Folded-Optics Microscopes 1 of 2

The Nm1 (Newton Microscopes): Their Heritage

R. Jordan Kreindler (USA)

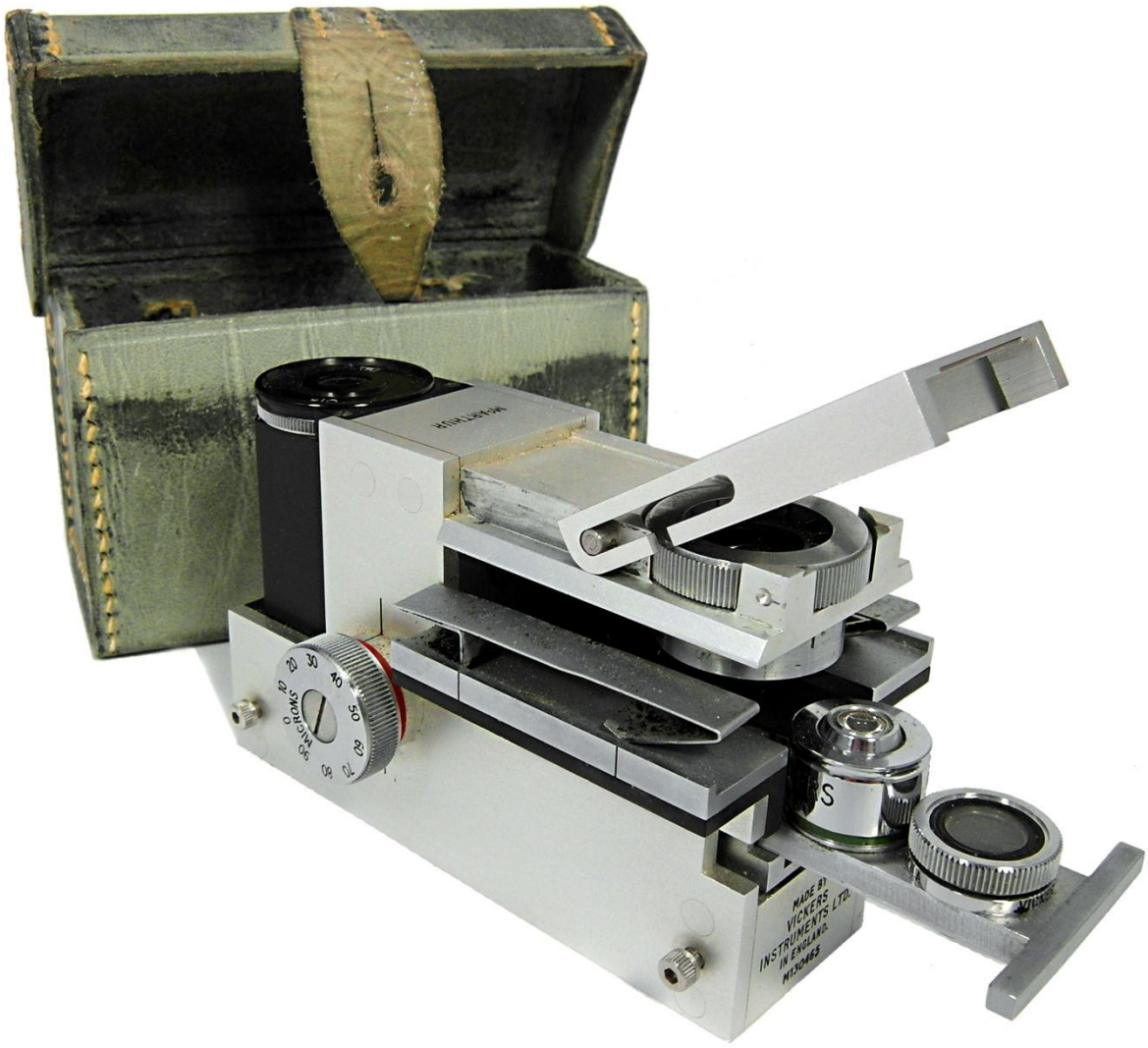


Figure 1. McArthur folded-optics microscope, made by Vickers Instruments, Ltd. England. (In case, approximate size: 11cm x 7cm x 6cm; weight: 1 pound, 5.6 ounces). Post 1963

Folded Optics Microscopes

At the beginning of the 1930s a seminal, and for field microscopes a "sea change", event took place. Dr. John Norrie McArthur (1901-1996) invented and produced the prototype of his first folded-optics microscopes. He discussed his microscope before the Quekett Microscopical Club in 1933. McArthur's name is now synonymous with his folded-optics microscope. This seems fully appropriate considering his importance in the evolution of portable field microscopes.

His compact instrument was approximately 10 cm x 6.5 cm x 5.0 cm. During WW II, Dr. McArthur was captured by the Japanese in Borneo, but allowed to continue his research by Japan's chief civilian administrator for Borneo, Tatsuo Inagawa-san. This freedom allowed Dr. McArthur a chance to use his newly designed microscope. This experience suggested to Dr. McArthur that some important changes to his original folded-optics design were needed. He made these changes at the war's conclusion. (Kreindler, 2011-2)

Folded-optics microscopes can trace their lineage directly back to the seminal work of Dr. John Norrie McArthur, begun in the 1930s. According to the 1974 Guinness Book of Records, Dr. McArthur's microscope was the world's smallest high power microscope. (Saitoh, 2006).

Mr. Saitoh was a Japanese physicist who was fortunate enough to meet Dr. McArthur in 1972/73 and then a decade later in 1982/83. The following is from Mr. Saitoh's personal account, with minor English corrections by the author, as told to Mr. Saitoh by Dr. McArthur,

> *I was studying malaria in Borneo, and was captured and confined in a camp by the Japanese army during World War II. Fortunately, however, Mr. Inagawa, a high ranking officer of the army administration, understood the importance of the research, and encouraged me to continue. He provided me with supporting money for research and even milk for my baby, under the difficult circumstances of getting foods.*
>
> *During my research, I desperately felt the need for a portable microscope usable in fields and under the kerosene lamp in a tent. After my release from imprisonment, I started developing compact microscopes with full versatility suitable for research. I am currently very busy in pursuing the ultimate design of models of various types, including the surface inspection model, to my complete satisfaction. (Saitoh, 2006).*

Figure 2. Plastic body McArthur microscope made for the Open University (OU), c. 1970s

The ubiquitous Open University (OU) McArthur microscope, Figs 2 and 3, perhaps best exemplifies McArthur's folded optics design. This microscope was made by Scientific Optics Ltd., Ponswood Industrial Estate, Hasting, Sussex England, for the OU; it was adapted for this use under Dr. McArthur's guidance. Traditional McArthurs (e.g., Figs. 1 and 4) are made of metal, and their cost was prohibitive for many users and uses. The unique OU McArthur

microscope was made of plastic (acrylonitrile butadiene styrene) and was, relatively, inexpensive to manufacture.

However, using inexpensive construction materials has had its effects on long-term durability. Now, decades later, many of the OU McArthurs show a significant loss, if not complete lack, of functionality. However, in spite of the, arguably, substandard construction material, particularly in making the objectives slider, possibly the instrument's "Achilles heel", many OU McArthurs are still in use. This probably demonstrates the general robustness of McArthur's design, even when less desirable construction materials are used. Many OU models have been converted to use AAA batteries and LED illumination, as the original battery compartment was too narrow to accommodate AAAs without modification.

Note the warning in Fig. 2, to "SLACKEN Focus screw after use". This screw was used to focus the instrument by flexing the objectives carrier. If left tightened, the plastic can lose its flexibility and fixed in place would be non-useable for focusing. This is one reason many OU models are now non-functional, and why the objective slider is likely the "weakest link" in the microscope's design.

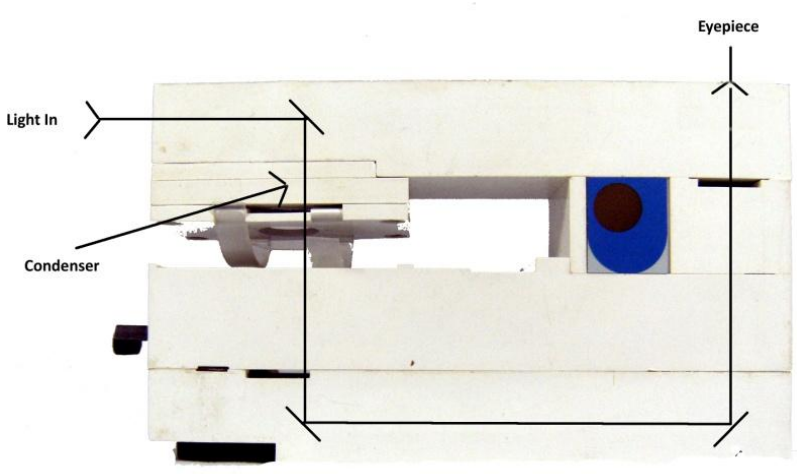


Figure 3. The folded-optical path in an OU McArthur microscope

As can be seen in Fig. 3, external light entering the McArthur is "folded" (reflected) through three right angles. It is first reflected downward to a second reflector, where it is transmitted across the base of the microscope to another reflector, and then reflected upward into the eyepiece. A slider can be moved so that the external light source is replaced by illumination from an internal light, e.g., lamp, or LED if modified.

Objects are seen "upside down" compared to conventional microscopes. The object to be viewed faces downward, as in an inverted microscope, rather than upwards toward the eyepiece. Because of this "inverted" nature of the microscope, only a single fine focus is needed, as the object viewed will always rest on top of the platform, i.e., at an almost constant distance from the top of an objective.

Mr. Walker (Walker, 2013) bought a McArthur microscope directly from Dr. McArthur in August 1968, for GBP 90. It had 10/40/100 objectives. Mr. Walker also said,

> *At that time, I remember, John told me that he had become so dissatisfied with the sales efforts of Cooke, Troughton & Simms that he had bought up their entire remaining stock of his microscope and was selling it 'himself'. I have no idea who took over its manufacture after that ...*

In less expensive McArthurs, as in some recent SLR cameras, and many folded-optics descendants, e.g., the FM-31, mirrors are used in place of prisms to reduce manufacturing costs.

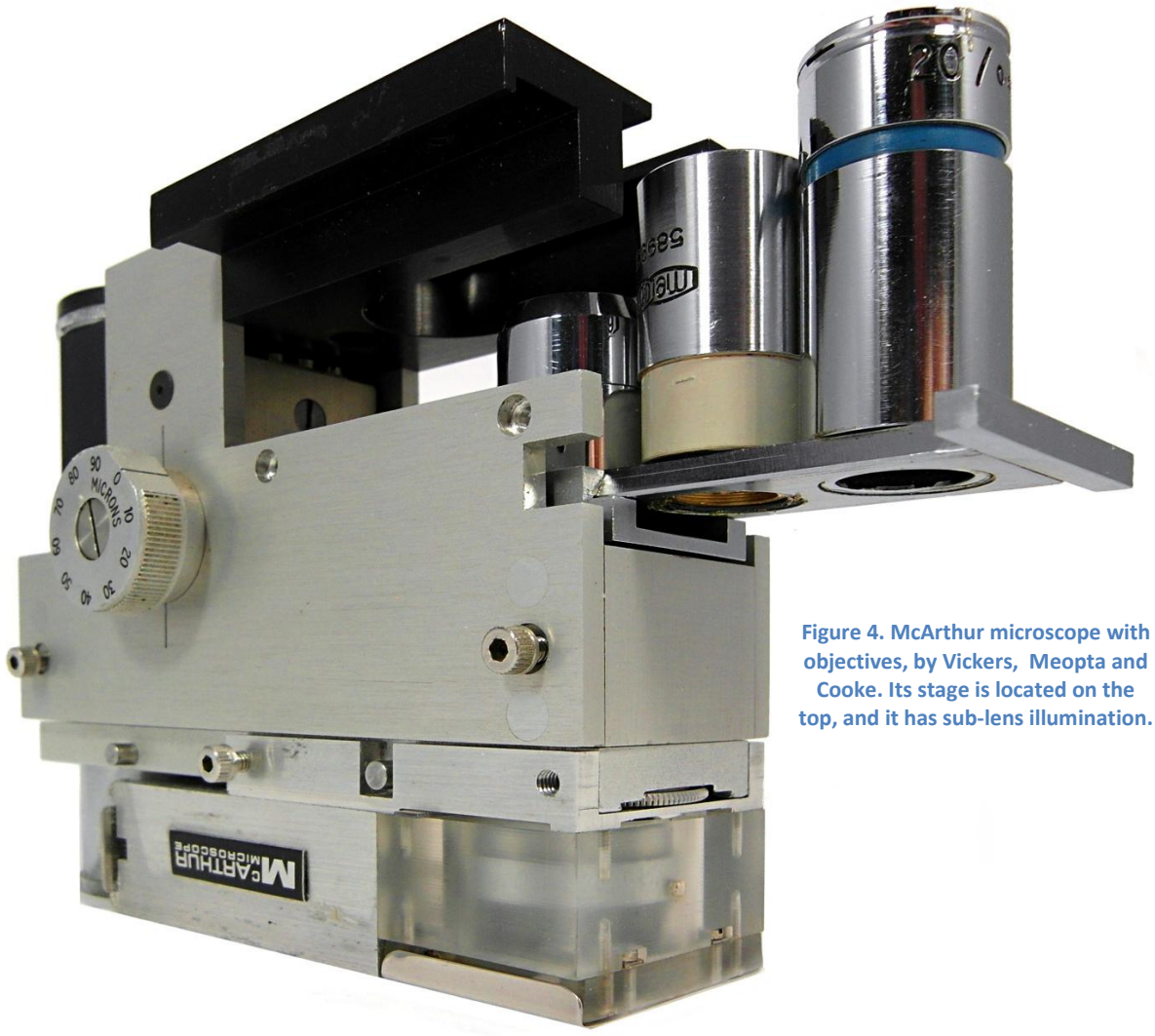


Figure 4. McArthur microscope with objectives, by Vickers, Meopta and Cooke. Its stage is located on the top, and it has sub-lens illumination.

Photomicrographer Spike Walker (Walker, 2013) was kind enough to provide the author with his following recollections about Dr. McArthur. [Author's note: What follows is a compilation from a number of emails received by the author from Mr. Walker.]

> *... I knew John McArthur very well from the mid 1960s onwards: he used to stay at our house in Stoke-on-Trent from time to time, and my ex-wife and myself once stayed in the caravan behind his cottage (one 'room' of which was a workshop where he worked out new ideas) in the Cambridgeshire fens. He last visited me in the early '90s but, although he recognized me, he was becoming rather confused by then. His microscope was his*

obsession. If he were designing a new attachment, he would carry the adapted instrument around in his hand and, if it did not 'feel' right, it was back to the drawing board.

His prototypes were machined by a car mechanic in a garage outside Cambridge. This craftsman was in demand by Cambridge University research departments, so much so that John told me that he had to get there very early in the morning to make sure he was at the head of the 'queue'!

I was sometimes surprised by his lack of understanding of optics. For example, when he was planning to adapt the microscope for blue-light fluorescence, he had me drawing a diagram to show him where the small tungsten-halogen lamp needed to be situated for maximum effect!

He was a most charming man (my ex-wife used to say that he could "charm ducks off water"). He, for instance, once turned up at the house carrying a bunch of primroses, which he had picked at the roadside for her. He had a particular passion for cornflakes. He once told me that, before the Japanese invasion, he used to sit and eat his breakfast (cornflakes no doubt) in the garden of their bungalow which was perched high above an estuary frequented by sea-going crocodiles. On the table would be a 'broom-handle' Mauser semi-automatic pistol which he used, between mouthfuls, to take pot-shots at the crocs.

One morning in 1969, while we were at his cottage, he suggested we have breakfast in the garden and out came the table and chairs, tablecloth, plate, cutlery and a Webley air pistol. I do not think that my wife and I made any comment but just sat and waited to see what would happen. He loaded the gun, started to munch his cornflakes, and then carefully aimed it at one of the ventilators on the roof of the pig farm across the way and fired. "Plus Ça change....."

... John was never satisfied with the efforts of the companies who were entrusted with the task of manufacturing his 'baby' and always managed to fall out with them, sometimes terminally!

He remains the only person I have met who claimed to have eaten human flesh! He told me that it occurred (before the arrival of the Japanese) during the festivities associated with the wedding of a child of a local chief As John [along with another] *were the honored guests, they were served with food by the chief himself. After the meal, John congratulated him on the excellence of the pork, to be told that it was actually someone from a neighboring village. The conversation may have occurred in 1989, but it is not something that it is easy to forget!*

In order to keep himself sane during his time as a prisoner, he began covertly to write an encyclopaedia of microscopy, on whatever scraps of paper (wrapping paper, labels from tins etc.) he could scrounge. Unfortunately the camp was bombed and the remains of the book were finally recovered from the bottom of a water-filled crater. John actually showed me what remained, [it was] *a wad of compressed pieces of muddy brown paper, like half-finished tobacco.*

He was a very handsome man - with his white wavy hair and goatee beard: so much is evident in photographs of him, but he also had a very attractive lisp-like impediment, which my ex-wife thought devastating.

John once showed me the prototype of his microscope which he constructed as a student and which he said he used to 'revise' Histology slides while travelling between his home and university department 'upstairs' on an open-topped London bus. It was made from a block of wood of the approximate size and shape of the familiar instrument, bored through to take x40 objective, an eyepiece and two 90 degree prisms, the latter obtained from an 'ex-War Dept.' store. There was no condenser.

From what I can remember, the objective was fitted in an RMS-threaded ring but have no recollection of the means of focusing it. In any case, I imagine that John must have published these details because he was very proud of his invention. He had a fitted case in which he carried the microscope and all its accessories and delighted in dismantling the instrument and reassembling it in its various guises with such dexterity that he reminded me of an armourer field-stripping a submachine gun.

John was convinced that the microscope could be of immense value to medical workers in inaccessible areas in the tropics, allowing them to examine blood samples for blood parasites 'in the field'. Not only was its extreme portability an issue, it could he thought, be easily dropped in from a low-flying aircraft without a parachute if suitably wrapped in foam rubber and fitted with a brightly-coloured 'streamer' for visibility. I seem to remember his mentioning that a 'feasibility study' was actually carried out over an airfield but he certainly tried it out by dropping it from the window of a flat in a multi-story block. ...

His son from his first marriage, took one of the microscopes on a British Schools Exploring Society expedition ... sometime in the 1950s ... one was carried on an expedition to the Antarctic. It was later fitted with a plate commemorating the event. (A photo of a bearded explorer using it was the illustration on the cover of a brochure about the instrument.)

McArthur's folded-optics design spawned a number of descendants. These include the Nikon H, Fig. 5, (Nikon, 2013). Dr. McArthur, tried to get Nikon interested in his microscope. He discussed the project with some very senior Nikon executives but they showed no interest. However, a year-or-two later, one of Nikon's own miniature microscopes arrived in the post. (Walker, 2013).

Figure 5. Nikon H folded-optics microscope, c. 1960s

These spawned microscopes include the TWX-1, Fig. 6, (Kreindler, 2011-2), as well as Tiyoda Models VI and VII, and.

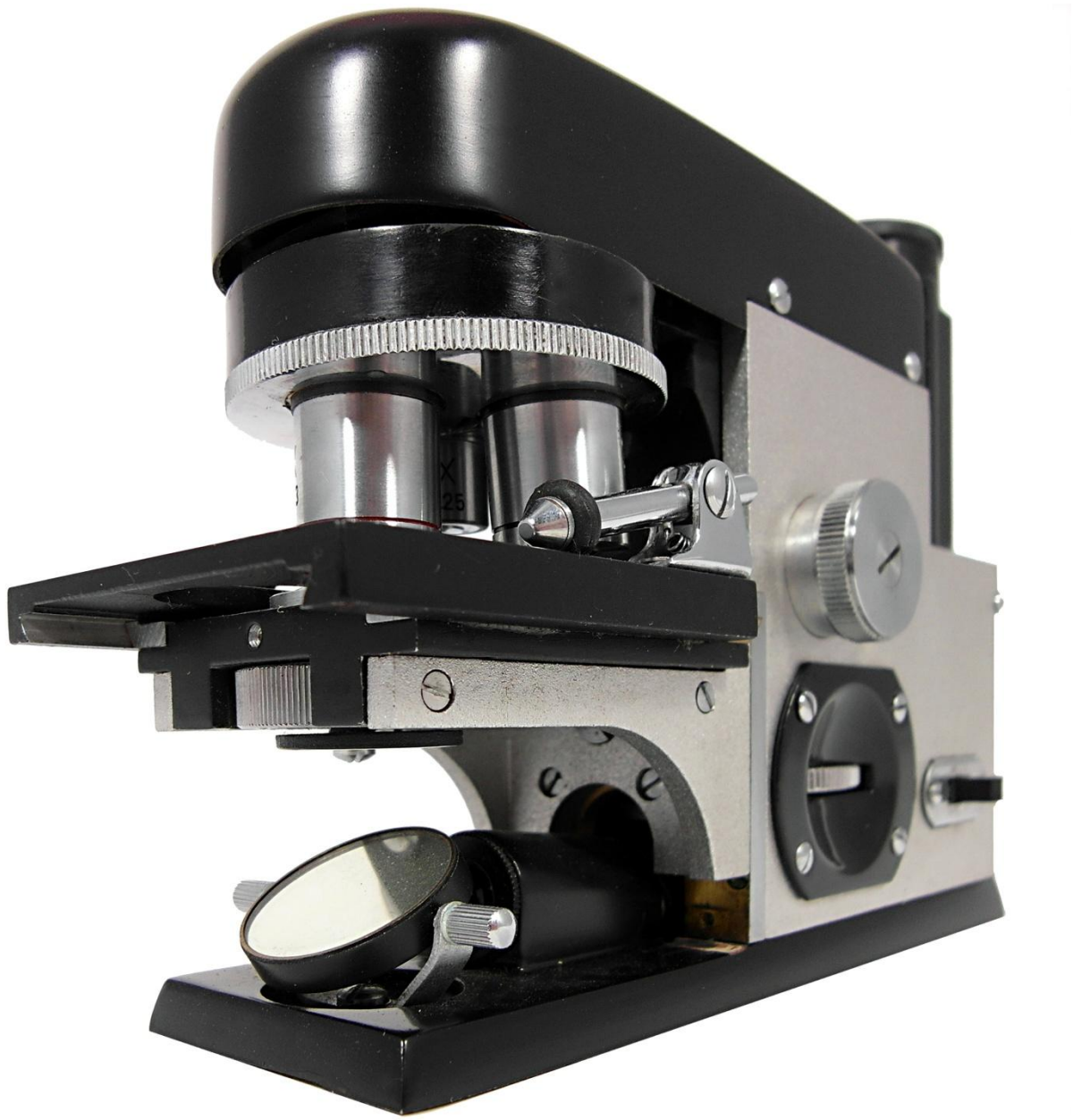


Figure 6. TWX-1, c. mid-1970s

the Swift FM-31, Fig. 7,

Figure 7. Swift FM-31 with Maglite ® illumination c. 1980s

and its clones, Fig. 8, (Kreindler, 2011-1).

Figure 8. Current FM-31 clone with attachable illuminator, stored in original packing Styrofoam

Newton Microscopes-Nm1s

These descendents also include the folded-optics implementations of Keith Dunning and Rick Dickinson, such as the Lensman, Enhelion Micron, Meade ReadiView, Trekker, and the Newton microscopes (the Newtons are discussed in detail in the second Part of this paper). To date, these Newton folded-optics microscopes include the Nm1-400, Nm1-400 XY, Nm1-600, Nm1-600 XY, and Nm1-1000 XY. Newton microscopes were originally marketed by Cambridge Optronics, but the name of the marketing/sales arm for Newton microscopes recently changed to "Newton microscopes" to avoid confusion. Cambridge Optronics will remain as a holding company, but "Newton microscopes" will be the public face of Cambridge Optronics for Newton microscopes.

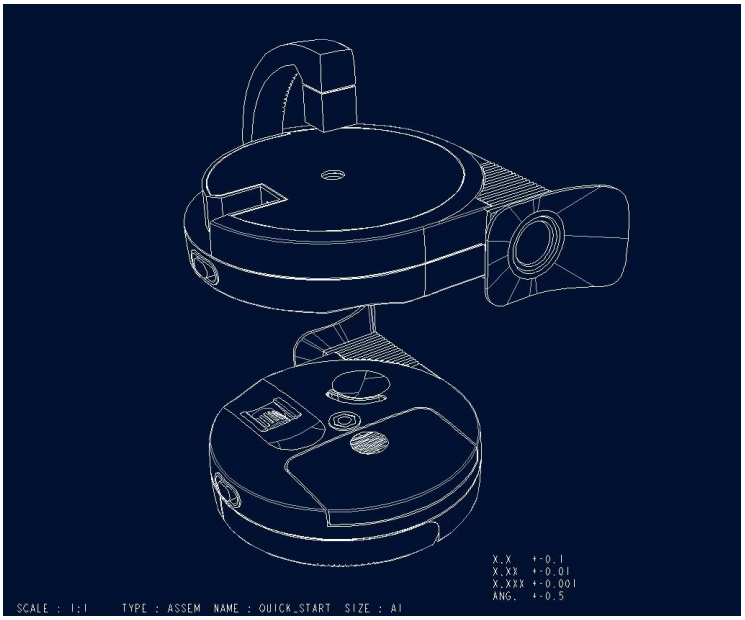
The following table provides summary information on the folded-optics microscopes developed by Messrs. Dickinson and Dunning (Dickinson, 2013).

Table 1

Name	***Launch Date***	***Sales Date***	***~ Number Sold***	***Manufacturing Loc.***	***Launch Price***
Lensman	1988	1989	7,000	UK	£99
Enhelion Micron	Modified Lensman	2001	4,500	China	£99
Meade ReadiView	Modified Lensman	2003	5,000	China	£ 90
Trekker	2003	2004	7,400	China	£ 49
		Newton Microscopes			
Nm1-400	2013	2013	n/a	China	£ 412.50
Nm1-400 XY	2013	2013	n/a	China	£ 492.46
Nm1-600	2013	2013	n/a	China	£ 497
Nm1-600 XY	2013	2013	n/a	China	£ 579.96
Nm1-1000 XY	2011	2013	n/a	China	£ 607.46
Newton Fluorescence	unk	unk	n/a	China	est. £7-800

Pictures and brief discussions of the Lensman, Enhelion Micron, Meade ReadiView, and Trekker are provided below. These microscopes were designed as relatively inexpensive, highly portable instruments that could be carried into the field, and they met these goals quite well. They were not designed to meet demanding scientific requirements. Although they can be used for initial screening, further definitive, detailed analyses requires a higher quality microscope with greater resolution. The Lensman and its derivatives are unique in using 3D folding, instead of the usual 2D folding found in most other folded-optics McArthur derivatives. They use a third reflective surface to fold (bend) the light in the z-dimension. These unique designs allow for a relatively large stage that is unencumbered by intrusions, and thus provide room for a removable ring magnet, visible in Figs. 11 and 12, to hold slides to a metal stage.

The Lensman, and its cohorts



The Lensman, Fig. 9, is roughly 4" in diameter; it was sold by Science of Cambridge, Cambridgeshire. It offers two magnifications, 80x and 200x. However, as with the Enthelion Micron discussed below, changing magnifications requires refocusing, as the dual magnification is achieved by moving a Barlow lens into the optical path.

Figure 9. The Lensman original concept. Illustration courtesy, and with permission, of Rick Dickinson

The optics for the Lensman were designed by UK optical designer Eddie Judd. In addition to dual magnification options, there are dual selectable illumination settings. The collapsible arm contains the bulb, which is powered by two AA batteries located in the saucer like section of the microscope, and accessible from beneath, Fig.9.

Mr. Walker had personal recollections about the company that produced Lensman and particularly the "Micropage", (Walker, 2013).

> *I myself got involved with the Lensmen by being asked to produce the photomicrographs and notes for a 'Micropage' (which never materialised on Protista and other freshwater organisms)* [Author: see below for more details on the 'Micropage']*. Unfortunately, the company ran out of money before I could be paid all they owed me, but I had a great deal of respect and admiration for them.*
>
> *They had boundless enthusiasm for the project and thoroughly deserved to succeed, but there was the feeling that the 'minor' optical manufacturers with whom they might have competed 'ganged up' on them.*
>
> *I must admit to having been doubtful as to the practicality of producing a 'Micropage' of photomicrographs of sufficient resolution to be useful in identification. The proposed method was to paste the necessary number of small prints onto a large sheet of cardboard, photograph them on 5 x 4 and then reduce the resulting transparency. I persuaded a local film-processor to produce the prints.*

However, perhaps not unexpectedly, Dr. McArthur was not pleased with the Lensman. Mr. Walker (Walker 2013) notes,

> *John could be very pig-headed. He disliked the OU instrument for its lack of precision and its feel, and detested the Lensman* (author, see below) *to such an extent that he totally refused to help in its design ... .*

Mike Dingley (Dingley, 1998), commented that the

> ... *quality of the images* [author: from the Lensman] *are at best reasonable but not good enough to take photomicrographs* ...".

M. A. Beale (Beale, 1991) says that,

> *The Lensman is not a high-resolution piece of equipment, and consequently the images seen are poorer than with conventional microscopes. Focusing is rather difficult because the focus wheel is not locked tightly into place: when pressure is applied to the wheel, the image clicks out of view. ... At present the Lensman is an educational toy, and it has little value as a teaching aid.*

S. B. Coghill (Coghill, 1992) observed,

> *The experience of using the Lensman microscope for 1 year indicates that this inexpensive, pocket-sized instrument, which can be used at the bedside or in the outpatient department, can assess the quality of needle aspirates although it is not suitable for making definitive cytological diagnoses.*

In spite of some negative appraisals, the Lensman was unique. It met its limited goals, and garnered a number of awards. These included the 1990 Prince of Wales Design Award, the 1990 BBC Award, the 1991 Archimedes Award, and the 1991 Camera of the Year Award, in the accessories category.

The Lensman could be purchased as a package with three slides, a 26 page booklet (the instruction manual was written by Professor Brian Ford), an instruction poster, and material on butterflies and moths, and other insects. This material was presented on microfiche, hence the square field of view. The use of microfiche (called micropage in Lensman "speak") was felt to make it easier for identification in the field without the need to carry field identification books.

However, this use of microfiche never caught on.

Perhaps, this was simply not an appropriate approach, or it may have been due to the rapid advances in electronic imaging that made microfiche seem "old-fashioned".

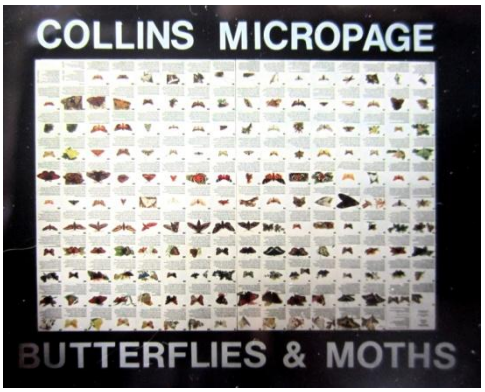


Figure 10. Lensman microfiche (micropage) used for field identification. Courtesy, and with permission of Rick Dickinson

Whatever the reason, the microfiche identification guides did not continue into subsequent microscope models. However, the more expensive square viewing format did persist, probably for its benefits to photography, and possibly the value of not having to retool. The numerical aperture (NA) for the Lensman and its derivatives is thought to range between 0.10 to 0.12.

A green colored ("Green Lensman") was made for the natural History Museum, London (Flickr, undated-1).

The Enhelion Micron

The Enhelion Pro 160's one sheet guide in introducing the Micron states,

> *The Micron range of microscopes, designed and produced by Enhelion is a radical and innovative departure from microscope convention. They are designed with portability and ease of use as a priority offering a compact and versatile instrument solution with an extremely wide range of applications.* ... (Enhelion, 2002)

Fig. 11 shows the Enhelion Micron in its storage case, in front of its retail box. This microscope provides both 80x and 160x magnifications, accessible via a knurled, rotating knob. However, the two magnifications still required re-focusing owing again to the use of a Barlow lens, i.e., they were not parfocal. The Micron uses two AA batteries for illumination. This is a light, highly portable instrument weighing, in its case, approximately 12.8 ounces. My microscope kit came with two slides: a somewhat amateurishly prepared slide of a "Butterfly Leg", and a clear shallow well slide. This microscope has a "Nextel" paint finish, and laser etched graphics.

The Meade ReadiView

Meade ReadiView's single user instruction sheet says the following,

> *ReadiView* (Fig. 12) *is a radical new microscope design. Designed for portability and ease of use. ReadiView is highly versatile and can fulfill a wide range of applications. ReadiView provides two magnifications levels, 80x and 160x. ... The eyepiece may be removed (just gently pulled from the body of the microscope) and be used as a 10x viewer* (Fig. 13).

ReadiView has a lighting arm, which conveniently folds down and out of the way for storage. Power for the lighting arm is provided by two user-supplied AA-size batteries. Included with [the] kit is a magnetic holder to secure your slides or specimens in place, plus two slides: one prepared with a specimen and one left blank so you can prepare your own specimens.

Enhelion was contacted by Meade to see if they would be interested in making the Enhelion Micron Pro 160 for Meade, with the "new" product marketed under Meade's name. Enhelion agreed. The primary change from the Enhelion model was the introduction of LED illumination, then under development for the Trekker (see below).

There were also some small cosmetic modifications such as the color of the microscope's outside diameter band and eyecup, he ReadiView name radiating inward toward the origin of the microscope's circle, and the Meade name on the circumference. A newly designed retail box and new instructions were produced by Meade. The ReadiView microscope was produced for Meade by Enhelion, in the same Chinese facility where the Micron was produced.

The Meade ReadiView, as noted, is a slight modification of the Enhelion Micron, which in turn was a slight modification of the original Lensman. This microscope, as the one discussed above, comes with a prepared slide of a "Butterfly Leg", and a clear shallow well slide. Although, relatively inexpensive, the optics are glass not plastic. The ReadiView's appearance is similar to that of the Enhelion Micron, Figs. 11 and 12.

Mr. Dickinson was kind enough to provide the following additional information (very slightly reformatted by the author) concerning the Lensman, Enhelion Micron, and ReadiView.

- *All came from the same tooling.*
- *All had the same square field of view.*
- *All have an internal polished metal reflector to direct illumination upwards for solids viewing when the lighting arm is in the down position and illumination left on. (This aspect seems to be often missed, and was a useful function for hobbyists.)*
- *Slightly angling the lighting arm can introduce dark ground illumination effects.*
- *All microscopes had pull out eyepieces, allowing them to be used as a 10x loupe.*

- *To save cost on the optics, mechanisms, and space, all had a single objective lens and the dual magnification was achieved by swiveling a Barlow lens into the optic path. This is also why the two magnifications were not parfocal.*
- *All instruments were supplied with a molded magnetic ring to hold down specimens or slides on their ferrous (magnetic attractive) stages.*

--- (Dickinson, 2013)

Figure 11. Enhelion Micron

Figure 13. ReadiView eyepiece removed for use as a 10x magnifier

Figure 12. Meade ReadiView handheld microscope

The Trekker

The Trekker, Fig. 14, was purchased in a see-through case, with the eyetube of the microscope extended to the graphics on the box. It comes with an attractive drawstring, gray and yellow cloth pouch case, approximately 6-1/2" x 4". A hard-sided carrying (storage) case is also available. That case is similar to those provided for the Lensman derivatives discussed above. The author's new Trekker came with a prepared "Feather" slide.

One small, but meaningful, change was to the magnetic slide holder, which now had a matte aluminum-toned finish, making it harder to lose in the field.

The following comes from the back of the Trekker retail box,

- *High resolution coated glass optics*
- *Views solid and transparent objects and fluids*
- *Magnifies x35 and x10*
- *Unique square field of view*

The 10x specification, although accurate, may be somewhat misleading. This magnification is not obtained through the compound microscope, but by removing the eyepiece and using it as a separate magnifier. While handy, a separate 10x magnifier would be smaller, and provide more flexibility and usability than the removed eyepiece.

The approximate weight for the microscope with slide holder, retail box, and cloth case is 10.2 ounces. The Trekker with only the magnetic holder weighs approximately 6.2 ounces. The hard-sided case adds an additional 6 ounces.

In this foursome of folded-optics microscopes, the Trekker is somewhat the "odd man out". While it contains some parts from the Lensman family, it was/is an essentially newly produced variation of the Lensman. The re-tooling was funded out of an upfront royalty payment from Meade. Owing to the lower magnification, i.e., 35x, the lighting arm present on the earlier three models was no longer needed. Rather a daylight temperature, white light LED is placed inside the body to illuminate solid objects, when appropriate, from the side. In some instances, this LED placement can show more object detail, although occasionally at the expense of not adequately illuminating object areas with relatively deep cavities. The object viewing circle is surrounded by a transparent acrylic ring to diffuse the LED light more widely.

The LED illumination required a different voltage than the earlier lamp's AA batteries, so provisions for a standard rectangular 9-volt battery were provided for in the battery compartment on the underside of the microscope, Fig. 15. Using a quality battery, illumination should be available for almost two weeks of continuous 8 hour/day use, without the need to change batteries.

In June 2005, David Walker evaluated the Trekker microscope for Micscape Magazine, after purchasing a new one for about 30 GBPs on eBay UK.

His article is interesting reading, as it provides both pictures, one with the microscope partially disassembled, and an independent evaluation of Trekker functionality. Mr. Walker concludes,

> *This is an elegantly designed microscope, genuinely pocketable and gives informative images of suitable subjects. It's also good value at its discounted price of ca. £30. The 35x mag would perhaps best suit a naturalist seeking a higher mag than a hand lens can offer to study the smaller features of fauna and flora critical to identification in the field ... It's also useful for studying aspects of smaller aquatic and land invertebrates. ... The Trekker is less suitable for more general studies of fauna and flora in the field where the lower power of a 5x - 10x hand lens with its greater depth of field, field of view and more intuitive use would be better. ... The Trekker's eyepiece does act as a 10x lens and is a useful feature, although ... its short operating distance makes it a less versatile hand lens than a dedicated one.*
>
> --- (Walker, 2005)

Mr. Walker also notes, *at 35x the depth of field is inevitably quite shallow (< 1mm),* and further observes that the microscope is best with relatively flat subjects.

A T-mount SLR camera adapter, that attaches to the microscope on one side and accepts an SLR's T-mount adapter on the other, is available. The T-mount option assures compatibility with almost any SLR. However, photographic images will not be up to benchtop quality, as resolution is likely at best to be about 4 microns.

For me, of the Dickinson/Dunning microscopes discussed here, the Trekker, possibly because of its reduced 35x magnification, has proven the easiest to use.

Figure 14. Trekker

Figure 15. Trekker battery compartment (bottom) and object lighting (top)

The Trekker is easily mounted on a tripod, Fig. 16, using the tripod socket on the underside of the microscope, shown in Fig 15. This allows for steadying the microscope for use, or for photographs through the instrument.

Figure 16. The Trekker on a tripod with slide held by magnetic slide holder

A picture of the "feather" slide provided with the Trekker is shown in Fig. 17. As can be seen, the resolution is not high, but likely acceptable for initial screening use in the field, and for hobbyists.

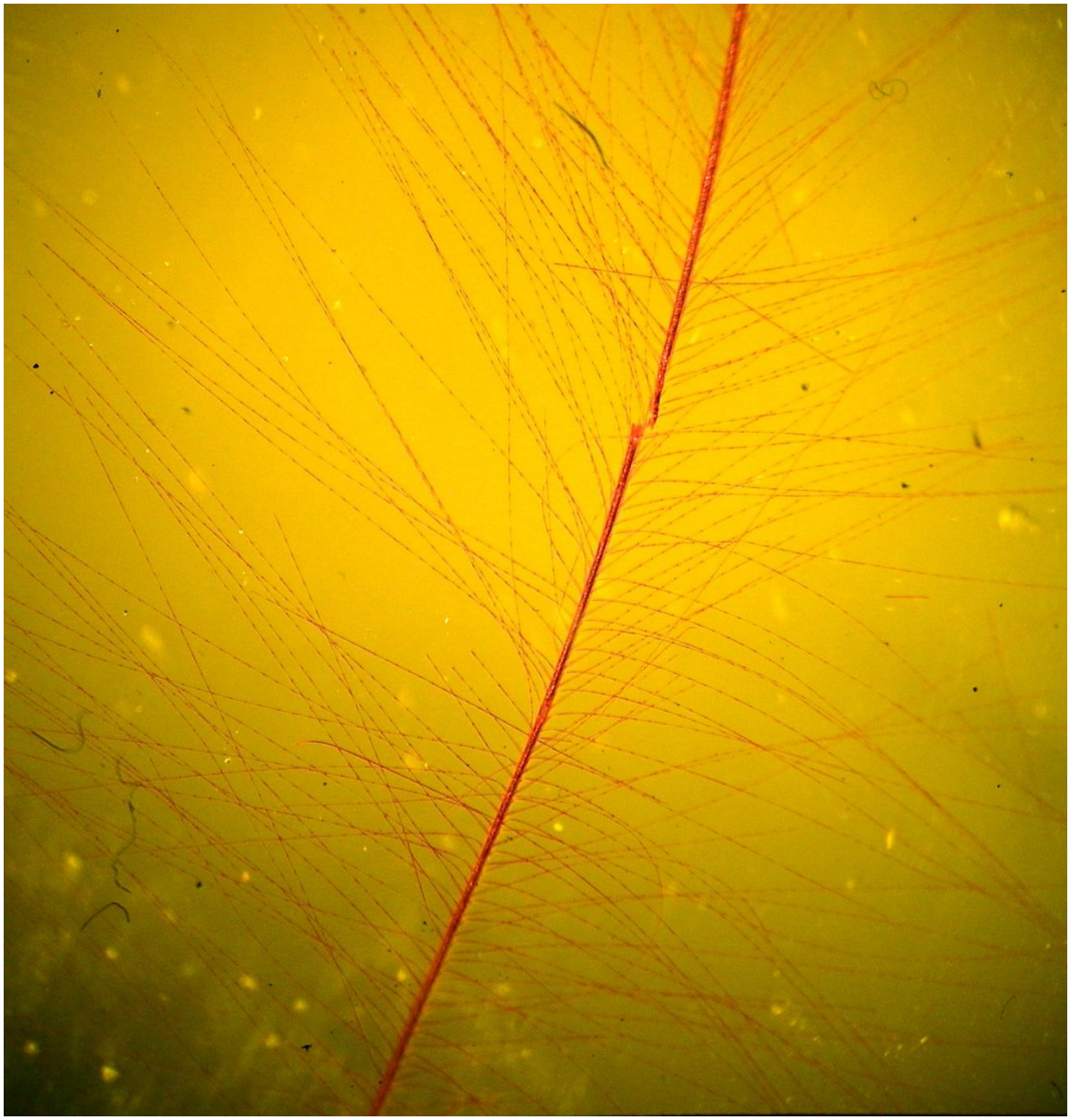


Figure 17. Feather slide provided with Trekker

The Trekker evolved from the Enhelion Pico, Pico Peep 35, prototype platform, Fig. 18. Note the lack of a lighting arm that is present in the Pico prototype, but absent on the Trekker.

At roughly this time Messrs. Dickinson and Dunning started a new brand called "Looksmall". The website, www.looksmall.com, will be found printed on the underside of the Trekker.

Figure 18. The Trekker and its development predecessor the Pico. Courtesy, and with permission, of Rick Dickinson

There were thoughts of a stereomicroscope in the Lensman family, but that, sadly in the author's opinion, never went beyond the concept stage, Fig. 19.

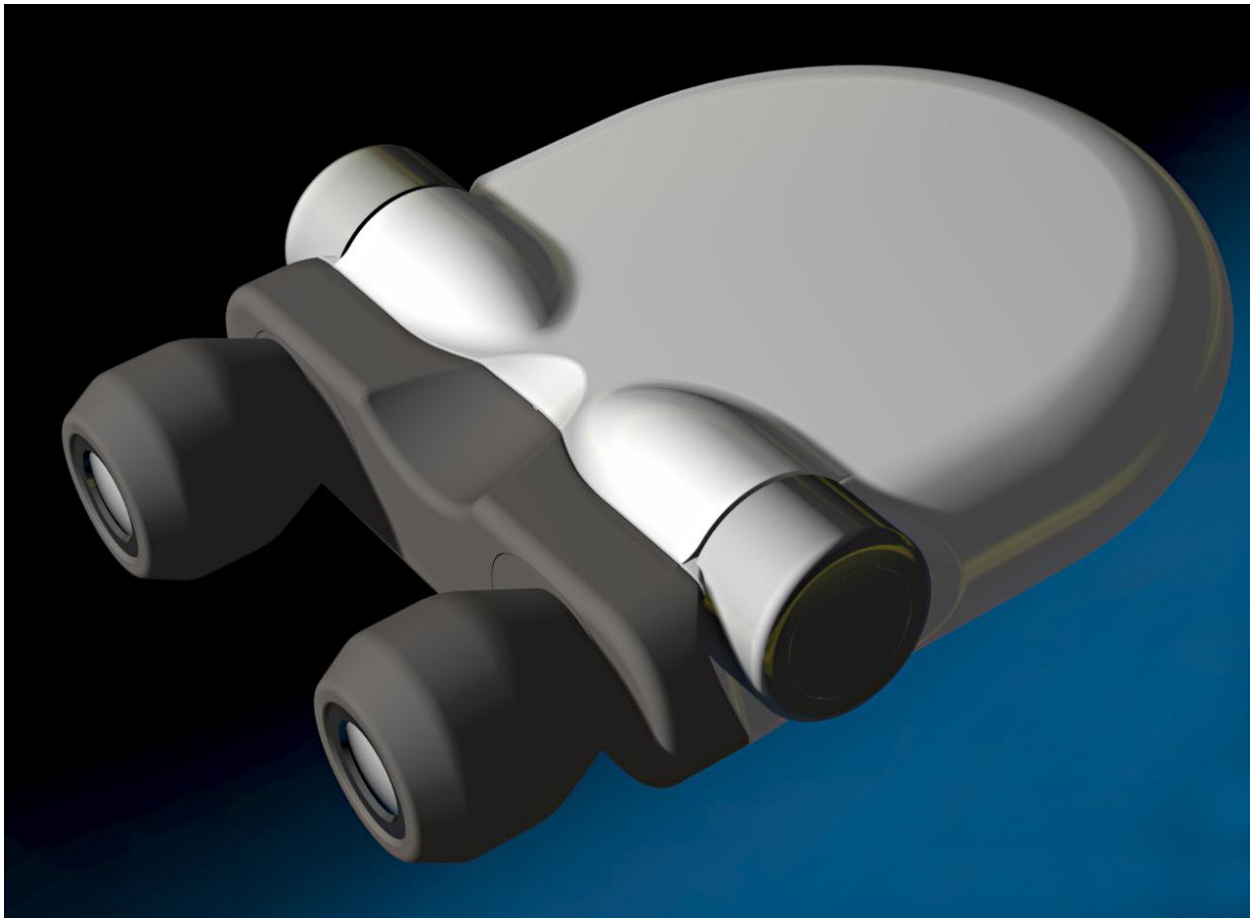


Figure 19. Concept design only for a stereomicroscope in the Lensman family. Courtesy, and with permission, of Rick Dickinson

Newton Microscopes-Nm1s

In the second Part of this paper, the Newton microscopes, Nm1-400, Nm1-400 XY, Nm1-600, Nm1-600 XY, and Nm1-1000 XY will be discussed in more detail. These microscopes are derivatives of the microscopes, discussed above.

These new Dickinson/Dunning folded-optics microscopes are now targeted toward a user community of scientists and other professionals. The Newtons have considerably increased capabilities compared to, e.g., the Lensman and its derivatives. Not surprisingly, a side effect of this increased capability is increased manufacturing costs. This has resulted in the Newton microscopes costing considerably more than their less capable predecessors, and exceeding their originally estimated prices.

As the Newtons are now targeted to a different audience than the Lensman and its descendants, it is appropriate to contrast them with, arguably, competitive professional-level field portable folded-optics microscopes. This comparison will be included in Part 2.

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The author welcomes any suggestions for corrections or improvements. He has a continuing interest in folded-optics and field portable microscopes, and stereo and unique historical microscopes.

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