THE DYNAMIC MICROSCOPE

by H Jay Margolis

The Era of Static Microscopy is Over

It has become a cliché to say that "light microscopy is undergoing a renaissance." That is true enough in terms of *types* and *techniques of research level instruments.* But the basic *configuration* of microscopes has remained substantially the same. Microscopes are still plagued by uncontrolled aberrations. They still focus by mechanical movement. They still utilize out of date objective design approaches. This situation should no longer be tolerated if there is a way to change it--and there is. It is now time for present-day *static* microscopes to confront the future and become *dynamic.*

By the 1980's virtually every major manufacturer of microscopes committed to a single optical configuration: infinity correction. This concept was not new but its successful industry-wide implementation and acceptance was. What was missing was the recognition that this simply made a *static* system a *better static system.* Even today, a textbook from 1900 is still valid in terms of how to correct preparation-induced aberrations. And with all too rare exceptions, the objective still has to *move* in order to focus.

InFocus

Then in the later 1990's Infinity Photo-Optical Company introduced my first generation InFocus module and successive versions thereafter. When added to most microscopes, InFocus can be activated to optically change focus. Then, by mechanically resetting the working distance of the objective, deviations (particularly spherical aberration) caused by cover glass thickness, media or preparation refractive indices can be compensated. All microscopes are set for one standard spherical correction. But preparations and other factors often deviate from the original factory-set correction for spherical and other aberrations. InFocus can be used to reestablish that setting, significantly enhancing imagery. In and by itself, InFocus can be used *either* for optical focus *or* spherical aberration correction (with mechanical reset)--but not for *both* at the same time. However, because it is easily used on most microscopes or in breadboard setups, InFocus remains the *single most important corrective addition in microscopy.*

Nevertheless, InFocus is a modular *attachment.* Even if equipped with InFocus, the finest research instruments can not focus high NA objectives *optically* without the introduction of *some* error. In order to *completely solve this,* something *beyond an added device* was necessitated. Ultimately, that required a break with present-day thinking and reaching the conclusion that the very configuration of microscopes was deficient.

Although it has been assumed that the configuration of the modern microscope has reached maturity, that assumption may well be in error. As things are today, microscopes (equipped without InFocus) use infinity correction with fixed tube lenses. Yet, if deep optical focus is to be performed free of mechanical movement, there must be a means to progressively compensate resulting induced spherical aberration. Ever since 1837 when Ross--acting on Lister's suggestion--made the first objective with a correction collar that separated the objective lens elements, it has been known how to correct spherical aberration due to preparation-induced factors. Very small separations of the lens elements act primarily upon the anterior Gauss particulars. That is almost precisely the opposite of what happens with InFocus which operates on both anterior and posterior Gauss particulars. I came to the conclusion that a *juxtaposition of the Gauss particulars must be utilized in order for a microscope to focus optically and also compensate aberrations.*

The question of how to juxtapose these two Gauss particulars in a practical way was uniquely answered by using *semi-objectives which mate with a common rear amplifying lens.* If the rear amplifying lens is movable or deformable, the result is an analog to the correction collar--but applicable to *all* semi-objectives used with it. This is the key to the efficiency of the Dynamic Microscope. By having the spherical correction transferred to a common rear lens that is either moveable, deformable--or both--the costs associated with producing objectives with built-in correction collars are dispensed with. Correction collar equipped objectives are usually costly and complex (some use twenty-six or more elements). Research budgets are strained. But by using semi-objective construction, these mechanisms are not needed. Moreover, for the first time, whole series of semi-objectives can be offered *matched to the camera format coverage utilized.* That is, most complex correction collar equipped objectives are calculated to fill large eyepiece fields. Today, CMOS and other formats are small. The semi-objective approach therefore not only provides corrective means, it also frees the need for expensive objectives of great complexity in order to provide high-quality imagery. It is now possible to produce *planapochromatic semi-objectives calculated for use with modern sensors--able to correct aberrations--that are priced so that the majority of reseachers can afford them.* Of course, it is still possible to make objectives for larger fields using the semi-objective approach. But just as photographic cameras have lenses matched to their formats, so can microscopes now have semi-objectives do the same.

All this is possible because the Dynamic Microscope is literally composed of the same component counterparts to all regular infinity-corrected microscopes, but with moveable or deformable elements that impart dynamic characteristics. This means that the Dynamic Microscope is not a new type of microscope or a new technique. *Whatever a present microscope may be, it may also be made dynamic.* Consequently, a *new level of microscope maturity will come to be.*

Significance of The Dynamic Microscope

For the first time, microscopy is possible where virtually all aberrations induced by the preparation can be compensated. Imagery can be captured more perfectly than ever before and scans can be made quickly in real time. Compression and displacement of cell structures can be completely avoided. Several microscopes can be assembled in a protractor arc or even in a 360-degree vantage pattern; once positioned and contents settled, minute focal adjustments can be made without disturbance or can be maintained even if there are temperature or atmospheric fluctuations. Software can be used not only for activation, but to determine minute amplitude changes with resultant data determination. The common rear lenses can be modular components for various techniques or technical efficiencies. Objective construction is simplified and less costly to produce; carried over to the researcher/consumer, quality optics become more affordable. In the Dynamic Microscope, the full potentials of microscope construction and usage are realized. A new era of extended capabilities awaits.

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The links below take you to all the details on this development. H Jay Margolis and Infinity Photo-Optical Company now seek to license this pending patent, presently filed in the USA and to be extended worldwide.