From the McArthur to the Millennium Health Microscope (MHM): Future Developments in Microscope Miniaturization for International Health

Keith Dunning¹ & J. Russell Sto thard²

¹ 10 Albany Rd, Bedford MK40 3PH, UK. E-mail: keith@dunningassociates.com;
² Biomedical Parasitology Division, Department of Zoology, Natural History Museum, London, SW7 5DB, UK. E-mail: r.stothard@nhm.ac.uk

The ambition to produce a functional miniature microscope suitable for tropical disease diagnostics in developing countries has exercised the ingenuity of many talented designers over the last 75 years. In the early 1930's the late Dr John McArthur produced the first prototype of his pioneering folded optic design and this portable gem measured a mere 102 x 63 x 51 mm, yet was able to deliver everything which would be expected from a conventional bench microscope of similar optical specification (see Fig. 1A).

To achieve this high degree of miniaturization McArthur employed a folded optical prismatic system: light entered from above the microscope via a mirror and then passed through a small condenser to the specimen, a revolutionary concept at that time. The objectives were arranged below the specimen and the image was reflected by two prisms to the eyepiece. A comprehensive range of interchangeable objectives was offered including 4:1 and a 100:1 oil immersion. McArthur's vision was predicated on the widespread use of his ultra-portable microscopes for the diagnosis of tropical diseases in peripheral health centers [see Box 1]. Following his machined metal model a later version, produced in molded plastic by the Open University (OU), took the design even further forward with the realization that future low-cost microscopes would inevitably utilize plastic fabrication technology. During his life McArthur received many awards, including the Duke of Edinburgh's Prize for innovative design in the 1980s for the OU model, but was perhaps never given full recognition for his pioneering work on microscope design nor for his studies of malaria and mosquitoes in East Asia.

Despite good intentions, McArthur's vision of revolutionizing the way microscopy could be used in tropical diseases was sadly never realized. Even with the cheaper OU model, the cost of the instrument was still out of reach of the comparatively meager financial budgets of Ministries of Health and without an appropriate technology transfer/implementation model between north-south country partnerships, all initiatives ultimately stalled. Although an eminently practical solution in microscope technology, the McArthur microscope was largely unaffordable for its targeted health market. Sadly the production of the McArthur microscope ceased following his death in 1996 and the international health scene lost a longstanding advocate and a strong voice for practical field microscopy.

Inspired by McArthur's work, a small group of Cambridge designers including Keith Dunning and Richard Dickinson (former Head of Design for Sinclair, UK) launched a new folded-optic microscope in 1990, subsequently licensed to Meade Instruments USA and marketed as the Readiview (see Fig. 1B). Like the McArthur, the Readiview is extremely compact and measures 105 mm in diameter x 25 mm in height, yet offers full functionality with magnifications of 80x and 160x. Three dimensional optical folding enables the microscope top to form a generously sized stage and the articulated lighting arm provides bright field, dark ground and reflected illumination dependent on position. Unlike the McArthur, the Readiview is capable of viewing opaque specimens in addition to conventional microscope slides and became increasingly popular amongst amateur and professional biologists alike during the 1990s. In 2004, a companion microscope, the Trekker, was launched for those requiring a low power (35x) version for fieldwork in forensics, botany, zoology, entomology and paleontology (see Fig. 1C). Together with its low cost, good ergonomics and supreme ease of use the Trekker has become evermore popular as an introduction to microscopy for younger people. More detailed technical descriptions of the Readiview/Trekker concept may be found at www.looksmall.com.

With the better affordability of the Readiview, at approximately 80 USD and at least a tenth of the price of a suitable conventional compound, it was perhaps time to revisit McArthur's original vi-
Microanalysis
detector technology from e2v scientific instruments

www.e2vsi.com

SPECIAL SERVICES

Microscopy

SiriusSD
Silicon drift detector for EDS applications

SiriusSD is a silicon drift detector designed to make short work of X-ray analysis. Its industry-standard restored preamplifier output provides some compelling benefits.

Contact us today for information on how you can upgrade your EDS system to include a SiriusSD detector, or for details of system suppliers offering SiriusSD.

Consider the SiriusSD advantage:

- No liquid nitrogen
- Analytical quality performance
- High rate capability
- Excellent resolution
- Stable peak position and resolution over a broad range of count rates
- Flexible system integration

see what we’re made of

STOP HASSLING WITH MULTIPLE SERVICE CONTRACTS!

START by putting all of our instruments under one service contract with MAS (regardless of make or model). Our expert EM SERVICE GROUP has the knowledge and skills to keep your instrument working at its best.

TEM’S / SEM’S

HITACHI TOPCON
JOEL ISI
AMRAY CAMBRIDGE

PREP EQUIPMENT
VACUUM COATERS
PLASMA ASHERS
SPUTTER COATERS
ION MILLS

SPECIAL SERVICES
STAGES
BEAM BLANKERS
CUSTOM DEVICES

NEW NEW NEW

Authorized service representatives for Gatan preparation equipment and Topcom TEM’S.

Contracts and On-Demand Emergency Service at Reasonable Rates from Factory Trained Specialist

800-421-8451

MAS

9415 Lakefield Court Suwanee, Georgia 30024 770-866-3200 FAX 770-866-3259
616 Hutton Street Suite 101 Raleigh, North Carolina 27606 919-429-7041 FAX 919-429-5518
ADVANCED ANALYTICAL PRODUCTS AND SERVICES
and with this innovation and with further validations in the field, e.g. and proven manufacturing techniques already developed for the Far East with many of the optical magnification range of lymphatic filariasis, for protists, the optical magnification range on par with the higher powered McArthur. In so doing, all children, and sometimes the surrounding adult community, is of interchangeable objectives (10:1, 40:1 and 100:1 oil immersion) for visualization of blood-borne helminths. For protists, the disease burden of infectious and parasitic diseases in the tropics is alarming. More importantly, they continue to be a scourge of socio-economic development, keeping many populations entrenched in grinding poverty through prolonged illness.

For protists, the greatest culprit is malaria being present within 140 countries, placing some 3.2 billion people at risk (see http://www.who.int/topics/malaria/en/), while for helminths, 650 million people are at risk of schistosomiasis (see http://www.who.int/topics/schistosomiasis/en/). Collectively both diseases reap greatest havoc in continental Africa where in addition to these, several others are also worthy of mention: protists – trypanosomiasis, leishmaniasis and babesiosis; helminths – lymphatic filariasis, onchocerciasis and soil-transmitted helminthiasis.

Surprisingly, perhaps, is that nearly all of these diseases are routinely diagnosed by microscopic examinations of either blood, stool or urine specimens. Prior to inspection these samples would have undergone a simple preparative and staining procedure. For example, finger-prick blood is taken and smeared onto a glass slide, dehydrated and then stained with Giemsa which is sufficient to visualize Plasmodium spp. under oil emersion, or stool is size filtered through a specific mesh, smeared and stained with malachite green to visualize schistosome and other helminth eggs at 100x magnification. Visualization of eggs, often produced in copious amounts from the adult worm is critical to precise disease identification, forms the foundation of parasitological diagnosis (see http://www.who.int/bookorders/anglais/detait1.jsp?sesslan=1&cocodlan=1&cocodcal=15&coccchal=417). For a fuller description of tropical diseases, and their methods of laboratory diagnosis, reference should be made to Monica Cheesbrough’s excellent text entitled District Laboratory Practice in Tropical Countries (ISBN: 0521676304).

**Box 1: A short primer on diagnosis of tropical diseases**

In contrast with infectious diseases resultant from either viral and/or bacterial agents in First World countries, infectious diseases in the tropics are largely resultant from a totally different group of agents, the protists (single celled animals) and helminths (worms). While there are many viral and bacterial diseases which sometimes overlap between regions and populations of the world e.g. HIV, the disease burden of infectious and parasitic diseases in the tropics is alarming. More importantly, they continue to be a scourge of socio-economic development, keeping many populations entrenched in grinding poverty through prolonged illness.

For protists, the greatest culprit is malaria being present within 140 countries, placing some 3.2 billion people at risk (see http://www.who.int/topics/malaria/en/), while for helminths, 650 million people are at risk of schistosomiasis (see http://www.who.int/topics/schistosomiasis/en/). Collectively both diseases reap greatest havoc in continental Africa where in addition to these, several others are also worthy of mention: protists – trypanosomiasis, leishmaniasis and babesiosis; helminths – lymphatic filariasis, onchocerciasis and soil-transmitted helminthiasis.

Surprisingly, perhaps, is that nearly all of these diseases are routinely diagnosed by microscopic examinations of either blood, stool or urine specimens. Prior to inspection these samples would have undergone a simple preparative and staining procedure. For example, finger-prick blood is taken and smeared onto a glass slide, dehydrated and then stained with Giemsa which is sufficient to visualize Plasmodium spp. under oil emersion, or stool is size filtered through a specific mesh, smeared and stained with malachite green to visualize schistosome and other helminth eggs at 100x magnification. Visualization of eggs, often produced in copious amounts from the adult worm is critical to precise disease identification, forms the foundation of parasitological diagnosis (see http://www.who.int/bookorders/anglais/detait1.jsp?sesslan=1&cocodlan=1&cocodcal=15&coccchal=417). For a fuller description of tropical diseases, and their methods of laboratory diagnosis, reference should be made to Monica Cheesbrough’s excellent text entitled District Laboratory Practice in Tropical Countries (ISBN: 0521676304).
Find New & Used Microscopes

Join over 120,000 members at www.LabX.com

- Search over 1,250 microscope ads currently online
- Buy & sell all major brands
- Free "wanted" ads for quick results
- Sell with no commission or final value fees

Over 325 equipment categories including:

Microscopes
Microscopes Accessories
Clinical Microscopes
Electron Microscopes
Image Analysis
Microtomes
Histology/Pathology
Semiconductor

And Also...
Balances
Glassware
HPLC
GC
Mass Specs
Pipettors
Mills/Grinders
Spectrophotometers
And More!

Great Microscope Deals!

MRS-5

We are ISO-9000 certified and ISO-17025 accredited
Microscopy Calibration Standard
Now you can calibrate from 1,000X to 1,000,000X!

This is our fourth generation, traceable, magnification reference standard for all types (SEM, FESEM, Optical, STM, AFM, etc.) of microscopy. The MRS-5 has multiple X and Y pitch patterns ranging from 80nm (±1nm) to 2µm and 3 bar targets from 80nm to 3µm. There is also a STM test pattern.

Free web resource guide!

GELLER MICROANALYTICAL LABORATORY, Inc.
426e Boston St., Topsfield, Ma 01983
www.gellermicro.com

Microbeam Analysis Society (MAS)
2007 Topical Workshop

Hyperspectral Imaging II

Advanced Measurement Laboratory (AML)
May 1-4, 2007 NIST, Gaithersburg, MD USA

Special provisions for students and postdocs!

Pre-Registration Open
www.microbeamanalysis.org/workshops/HI-II