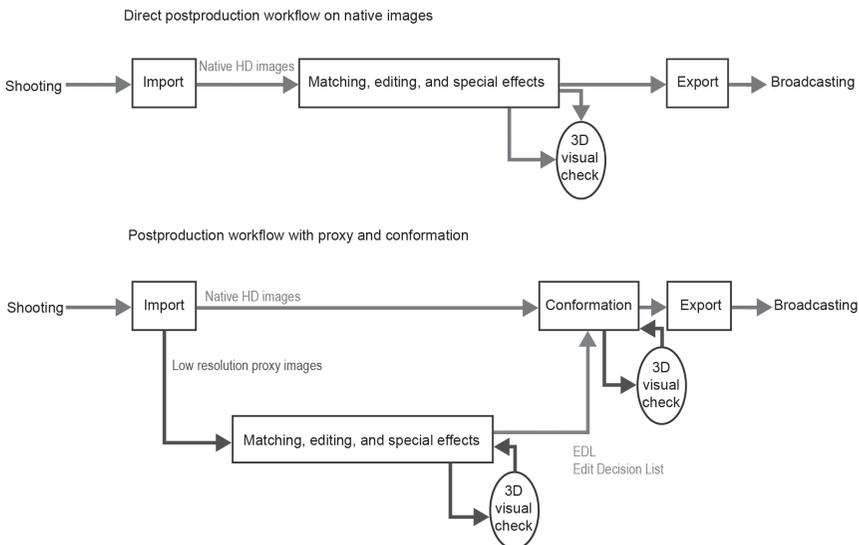


Professional 4K workstations are used only for finishing and color-grading tasks, when images of original size and resolution are required. Shot selection and editing are usually performed on proxies, *i.e.*, smaller versions of the original images. The lists of operations to be performed (*edit lists*) are established with Final Cut Pro or other editing software. Only at the end of the chain are operations in the edit list, often including color grading, applied to the original images. What is more, this is done in a single step in order to minimize handling of the huge and valuable original files.

Postproduction and 3D

Working on a 3D movie means not only handling twice as much information, but also adding a number of specific steps, such as clip matching and 3D validation, to the workflow. It also involves creative editing in stereoscopic depth budget, depth transitions, and overlays, as well as positioning subtitles carefully at the correct depth.

Each studio organizes its own workflow according to deadlines and production requirements, while coping with a budget that is almost always fixed beforehand. We can divide the postproduction workflows into two main categories: direct image handling and processing with proxies. Both methods are presented in the two simplified diagrams below.



Two types of workflow coexist: with proxies for large productions and with direct processing (closer to live editing) for short-cycle productions.

At the end of postproduction, images and sound are combined in the so-called “DI” (Digital Intermediate), which contains the finished film in its best quality. The distribution chain will be responsible for reducing the amount of DI data to the minimum necessary required by each involved channel (DCP 2K or 4K for theater distribution, AVCHD for TV broadcasting, Blu-ray Disc or DVD for sales and rental stores, etc.).

Direct Postproduction

Once the rushes are imported and checked, the *workflow* is dedicated to special effects and editing. Workstations manipulate the images in their native formats directly. Editing software, also known as *edit suites*, fortunately comes increasingly with more and more 3D-specific features. When this is not the case, plugins and other third-party software add-ons improve the range of available tools. The most common editing suites are Apple Final Cut Pro and Avid DS. The stereoscopic add-on of choice for Final Cut is Neo3D from GoPro-CineForm. The 3D add-on tool for Avid is free and called MetaFuze.

Postproduction with Proxy Files

In the case of big productions such as blockbuster feature films, data size is such that native file editing is very detrimental. So, low resolution proxy copies of the original are used for editing. All editing operations are recorded and then applied to the original images in an offline rendering step.

The list of recorded operations is often called the *edit list* or EDL (edit decision list). It is quite common to edit – or at least to do a first draft of the edit – in 2D, as a non-stereoscopic film. The 3D check and adjustment are done in a second round, and only on the takes selected during the first edit. Color grading and 3D corrections are performed simultaneously on a professional editing station (see box above) powerful enough to handle the huge data flow of native-size stereoscopic images.

Importing and Matching

The most expensive sentence used in the cinema industry, “We will correct it in post,” takes effect as of the first step, when images are received from the shooting stage. Strictness is always mandatory during this importing step, and even more so in 3D.

File Names

The left and right files of each imported stereoscopic pair must be named identically with “-L” and “-R” suffixes to distinguish the left one from the right one. If the files are already named correctly, it is mandatory to check on a 3D display that no switching has occurred. Indeed, inverting two files afterwards will become difficult, if not impossible, after a series of destructive handling steps such as overlays, fades, cropping, etc.

Metadata

Ideally, the various tools used in a workflow should keep all the ancillary data accompanying the images, *i.e.*, the metadata, intact. Unfortunately this is not always the case. So, to avoid many problems, we create a database in which we save all metadata as soon as they become available. Thus, as the footage is being imported, the metadata from the shooting location (cameras’ convergence angle and interaxial distance, aperture, zoom, focus, position, and orientation of the camera) are saved. A number of devices insert this type of data in the images but, alas, many programs ignore them at the very next step. After a half-dozen steps, the workflow has lost track of most of the information painfully inserted at the beginning; hence the advantages of storing them in a separate database that stays accessible in all workflow steps. Such data are precious, as all shooting conditions, including convergence and interaxial distance of the cameras, are very important parameters when you want to mix images from different sources in postproduction, *e.g.*, an overlay of two takes, addition of CGI elements, etc.

Matching

Depending on the matching quality of the image pair at shooting time, the amount of corrections required will be large or small. The base rule is that between the left and right images of a pair, the only permitted differences are horizontal parallax shifts. All other discrepancies must be removed before any edit. Therefore we will correct:

- geometric disparities: zoom, rotation, and vertical position differences;
- colorimetry disparities: exposure, gamma, gain, and contrast;
- retinal rivalry: objects, reflections, light sparkles, etc., present in a single image or present in different places in the two images; and
- synchronization.

Most rivalries are corrected using purpose-built tools such as the CineForm FirstLight add-on for Final Cut Pro or just the free utility StereoMovie Maker.

In some cases, especially when significant airbrushing is anticipated, we had better check whether another take may be usable, as touching up a single image is tricky and may introduce other unforeseen rivalries. Painting a pair of stereoscopic images is almost impossible to get right in a reasonable amount of time without using specific software. Fortunately, such tools are beginning to appear!

Color Grading

Grading – or color adjustment – can be done independently from color disparity corrections. However, since these operations are in the hands of the same operators and performed on the same machines, they are often coupled.

Synchronization

Left and right shot synchronization is theoretically perfect when the cameras are time-locked by a control signal called “genlock.” When cameras are not synchronized at shooting time, time alignment is required. If both shots are accompanied by a soundtrack, you can superimpose the waveforms of the audio signals to check for any synchronization error. Otherwise, locate in the left shot a fast motion, such as a clapboard closing at the beginning of the take, then look for it in the corresponding right shot and align the two shots. The accuracy will be of course less precise, with the risk of a half-image shift in the worst case. Here again, various software packages can do the job automatically.

Storage

Once both shots are matched, we can save them in the trim bin. With a specific 3D codec, such as CineForm Active Metadata, which is used by the combined Final Cut and Neo3D, the pair of shots is mixed in a single file. With less 3D-savvy editing software, use the least destructive codec allowed by the limitations of the available hardware; then mark the left and right files clearly. In addition to names ending in “-L” and “-R,” we can also categorize the clips in various ways. For example, with Edius Grass Valley, the red color is attributed to the left shots’ icons and cyan is associated with the right ones.