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Title: Digital Imaging Workflow in Microscopy and Microanalysis

Digital Imaging has replaced photography in many areas of microscopy. New Scanning Electron Microscopes (SEMs) are, for example, almost exclusively digital. With this evolution from photography where there was a well established workflow to digital imaging where there were limitless variations, the "correct" workflow has yet to be firmly established .This talk will propose a workflow that can be thought of as a starting point for establishing a best practices for digital imaging.

One of the most important developments of digital imaging is often overlooked. Storage of images is virtually free and even with our current capacities limitless. Information technology professionals are talking in terms of petabyte storage systems, and there is no sign of an upper limit. Most microscopists are not accustomed to calculating storage requirements because film had a physical size and storage was limited by the size of the film. A calculation of the magnitude of a terabyte worth of SEM images is most instructive.

Polaroid film resolution in the SEM is limited to about 1000 lines. A digital image of 1280 x 960 pixels would match this resolution. Each image is about 1 megabyte. How much data is a terabyte? If we assume that a microscopist has a career of thirty years and works 220 days per year for 10 hours a day, this microscopist would have to take an image every six minutes to reach a terabyte of data.

Unlimited and virtually free storage is an important starting point because it relieves the constraint of storing a single copy of an image. Because the image is in digital form, a copy is identical to the original. A copy of a photograph was always inferior so the original film was unique. Digital imaging does not have this constraint. The ethics policy of MSA suggests that most if not all image manipulations should be documented. Some minor corrections need not be documented, but in many instances, it would be wise to have the original.

The workflow that I would propose is therefore that the acquired image be saved in uncompressed TIF file format and stored on either a CD or DVD (non-rewritable). This insures that an original can always be produced that has not been manipulated in any way. This is analogous to "film". Subsequent manipulations can be saved as separate files as the number does not get unworkable even if ten or twenty versions are created.

Many database programs suggest work flows that contradict this model. It is tempting to "fix" the image prior to saving. If we have an original image, there can be no question about subsequent manipulations, because the manipulated image can be directly compared to the original.

Another component of the workflow that needs further discussion is to establish better guidelines for defining the resolutions required for acquiring, storing and printing images from the wide variety of imaging systems in microscopy.