Traditional Film Restoration Techniques in a Digital World

By Peter Eaves

In our present world of great technological advancements, we are constantly aware of the enormous changes that digital technology has made to our industry. It seems that every week we read how this technology has changed the way production and post-production in both film and video is accomplished. And frequently, we are treated to the re-release of great movies in their new digitally restored versions. The results achieved are truly amazing, but as awe-inspiring as these results are, an often overlooked fact is that the cost of restoration via digital techniques frequently surpasses the original cost of production. The use of traditional techniques for restoring film elements is the methodology of choice for the majority of film producers and distributors. This paper will describe some of the considerations that must be made when assessing the condition of available printing materials and how this assessment is used to determine the equipment and techniques required for a successful restoration.

Before any restoration effort can be successfully embarked upon, a complete and thorough inventory of available materials and their condition must be undertaken. The restoring facility must know what elements are available for its use. Unfortunately, it is not uncommon for there not to be a complete set of elements for a particular show at any level. In such a situation, it becomes necessary to use elements of different generations, which produces the analog problems associated with grain, contrast, resolution, and other generational losses.

Physical condition of the available elements must initially be determined. This determination will dictate the type of equipment that must be used to properly achieve desired results with minimum risk to the physical integrity of the valuable material. Film that shows the detrimental effects of poor storage accommodates materials that exhibit dimensional instability or deformity. This determination will also indicate any special handling techniques such as liquid-gate printing or accommodation for dimensional change, that may be incorporated into the printing scheme.

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Typically, the initial determination of physical condition addresses the damage incurred to the emulsion and base surfaces of the film. Excessive dirt deposits on the film surface, if not too ingrained, can be removed by careful cleaning of the film, often painstakingly done by hand. Heavier deposits of dirt can be removed by ultrasonic film cleaning or even rewashing through a modified processing machine.

The condition of the film surfaces must be evaluated to determine physical damage, such as nicks, scratches, abrasions, and cinch marks. This damage, generally the result of poor handling, can result in visible, detrimental marks apparent on the film during projection. Results of the evaluation will dictate whether the film should be printed in a dry or liquid environment.

Damage to the base or support side of the film is frequently rendered invisible by printing in a liquid-gate system. The liquid of choice, perchlorethylene, having the same refractive index as the film support base, allows the light to pass without refraction, thus temporarily inhibiting the detrimental optical effects of the damage.

Such physical damage to the emulsion or cel side of the film, however, may result in the actual loss of the image-bearing layer, thus rendering liquid-gate printing ineffective. Less invasive damage that does not remove layers of emulsion can frequently be a good subject for liquid-gate printing. If liquid-gate printing does not provide adequate corrective therapy, alternate materials may have to be identified and located to replace those that exhibit irreparable damage.

The physical evaluation must also consider the integrity of the film. Damage to the film such as tears or perforation rips must be repaired in order to allow the film to be printed without any further damage. If these repairs are extensive, or cannot be seamlessly performed, then once again alternate materials may have to be identified and located.

Having to choose printing elements from differing film generations introduces the probability of contrast and grain difference, thus making the generational difference quite apparent. These problems can be dealt with to a great extent, as will be seen later.

Shrinkage

A commonly observed physical defect, lack of dimensional integrity, is the result of poor storage conditions. Shrinkage of motion picture film renders the carefully engineered and machined sprocket drives ineffective in the safe transport of such film in any film handling situation. This is because drive sprockets are engineered to accommodate a film's pitch or the dimension from the leading edge of one drive perforation to the leading edge of the next perforation. Shrunken film will no longer fit on the drive sprocket and extensive damage may occur.

Not only may the film be shrunken and possibly damaged, but the image may be grossly distorted due to uneven shrinkage patterns. Often the result of moisture loss, such shrinkage can sometimes be temporarily corrected by maintaining the film in a vacuum atmosphere into which moisture is introduced. Under such conditions, moisture may be absorbed into the film support in sufficient quantities to swell and expand it. This swelling may be enough to restore the film's dimensional integrity as well as reduce its brittleness.

In the event that reconditioning of the film does not produce the required result, printing equipment may have to be modified to satisfy this nonstandard dimensional requirement. Many pieces of film handling equipment can be equipped with modified drive sprockets, machined so their root diameter is reduced, thus decreasing the distance between the teeth of the sprocket. This will more appropriately match the shortened distance between the leading edges of the shrunken films perforations and works very well for contact printing.

Optical printing equipment has even more forgiveness for shrunken film, since the registration pins and pull down claw can be adjusted for an almost limitless range of perforation pitch. However, while aiding in the solution of one problem, optical printing introduces its own detrimental effects: it is likely to increase the contrast in the resulting generation and may introduce some of the other artifacts commonly associated with optical printing, not to mention the increase in cost.

Photographic Evaluation

A photographic evaluation of the materials must also be undertaken. This evaluation will make known such conditions as exposure levels, contrast, granularity, color fading, misalignment of separation elements, etc. Based on this evaluation, special printing or processing conditions may be determined to be necessary.

A great deal of information may be obtained from viewing the film on a color analyzer used to establish printing exposures. But many problems, such as color fading, flicker, excessive grain, contrast, and misregistration of separation elements, may not become apparent until the film has actually been printed and screened. A photographic test of a representative sample of the film is typically performed, taking the images through all of the anticipated stages and screening the end result. The results of this test may dictate a course of action with modified processes peculiar to the specific project.

For example, if the test should demonstrate alignment of separation elements, it would be necessary to ascertain the degree of misalignment and make suitable adjustments to the printing equipment. It may even be decided to use another piece of printing equipment more suited to the task. For the task of printing separation materials, three-headed optical printers have been manufactured. These specialty printers have three projector heads, one for each of the yellow, cyan, and magenta separation rolls; each of the heads can be individually aligned to present a perfectly matched image to the camera. This is a technique that was previously very time-consuming and painstakingly performed on conventional printing equipment.

If the film test exhibits especially high contrast levels, careful selection of film stocks can be combined with modification of the printing and processing parameters in order to produce a more pleasing visual result. The understanding and judicious use of sensitometric analysis enables the modern film laboratory to make extremely accurate predictions regarding the result of a process change.

Similarly, excessive grain can often be controlled by carefully selecting the film emulsions to be used. Recent advances by film manufacturers in improved emulsion technology have greatly aided the film laboratory in its endeavors. Finer grain structure, better color reproduction, and other advancements have served to make the restored elements look and feel much closer to the original than was previously possible.

Time and Printing

Digital technology itself has been called on to aid traditional techniques. With microprocessors now routinely used in timing, printing, and processing equipment, more reliable and repeatable methods are available to us.

Some of us still remember the days when the edge of the film was notched to indicate a timing light change; maybe fewer of us recall manually moving a dial indicator to preset the next timing light. Timing changes that were too close together created many headaches and many remakes. Now microprocessor-based, these functions are automatic, reliable, and highly repeatable. While timing changes used to be recorded with a pencil and a pad, the exposure information along with the cue point information is now gathered at the analyzer and fed into a database. This information can be supplied to the printer via a computer network's data stream, negating the need for timing cards or fragile, punched paper tapes.

Printing equipment, too, has been updated. Exposure functions, once performed by electromechanical light valves, are now accomplished through the use of electronic light valves able to accomplish their goal within nanoseconds as compared with fractions of a film frame.

Conclusion

The modern film laboratory, when dealing with the preservation and restoration of film using traditional film-to-film techniques, must make use of many disciplines. It must call on the sciences of physics, chemistry, mechanics, optics and, occasionally, a little magic to achieve the required end result. While the actual procedures used have not changed much in past decades, many of the tools available have been modified, improved, or newly developed over that same time period. Although no claim can be made that traditional film techniques can do all that modern digital technology can do, it can be justifiably argued that film techniques are just as effective and, in many cases, considerably less expensive.

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