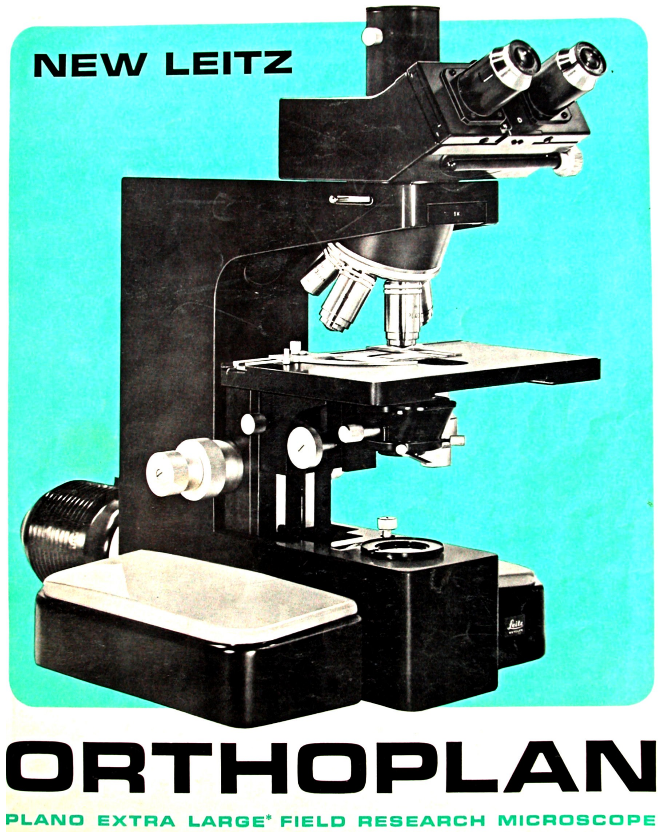
Leitz Orthoplan
Universal Largefield Research Microscope
A brief illustrated history

Mike Andre, USA



Leitz introduced their flagship large field research stand, Orthoplan, ca. 1966, which continued in production essentially unchanged until 1991, a run of over 25 years, attesting to the capabilities designed in from the outset; it was just as viable in 1991 as when first introduced and remains a premier research stand used at universities and other research facilities around the world today.

From one of the original sales E. Leitz NY flyers: "The ORTHOPLAN is a new member of the family of Leitz Research Microscopes. It is the first instrument designed for a field of view of 28mm; it allows more than twice the field area of a conventional microscope with widefield eyepieces."

The Orthoplan was designed to be the epitome of functionality and flexibility with ability to switch from one form of illumination to another quickly and easily, setting the standard for quality and capability, costs be damned! Likely this is the primary reason for its eventual discontinuance – the cost to produce these units was economically unacceptable.

The initial fifty Orthoplans were made in all black; these are very rare and rarely seen (or even known) today, almost all surely in the hands of collectors. General production was 'hammer tone gray' followed by 'light silver gray' and finally the off-white/ivory version. The hammer tone gray units had light gray handrests that tended to turn yellow-gray with age; all later models came with textured black handrests. Another variation was the very early models had a square blue Leitz logo, followed by square red and ultimately the round red logo seen on the later versions.

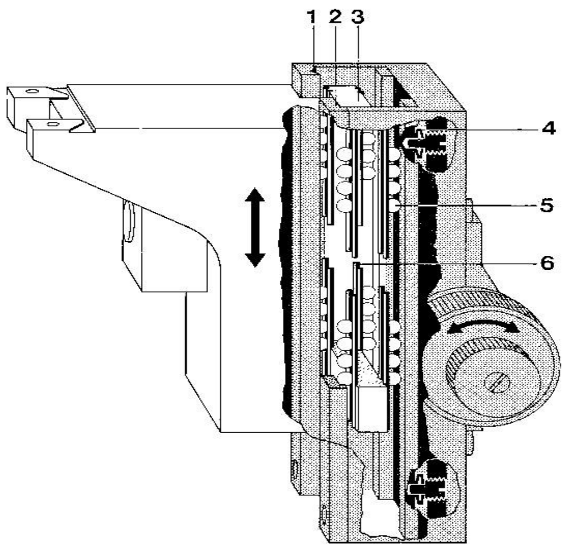
First standard (after black) issue – Hammer tone Gray. Yellowing of the armrests is evident in this shot. If anyone knows how to remove 30 year-old cellophane tape – please advise! (This stand is used for parts.)

Later production in 'Silver Gray' – note the square red Leitz logo. Note the change in the armrests from gray to textured black, which were used on all subsequent production Orthoplans.

Later variant of 'Silver Gray' with round red Leitz Logo

Orthoplan in final Off-white/Ivory color. This unit has a Variotube mounted.

The “mechanical heart”* of the Orthoplan microscope is the focusing block that was built so well and to such tight tolerances, it was used on at least two space shuttle missions for some particularly delicate work. It is equipped with a coaxial “dual coarse and fine adjustment on ball bearings with a displacement accuracy of 0.001mm. Backlash and lubrication requirements have been completely eliminated”* ; one division on the drum scale of the fine adjustment is equal to 1µm movement of the stage. This was achieved using a planetary gear system in the focusing mechanism. (* - from Leitz flyer)



Backlash-free precision stage movement. The diagram shows the almost frictionless movement. It is a combination of ball and steel-needle guides in prismatic basic arrangement. The balls 5 with the hardened steel needle races 6 are visible. Seen from the observer's point of view the rear guide track 1 is prismatic, the front one 2 plane. Both guide tracks are rigid. The prismatic guide determines the movement, the plane guide the lateral fixation. The guide track 3 is movable and is pressed against the fixed guides 1 and 2 by means of a spring bar 4 via the balls. This ensures constant pressure; the spring arrangement eliminates any backlash.

An Orthoplan is **not** a portable unit – weighing in at ~20 kgs - probably closer to 30 kgs fully fitted out - this is a substantial microscope! The base is 300mm X 295mm, height without tube 340.5mm, height with tube 517mm, viewing level 413mm. (Be mindful these figures do not take into consideration the lamphouses and mirror houses, nor the impact on the height of adding a Variotube. When I received my first Orthoplan I realized it took a lot of real estate on the bench!)

One of the major differences in the Orthoplan is it's a 'Largefield' microscope; the eyepieces are quite a bit larger than traditional - 30mm Ø versus 23.2mm Ø, resulting in a field of view of 28mm Ø versus 18m Ø. Since area increases as the square of the diameter, a field of view of 28mm Ø is more than twice as large as that of 18mm Ø, all this with Plano objectives maintaining a flat field from edge to edge.

To dispel any confusion as to tube length – **all** Orthoplans are **170 mm tube length** for transmitted light; incident light elements are infinity with the exception of some early versions of the pol vertical illuminator at 215 mm tube length, later changed to infinity to take advantage of better optics as they became available.

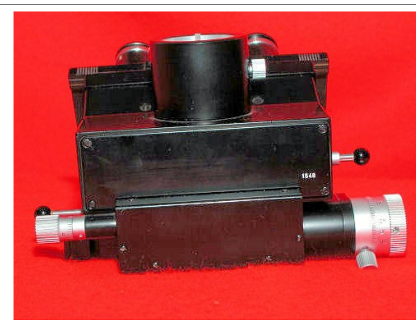
The early Fluorescence Vertical Illuminator according to Ploem was designed to be used with 170 mm tube length objectives, thus allowing it to be used in combination with all methods of transmitted light microscopy (phase contrast, darkground, etc.)

A comparison of GW (30mm) eyepieces on the left versus GF (23.2mm) eyepieces on the right. At the back are two photo tubes for use in the trinocular port of the body tube; center are adapter sleeves that allow the GF (23.3mm) eyepieces to be used in the FSA body tube.

There were three primary body tubes made for the Orthoplan; the FSA (trinocular with choice of 80% light to camera, 20% to binocular tube or 100% to the binocular tube); FSA 55 (selectable 100% to eyepieces or 100% to camera port) and FSA 50 with built-in analyzer, rotatable through 360° with vernier reading to 0.1°, centerable/focusable Bertrand lens and selectable pinhole stop.

Left side view of FSA-50 body tube. The large silver knob on the bottom is the analyzer control drum that can be rotated 360° with an accuracy of 0.1°.

The two silver knobs on left of the black knob are for centration of the Bertrand lens. The black knob controls the pin-hole stop.



On the left are the controls for the Bertrand lens: black knob controls the Bertrand lens, the silver knob is for focusing. (See note below)

*[In the event you end up with an FSA-50, __**do not try to focus the Bertrand lens**__ until you make sure there is free movement of the lens. The focusing knob moves the Bertrand lens via a small braided cable working against a coil spring. The grease used for lubrication is almost inevitably hardened to the point of being stuck. The mechanical advantage attained with the focusing knob is great enough to snap the cable, necessitating a very costly repair job as it is not easily replaced.*

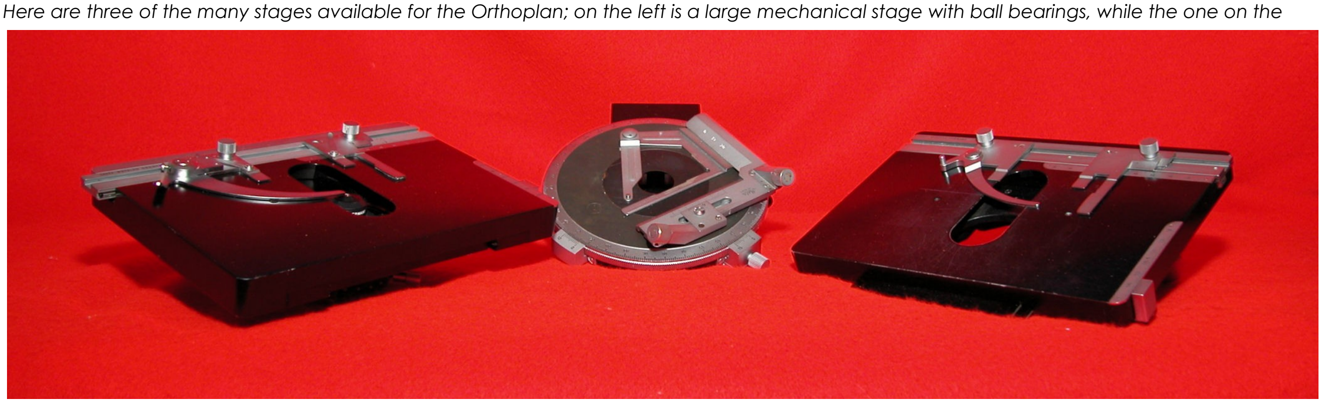
It is quite easy to open the back cover (be careful as there is one spring under the cover which is easy to lose if one is not aware of it!) and move the lens by hand to determine if it needs to be cleaned of dried grease and relubricated. This is a good job for a microscope technician, as the risk of damaging an FSA-50 easily outweighs the cost of having someone who knows what they are doing work on it.]

This is an FSA-55; the knob on the right controls the light either 100% to eyepiece or 100% to the trinocular tube. (The 10ml beaker is for photo positioning only!)

An FSA, the only difference between it and the FSA-55 is this model provided choice of 100% to eyepieces or 80% to trinocular and 20% to the eyepieces.

The Orthoplan system was designed to be truly modular and capable of all methods of illumination – brightfield, phase contrast (transmitted and incident), phase contrast fluorescence, dark field, interference contrast (transmitted and incident), transmitted fluorescence, interference contrast fluorescence, polarized, epi-pol, epi-fluorescence, epi-BF & epi-DF and on and on were all within its abilities simply by changing out the various pieces – nosepiece, bodytube, condenser, stage, lamp-house!

Here are three of the many stages available for the Orthoplan; on the left is a large mechanical stage with ball bearings, while the one on the



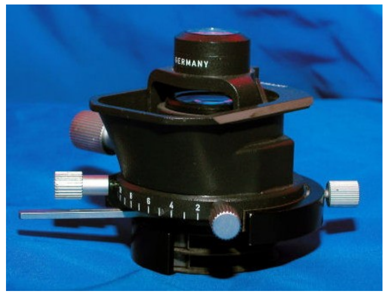
right is the standard unit. In the middle is a 150mm Ø rotating stage #837 with scales and verniers reading to 0.1°, click stop at 45° intervals, locking device and interchange carrier, fitted with attachable low-profile mechanical stage #42 with graduated vernier to 0.1°.

All this capability had a price: in 1966 the Leitz NY flyer listed a price of $3,521 for an Orthoplan equipped for transmitted light with FSA trinocular body tube (80/20), #602a condenser (0.90 NA achomat), large mechanical stage – 150mm X 210mm, quintuple revolving nosepiece fitted with 4, 10, 25, Fl 40 and Pl apo100X objectives, 30mm periplanatic large field eyepieces and built-in precentered illuminating system 12V/60W with transformer. (including one spare bulb!)

By the mid 70s' Preiser catalog listing "The Orthoplan is supplied complete with quick change bayonet mounts for transmitted and/or incident light sources; carrier for mechanical stages or substages. Supplied **without** bodytube, eyepieces, nosepiece, condenser, objectives and illuminator which must be ordered separately - **$4737.00**" Fitted out with objectives, eyepieces, condensers and bodytube one could grab one for only **$14,673.00**, unless you wanted it fitted with Plan apos; then it would set one back **$18,507.00!** And that is mid-70s' dollars! Adjusted (roughly) for inflation that would equal ~**$60,000** today!

But remember, this system is modular and capable of all forms of optical microscopy – all that is needed are the correct accessories. And what a selection to choose from! Achromats, NPL (Planar) achros, Fluorites, Plan apos, LWD, Phase, Pol, Oil or Water Immersion and on and on just in objectives!

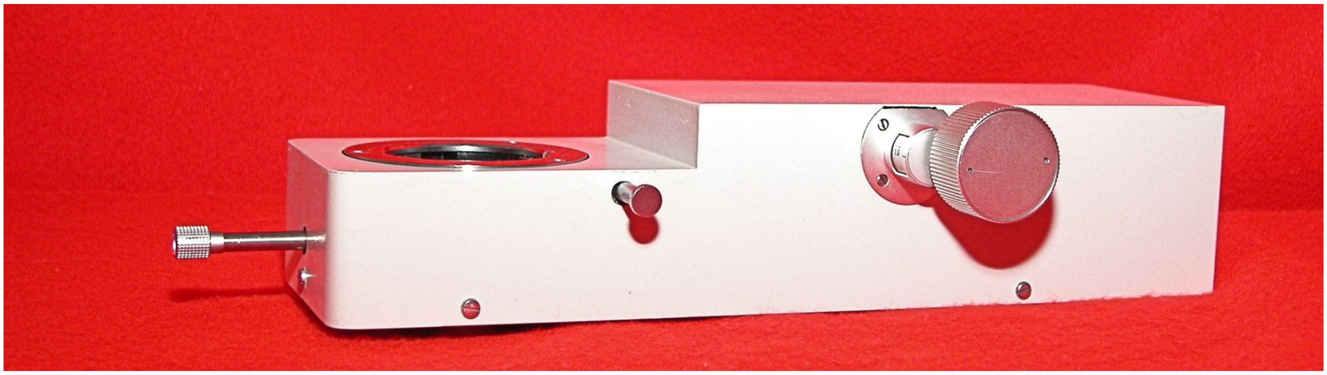
 *Condenser with detachable filter holder; 0.60 NA top lens.*	 *Condenser with detachable filter holder; 0.90 NA top lens*	 *Low NA (0.80 – 0.95 NA) darkfield condenser*	 *High NA (1.20 – 1.40 NA) darkfield condenser*

 *Phase contrast condenser 402A with 0.90 NA top lens*	 *Condenser with rotatable film polarizer at bottom; 0.90 NA*	 *Nomarski DIC Condenser with Wollaston prisms, rotatable film polarizer at bottom; 1.25 aplanatic top lens*

At least fourteen different condensers, four different lamphouses each capable of using halogen, HBO or XBO lamps, four mirrorhouses, at least 7 different nosepieces with varying mags from 0.8X to 1.25X, three or more different bodytubes, I don't know how many stages...... I think you get the idea!

 *Centerable pol nosepiece with two filter slots, swing-in auxiliary lens for conoscopic image of small object detail.*	 *Standard 1X quintuple nosepiece with NPL Phaco lenses.*	 *Standard 1X sextuple nosepiece with Plan and Plan-apo lenses.*
 *Epi-fluorescence after Ploem nosepiece. This uses standard 170 TL objectives.*	 *Pol vertical illuminator infinity corrected optical system, plane glass plate and compensating prism and auxiliary lens*	 *Incident light for BF/DF 0.8X quadruple nosepiece with Plan BF/DF lenses*

Then there are the 'add-ons' - Variotube, Variolum, different magnification eyepieces in both the 30mm diameter (GW – widefield) as well as the 23.2mm diameter (GF) used in the FSA-50 bodytube and usable in the FSA-GW bodytube via adapter sleeves.

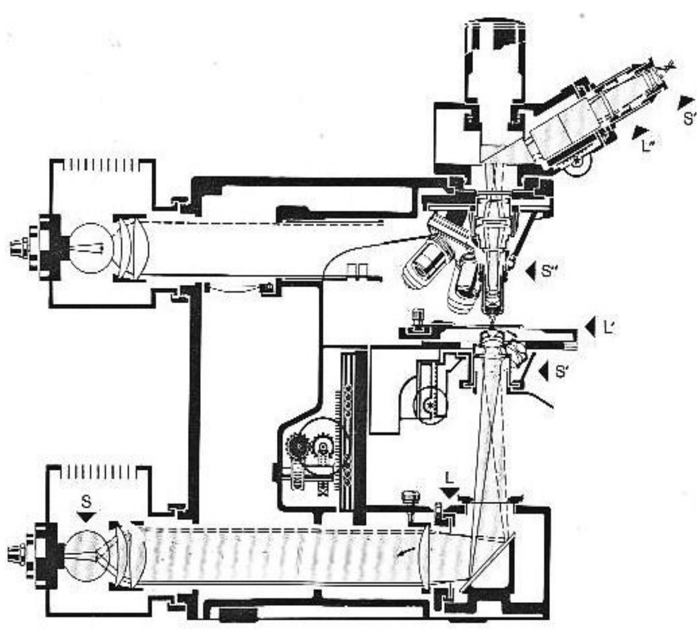


The Variotube allows one to change magnification from 1X - 3.2X by rotating the large silver knob. The knob on the front controls the built-in Bertrand lens – by pushing/pulling the lens is moved in/out of the optical path, what is interesting is the Bertrand lens is focused by rotating the same knob!

Leitz supplied equipment for the Orthoplans allowing Interference Contrast in at least the following methods, (there may have been more):

DIC after Nomarski (Original Leitz France version, only available a very short time)
Smith T System
Jamin-Lebedoff
Interference Contrast R
Françon Pol-interference for Incident light

All these bits & bobs were made to the highest levels of quality and performance – it's been said many times, "if it's Leitz and it moves it probably has ball bearings!" An example of the level of quality built into every part for these instruments is the rotating objective carrier on the original epi-fluorescence nosepieces; the turret revolved on forty-eight 3mm steel bearings held in a race formed by the nosepiece and the turret; a machine screw holds the turret to the body on a race set on ten 1mm bearings. Overkill? Absolutely! Will it last a long time? Absolutely! This is typical of the engineering, build quality and attention to detail demonstrated in every element of the Orthoplan. Although there were numerous improvements and changes made over the ~25 years this model was produced, all of the various parts will fit all of the Orthoplans. As one can easily see, amassing a 'complete' collection of Orthoplans and allied equipment is a daunting task.



Schematic of light paths and main conponents

I have no idea how many Orthoplans were produced, nor how many are still in service in research facilities, universities and industry around the world – certainly a significant percentage! Fortunately for those of us who do not enjoy the benefits of deep-pocket corporate budgets, alumni bequests or government grants, the majority of Orthoplans that show up on the market still have plenty of life left in them and are available at very reasonable cost when one considers their capabilities and what they cost new.

An expert on Leitz Orthoplans has stated Orthoplans have a design life of 'at least 100 years' and with reasonable care and normal maintenance, this can be extended almost indefinitely. If you haven't picked up on it by now, I am a great fan of Leitz Orthoplans. By careful searching and a great deal of good luck, I have been able to collect a number of them, as well as a broad selection of the necessary accessories.

The way I look at it, Leitz stopped making them 15 years ago but as long as they are maintained and cared for, probability is they will hold their value for decades to come. As well, I paid pennies on the dollar for the most part, and can, in all likelihood, resell everything for at least what I invested, (not that I ever will!)

I know the title says this will be a very brief illustrated history, but inevitably one does warm to the task and there is much to be said about this wonderful machine. To cover the entire Orthoplan line would take numerous articles – one could do complete articles on various forms of interference contrast methods and the equipment; the camera systems developed specifically for use with the Orthoplan; the special uses for which Orthoplans were adapted such a Linnik Interferometry or their version of the MVP-SP microspectrophotometer attachment, that was dedicated for oilfield research, called "Vitrinite Reflectance", but these remain for later articles.

I'd like to thank the many individuals who have helped me in my interests in Orthoplans.

Comments/questions to mandre **AT** adelphia **DOT** net