big sign on the door saying ›Restoration‹, but when you open the door, you find that there's nothing behind the facade. There really doesn't seem to have been any restoration work going on at all. In fact, all they did was take the original negatives, and, using the best technology available at the time, make a new master and print.

But wait – who's this rolling into town with a fanfare of trumpets and a blaze of colour and sound? It's a whole new outfit, and they call themselves ›Digital Restoration‹ ... and wow, these people are good! Just look at what they are throwing up all over town – it's big and bright and sharp and really, really clean! And when we look back at poor old NAPOLÉON, we see that actually it's a bit untidy – the pieces don't fit together all that well, and if you go up close, you can see this sort of ... texture. The digital restorations don't have that: they are as smooth as silk. And everything matches so perfectly you can't see the joins at all. But don't worry, right next door there's another construction going up behind a big fence – and the sign on the gate says ›NAPOLÉON, the Digital Restoration, coming soon!‹ Fantastic!

Meanwhile, down IWM Avenue they are at it as well. There are digital restorations popping up all over their place too, and what are they working on right now? WESTERN APPROACHES, of course! Only this time it really is a restoration. It's a restoration because we have taken the original negative, and, using the best technology available, made a master copy, and a new print. Exactly as we did in 1978, when it wasn't a restoration. So actually, it isn't a restoration this time either – because there is no such thing as a digital restoration. There is restoration and there is digital technology, and sometimes you might use the latter in the cause of the former, but the term ›Digital Restoration‹ is just used to convey the fact that digital technology offers a greater ability to extract the best out of an original. You're not restoring anything, because you haven't lost anything in the first place – it's all there in the original masters.

To take a specific example, consider these frames from WESTERN APPROACHES, before and after restoration – ›before and after‹ being the usual, and wholly spurious, method of demonstrating the tremendous things done to a restored film: On the left, the ›before‹ frame, where one of the original elements had been torn across the frame. On the right, the ›after‹ frame: miraculously the tear in the negative has been spirited away. Restoration? Not really – we have a perfectly acceptable original Technicolor nitrate print from 1944 which does not

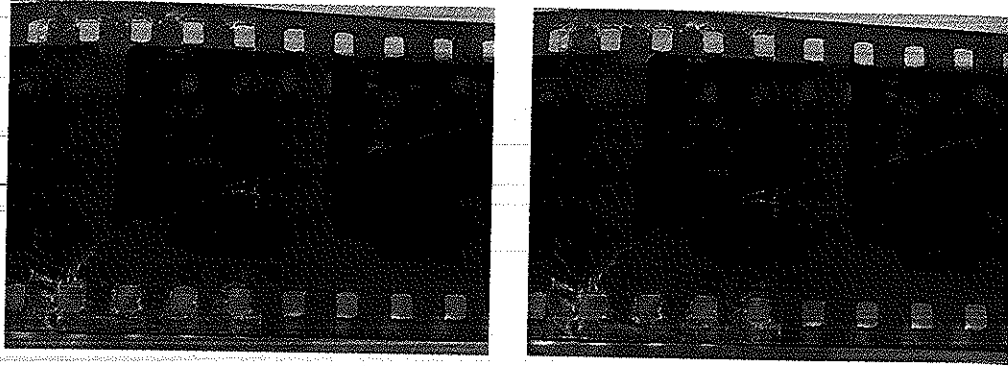


WESTERN APPROACHES Imperial War Museums (C01 393)

have this fault, so there is no sense in which we are recovering something which hasn't always been available. A more honest comparison would have been between the 1944 Technicolor print and the new digital version, and then there would be no miraculous repair work to see. The kind of work carried out to remove this type of damage is just the standard process of producing a new ›digital version‹ – a term I use as shorthand for any film which has passed through a scanning and digital manipulation process, whether or not it has been recorded back on to film or not.

In the parallel world of digitisation of photographs, this obsession with restoration is less marked. Photographic digitisation technicians know that the photographers and studios would never have issued a print made from the negative without there being a degree of intervention, both creative and technical, using various techniques in order to approach an ideal rendition of the scene captured in the negative. A digital scan of an original negative is considered to be just a digital version of that negative, and in order to produce a digital print, a similar process of enhancement is carried out, the difference being that digital technology offers the ability to approach even closer that ideal image, with considerably less effort. This process, entirely analogous to the work which technology is increasingly making routine in the film world, is usually called optimisation, not restoration.

In the fine art world, things are rather different. A torn canvas, the equivalent of the tear across the negative of WESTERN APPROACHES, might on the face of it appear to be comparable. The restorer goes to work with the aim of making the viewer as unaware of the damage



WESTERN APPROACHES Imperial War-Museums (COF-393)

as possible, much as the digital technician did with our film, but the difference is substantial: the restoration of the artwork involves delicate work on the original unique artefact. This work is irreversible: if the restorer makes a mistake, only further restoration work will do anything to attenuate the error. The result of the restoration, good or bad, is there for the audience to examine directly, as it is now an inextricable part of the original object. The digital repair of a film, on the other hand, is carried out by tinkering with the digits which represent the film content: the process is completely reversible, and the audience only experiences the result as an image created through some intervening mechanism. If we are to draw a parallel between film restoration and art restoration, the legitimate way of presenting the work on the damage to the WESTERN APPROACHES negative would be to show these two 'before and after' images: On the left, the tear in the original negative before digital restoration, and on the right, the same tear after digital restoration. The two pictures are identical of course, because we have done absolutely nothing to the original negative. We have not restored it.

2 Having now dismissed most current film restorations as nothing of the sort, perhaps we should adopt a more nuanced approach which takes into account all the processes carried out during a restoration, and to this end I offer a quantitative analysis tool for restorations. To do this, let us take some of the essential ingredients of a restoration, such as how incomplete the archive's current master is, how widely the materials needed for the reconstruction

have been dispersed and how long the desired version has been lost, and by adding these elements together with some weighting factors, two simple formulae, one measuring the degree of reconstitution or reconstruction, and one the quality improvement, can be produced:

$$\begin{aligned} \text{Reconstruction factor (R)} & R = 2g + 2c + d + t \\ \text{Quality change } (\Delta Q) & \Delta Q = q_1 - q_0 \end{aligned}$$

where: g ... Gain in completeness (Difference in completeness between the final version and the archive's master)  
c ... Complexity of reconstruction  
d ... Degree of dispersal of elements  
t ... Time since aimed-for version last available  
q<sub>1</sub> ... Quality of final version  
q<sub>0</sub> ... Quality of previously available version

These two aspects can then be plotted on a simple graph, in which a move towards the top right corresponds to an increasing degree of restoration, and we can test this by plotting some actual restorations, with *Reconstruction* marked out of 4, and *Quality* out of 10 (the figures are of course largely subjective). So for the analogue work on NAPOLÉON, a film which had effectively been lost in any remotely complete version since its release,  $g = 4$ ,  $c = 4$ ,  $d = 3$ ,  $t = 3$ . Marking the quality is more difficult since the quality varies widely in different parts of the film, but the versions that existed previously were fairly poor, so  $q_0 = 2$ ,  $q_1 = 6$ . Putting these figures into the formulae:

$$R = 22$$

$$\Delta Q = 4$$

METROPOLIS, on the other hand, was widely available in shortened versions of often reasonable quality; nonetheless digital tools were employed to match scenes from disparate sources, and so  $g = 3$ ,  $c = 3$ ,  $d = 3$ ,  $t = 3$ ,  $q_0 = 5$ ,  $q_1 = 8$ , to give:

$$R = 18$$

$$\Delta Q = 3$$

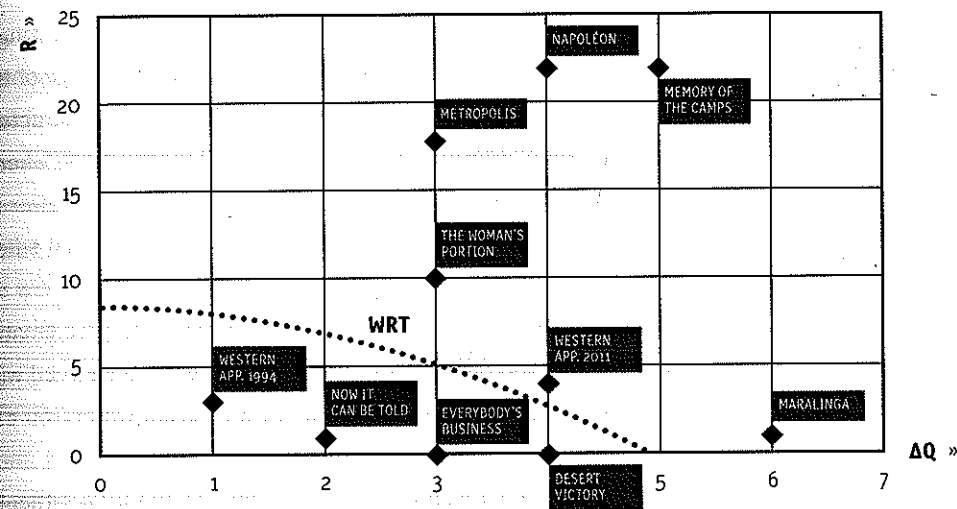
Others may disagree with the precise numbers, but the important thing is that both films score well in terms of reconstitution, and this puts them both well towards the top right of the graph.

36 How does the analogue work on WESTERN APPROACHES score? In the 1994 version there was, in fact, a small degree of reconstruction work carried out, namely restoring some optical effects missing from the original elements, so this just scrapes a score of 1 for gain in completeness, and perhaps another 1 for the complexity of doing this, but we get 0 for dispersal – all the material came out of our own vaults – and also 0 for the time since the full version was available – we have always had a complete original print of the film. So R is only 4, and because we had a perfectly acceptable release print of the film already, ΔQ is at best 1. For the current digital work on the same film, the R factor is exactly the same as the 1994 release – as before we had to recreate the optical effects, digitally this time – but the quality score is higher because of the power of digital technology. Although the film now looks very fine indeed, the original print was remarkably good itself, so the improvement is from >quite good< to >very good<, and is awarded a ΔQ of 4, which moves it a little further along the graph towards the right.

Now we can start putting all the digital versions of IWM films on the chart:

	R	ΔQ
<b>MEMORY OF THE CAMPS</b> (1946) Huge reconstruction from original negatives	22	5
<b>BRITISH ATOMIC TRIALS AT MARALINGA</b> (1956) Very little reconstruction, but huge quality improvement	1	6
<b>THE WOMAN'S PORTION</b> (1918) Reconstructed, small quality enhancement	10	3
<b>EVERYBODY'S BUSINESS</b> (1917) No reconstruction, small quality enhancement	0	3
<b>NOW IT CAN BE TOLD</b> (1946) No reconstruction, small quality enhancement	1	2
<b>DESERT VICTORY</b> (1943) No reconstruction, significant quality improvement	0	4

The curved line, which happens to be defined by the formula  $R^2 + 3\Delta Q - 25 = 0$ , I call the *Walsh Restoration Threshold* (WRT): anything above the WRT is a restoration, and anything enclosed in the area below is not (I have called it the Walsh Restoration Threshold because it represents where I personally consider a digital version can legitimately start to be called a



restoration). The line is curved to reflect the notion that quality can only be considered part of the restoration process where a really significant improvement has been achieved. With this we see that NAPOLÉON, METROPOLIS and MEMORY OF THE CAMPS are all comfortably in the restoration zone, but the 1994 version of WESTERN APPROACHES does not make it. The 2011 digital version is just above the borderline. However MARALINGA, despite having had very little reconstruction, gets in by dint of the large quality improvement.

I invite the reader to plot their own efforts on the graph and see if they qualify as genuine restorations or not! I am not actually proposing an International Restoration Standards Committee to police the work of film archivists, but rather drawing attention to all those so-called restorations which are nothing more than digital scans with a little image manipulation to make them more acceptable to the clean look of High Definition Television (HD TV).

In the end, though, it really doesn't matter whether you call your digital versions >restorations< or not – anything which helps to persuade audiences to come and watch archive films is, arguably, justifiable – but more important is the question of the acceptability of what has been done to a film as part of the digital process.

The Walsh Restoration Chart implies that technical quality can be improved indefinitely as we move to the right, all the way to the point where the scene presented is indistinguishable

38 from the original reality in front of the camera, in other words, where the medium is no longer detectable. This may be a valid approach for actuality footage: imagine taking footage of the Battle of the Somme and increasing the sharpness and resolution so that no image structure remains visible, interpolating frames and increasing the frame rate so that the wagon wheels go forward rather than backwards, adding colour, transforming it into 3D, until the viewer is, in effect, standing in the trenches with the cameraman. Used responsibly, this would surely be an amazing experience.

For cinematographic works, that is ›films‹ rather than ›film‹, it is a little more problematic. Are we looking forward to a future where you can actually stand on the yellow brick road with Dorothy, where you really are in the courtroom sharing Joan of Arc's passion, where you can actually feel the heat from the incinerator as Rosebud goes up in flames?

This all may seem a ghastly fantasy, but as technology develops, there will be little difficulty in achieving this kind of virtual reality. I suspect most film archivists would feel that we have a responsibility here, but I suggest that our responsibility is not to spoil people's fun, but rather to be the guardians of the authentic cinematic experience by ensuring that ›we‹ strive towards an accurate simulation of the original cinematic work, whatever medium is available to us. So as digital technology moves us ever further away from our poor old grainy, flickery analogue films and towards a perfect simulation of reality, the real question is: how far may we go?

Many film theorists of a purist inclination will assert that the rule is very simple: the aim of any restoration is to produce as close an approximation as possible to an original print at the time of release, so in the case of WESTERN APPROACHES, the image displayed on screen should look exactly like the Technicolor print would have done when projected in 1944. Some would go further and insist that the result should look specifically like a nitrate print shown using a carbon-arc projector in a cigarette smoke-filled auditorium.

This is, of course, madness. It is madness because it necessitates the following scenario: the restorer scans the original three separation negatives, registers the resulting digital files, carries out a small amount of clean-up work on blemishes and dust marks, and produces a graded copy. The archivists view it, amazed at its superb quality and in awe of the skill of the Technicolor engineers of 75 years before. And then the restorer says: »OK, no one else is allowed to see this, because when we produce a release version of this film we are deliberately going to make it ›worse‹.«

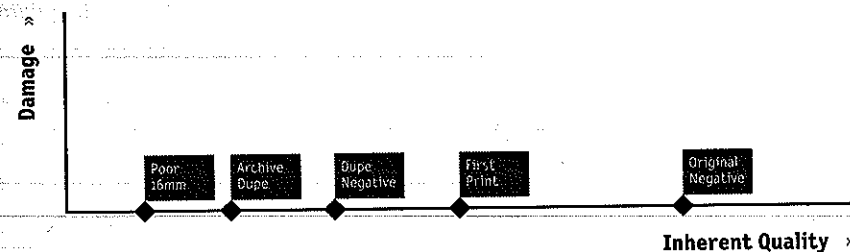
Nobody will ever do this. Apart from the fact that restorers are unlikely to be persuaded of

39 the need to degrade their work, to do so requires the application of highly inauthentic digital manipulations such as re-graining. It's not dissimilar to current video editing applications which have an effect called ›old film look‹ that can be applied to any footage. Are we seriously advocating applying the ›old film look‹ to our pristine restorations?

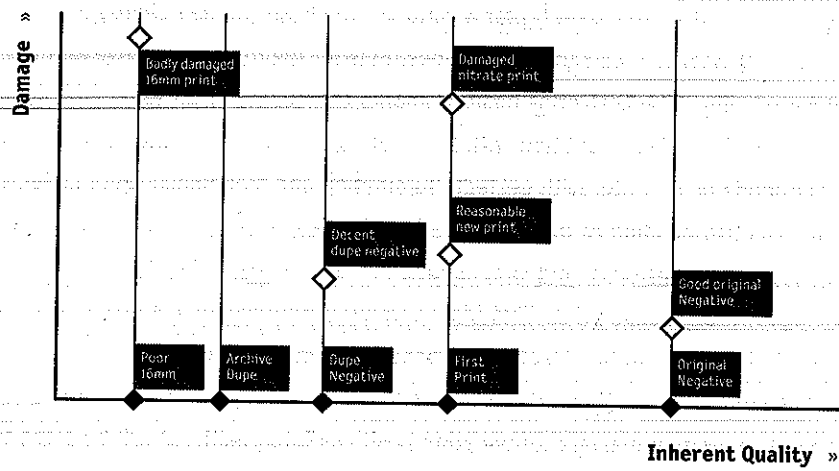
I propose instead a very simple set of guiding principles, which can most easily be illustrated in the form of a graph. This time, rather than plotting the ›change‹ in quality of a restoration, we will plot *Inherent Quality*, that is, the quality, rather than the condition, of any particular copy of a film. On the other axis we will plot a variable which we will call *Damage*.

Along the *Inherent Quality* axis we can mark the positions for the master negative and the first release print for our film. The first print position marks the quality of an ideal analogue film print, that is, a print in perfect condition with no scratches, dust marks, blemishes or fading of any kind, and made on a printer with perfect illumination and steadiness; the master negative marks the effective position of a perfect, and perfectly graded, positive rendition of the negative (and original soundtrack), and is consequently less grainy and with better resolution than the (analogue) first release print. This ideal version of the negative is not achievable by analogue film printing, but can be closely approached by digital technology.

To these two key points we can then add positions to represent any other copy which may be available: second generation masters (duplicating positives/interpositives) will be close to the print in terms of inherent quality, while third generation masters (i.e. duplicate negatives) will typically be a little further to the left. For the type of master all too frequently encountered in an archive, namely a duplicate negative made in the 1960s from a nitrate print in poor condition (and since destroyed), the inherent quality is even worse, and for a 6<sup>th</sup> generation 16mm print made on a poorly maintained optical printer, the inherent quality is heading towards zero. Far off the scale, to the right, is reality.



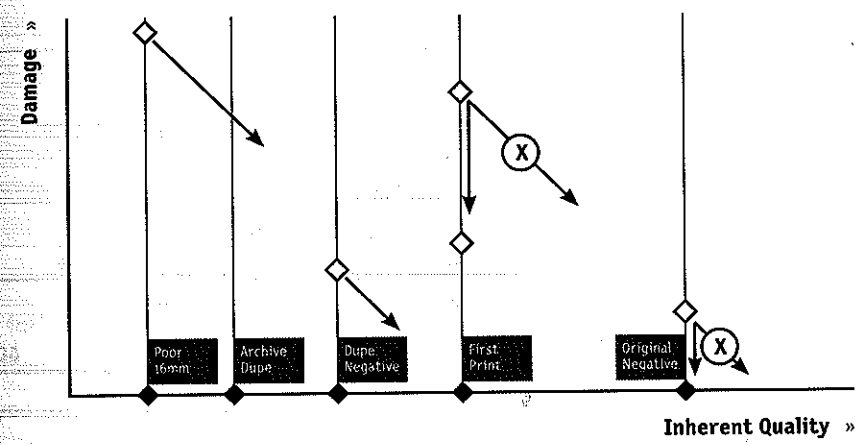
40 In the real world of analogue film, the perfect, damage-free copy cannot exist, of course. A copy in very good condition will still have some blemishes, while an archive's copy of a release print will very often be in quite poor condition. We mark the degree of damage in the vertical direction on the chart (in this example a good original, a reasonable new print, a decent dupe negative, a damaged nitrate print and the 16mm print in terrible condition – since we are only interested in relative positions, we don't need to assign actual values):



The rule for making an archivally acceptable digital version is then straightforward: starting with your source material you can move vertically down the graph, but not sideways. With one exception, it's as simple as that. In other words, you can use all of the digital tools available to remove scratches, tears, blemishes, and clicks and pops on the soundtrack, to stabilise printed-in frame movement and flicker, to balance and enhance faded colours, all of which are aimed at redressing the ›damage‹ factor, i.e. printer-generated defects, handling damage and age-related deterioration. But you cannot do anything to ›improve‹ the inherent quality, such as removing movement generated in the camera gate, sharpening, colourising, reducing grain or converting the mono sound into 5.1 surround.

The exception to this rule is where the starting point is to the left of the first release print, in which case it is permissible to apply any additional manipulations which move the quality towards, but no further, than the first print – ›provided‹ that these introduce no digital side-

effects. In practice the amount of inherent quality enhancement which can successfully be carried out with current technology is fairly limited: reducing flicker, using secondary colour correction, and enhancing shadow and highlight detail are unlikely to create any obvious digital artifacts, but grain reduction, for instance, can quickly lead to an unnatural ›digital‹ look.

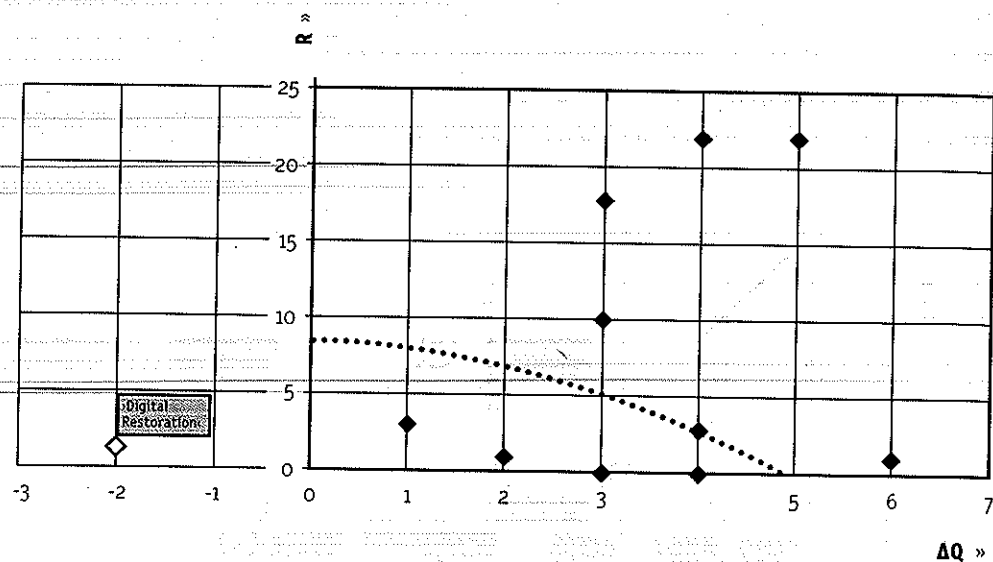


This rule allows the archive to take advantage of the better inherent quality of the original negative, if this is available, but forbids attempts to improve the inherent quality of a first release print by, for instance, reducing grain in order to move towards that of the negative.

If we like, we can incorporate the notion of unacceptable image improvements into our earlier formula by adding (or rather, subtracting) a penalty, P:

$$\Delta Q = q_1 - q_0 - P$$

The work accrues penalty points for any forbidden movement away from the vertical, and so, for example, where the original negative has been scanned, cleaned up, and then turned into an emulation of HD TV by stabilising, sharpening and removing all the grain, we can award a penalty of, say, 3 for this unacceptable horizontal movement. If the original negative was in good condition anyway, the quality improvement,  $q_1 - q_0$ , is no more than 1. Subtracting the penalty of 3 then gives a  $\Delta Q$  of minus 2. The reconstruction factor is at best 1; so this ›digital restoration‹ goes here on the graph:



To sum up, we need to stop considering digital technology as something special in itself: it provides an alternative way of copying and presenting film, and it offers improvements in extracting the inherent information in analogue originals. Rather than being a challenge, it is a solution which offers film archives the ability to keep their films alive in a world where viewing habits are rapidly changing. It can be misused, deliberately or otherwise, but there is a simple rule when making digital versions of films: remove as much damage as you like, but do not carry out digital manipulations to improve the inherent quality of the film beyond that of an original print. Finally, if you come across a 'restored' film which is rock-steady, razor-sharp and completely grain-free, plot its position on the Walsh Restoration Chart, and send this off to those responsible, pointing out that they have achieved a negative score. If we all do this, perhaps we will have contributed in part to retaining some of the magic of cinema.

## »Who are these new archivists?«

This text sees me assuming the role of a futurist. So, as I stare into my rather hazy crystal ball (something that is perhaps done best late at night, with a good brandy in reach), let me tell you what I think the future will bring – and let's see if, in a few years, I turned out to be right or not.

Audiovisual archiving, I believe, will become increasingly important in the future, for the simple reason that our world will not cease to produce audiovisual records. On the contrary, it will produce ever more audiovisual records in place of other documents and thus there will be a greater need to collect and preserve these records.

I also believe that the future of audiovisual archiving will see a fusion of the various sections of archival institutions dealing with audiovisual records, whether film, television or recorded sound. This is for the simple fact that the challenges of audiovisual archiving are going in one direction, and one direction only: digital.

The digital domain will ultimately be the domain where all audiovisual archiving will take place. When all access to and handling of audiovisual heritage material is digital, audiovisual archivists will use the same tools and procedures, regardless of whether they started out as sound engineers, moving image archivists, photo restoration specialists, or information technology experts.

This point does not just concern the future, however, as this future is here already. The final report of a study called *Challenges of the Digital Era for Film Heritage Institutions*, published in December 2011, bluntly states: »Cinema is Digital«. This is not a possibility or a future