

## Costs Of Photographic Film Versus Digital Imaging

The question of digital imaging versus photographic film imaging keeps appearing on microscopy related listservers, in other media, as well as in conversation. While there are many important sides to this question, such as resolution and the possibility of archiving images, the costs of digital imaging vs. film imaging are less well considered. So Microscopy Today recently invited Michael Bode of Soft Imaging Systems and Geoff McAuliffe of the Robert Wood Johnson Medical School to discuss this issue, based on their well reasoned and informed comments they have posted to the MSA microscopy listserver.

### The Case For film

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Recording images from the TEM with photographic film has a number of advantages over digital imaging. The first advantage is cost. Most institutions, whether academic or industrial, already have a darkroom so there is little or no start up cost. Even if a new darkroom must be equipped, a professional quality enlarger, lens, timer, paper cutter, paper safe, easel and safelight are easily under \$2500 total. Trays and chemicals are inexpensive while an automatic print processor, which speeds up work significantly, while reducing exposure to chemicals, is about \$2500. Additional lenses, so the same enlarger can be used for other film formats (35 mm), are about \$200 each. The technology is mature and will not be obsolete

for the foreseeable future. Film for the TEM, 3 1/4 by 4 inches, is a bit less than \$0.70 per sheet, less in bulk. Glossy photographic paper, 8 by 10 inches, is about \$0.50 per sheet. Modern resin-coated photographic papers do not need extensive washing and can be hung up by a clothespin to dry. Chemistry for processing film or paper is inexpensive, one gallon of D-19 develops 120 films while one gallon of Rapid fixer processes 700 films. One thousand films could be processed and printed (including extra paper for test strips) for about \$1600. Adding it all up, a complete new darkroom with processor and 1000 films and prints for \$7600, less if you have a darkroom. The cost of a digital acquisition system for a TEM is 3-6 times that figure and it will be obsolete in 3-5 years.

A second advantage of film is information content, film has many times more than digital. Some might argue that there is far more content in a TEM negative that is needed for either viewing or reproduction and this is true. However, if one needs to enlarge a small portion of a TEM negative by a factor of 5, the information content in film will not be degraded, as it would be with digital.

A third advantage of film is that it has been proven to be highly stable in storage. Black and white film that has been properly processed and stored has a life of 100 years or more. Conversely, some magnetic media show signs of degradation in 5-10 years or less. Optical storage media should last longer but still do not have a track record. Furthermore, as technology advances, equipment to read older storage formats is becoming unavailable.

I will be the first to admit that traditional film and paper processing has its weaknesses. While making prints can be time consuming, a processor is a great asset. Study prints need not be artistic masterpieces and anyone (interns, work study students) can learn to print in a few hours. Prints for publication are another mat-

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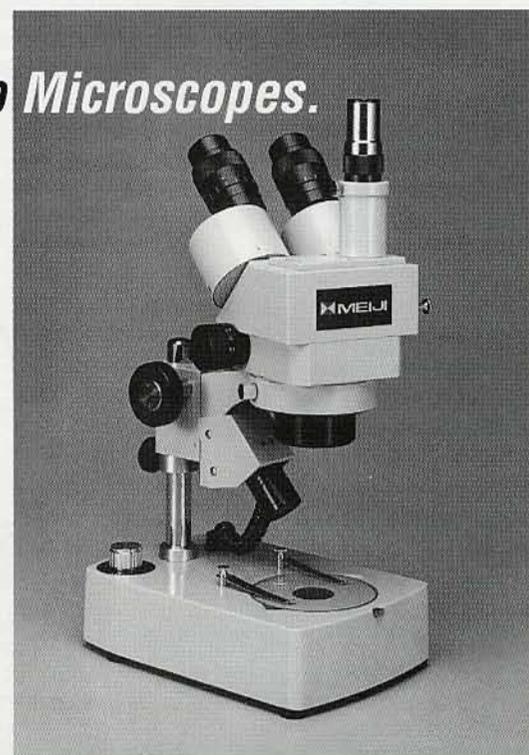
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ter. In a recent week I spent every afternoon in the darkroom getting prints just right for a paper. Should the print be a little darker, a little lighter, a little less contrast, a little more contrast? Then there is the trimming, the mounting, the scale bars, the arrows, extra sets for the reviewers, the other authors, etc. We've all been there. The whole job could have been done in one day with Photo-Shop. However, the negatives would still have to be scanned in and I would need a high quality printer. Alternatively, these tasks could have been contracted out.

In the final analysis the question of film versus digital will boil down to a time versus money decision; slower, cheaper film versus faster, more expensive digital. Different labs will have different needs. Several of my colleagues are choosing to merge the technologies. They acquire their images, both light microscopy and TEM, on film and then digitize selected images for transmission to collaborators, inclusion in grants and manuscripts, etc. while retaining the quality, storage advantages, and low cost of film.

### The Case For Digital Imaging

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Geoff eloquently makes a case for film as opposed to digital image acquisition and processing. And while I agree with many of his points, I also have a slightly different point of view on several aspects.

Let's start with the darkroom. While Geoff is correct in saying that many institutions already have a darkroom or have access to one at no cost, this only tends to hide the cost. Somebody has to build the darkroom and somebody has to pay for building main-

taining and equipping the darkroom. If this is paid out of some overhead and not paid for directly, then the cost is hidden in that overhead, which would be less without the darkroom. But in the final analysis, this cost factor does not even play a significant role, as we will see below. And by the same logic many institutions and companies do have high quality digital printers, which we should take out of the equation as well. So, to be fair I will include both darkroom and printer for a cost comparison.

Let's take Geoff's numbers for prices: \$6000 to equip a darkroom and \$1,600 for negatives and paper and chemicals for 1000 negatives, i.e., \$1.60 for each negative. As I mentioned above, I will include the construction of a darkroom in the equation. As a rough estimate I will assume \$10,000 for the entire darkroom: building material, space, water, power, sewer, labor cost, etc. Further, let's assume, that the darkroom has a lifetime of about 20 years, which leaves us at \$800/year in fixed costs plus \$1.60 per negative without calculating the cost of labor we will add later. On the other hand, a complete digital imaging system with a high quality printer is roughly \$ 60,000. Let's assume only a lifetime of 10 years for this equipment.

Item	Film	Digital
darkroom	\$800/year	\$0
digital system	\$0/year	\$6,000/year

So far, film looks pretty good. Now let's add the cost for acquisition and assume that we use 100 negatives a week, and that only 10% of the images are actually printed. The acquisition costs for film consist of negative (\$0.70), chemicals (\$0.05), storage

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