

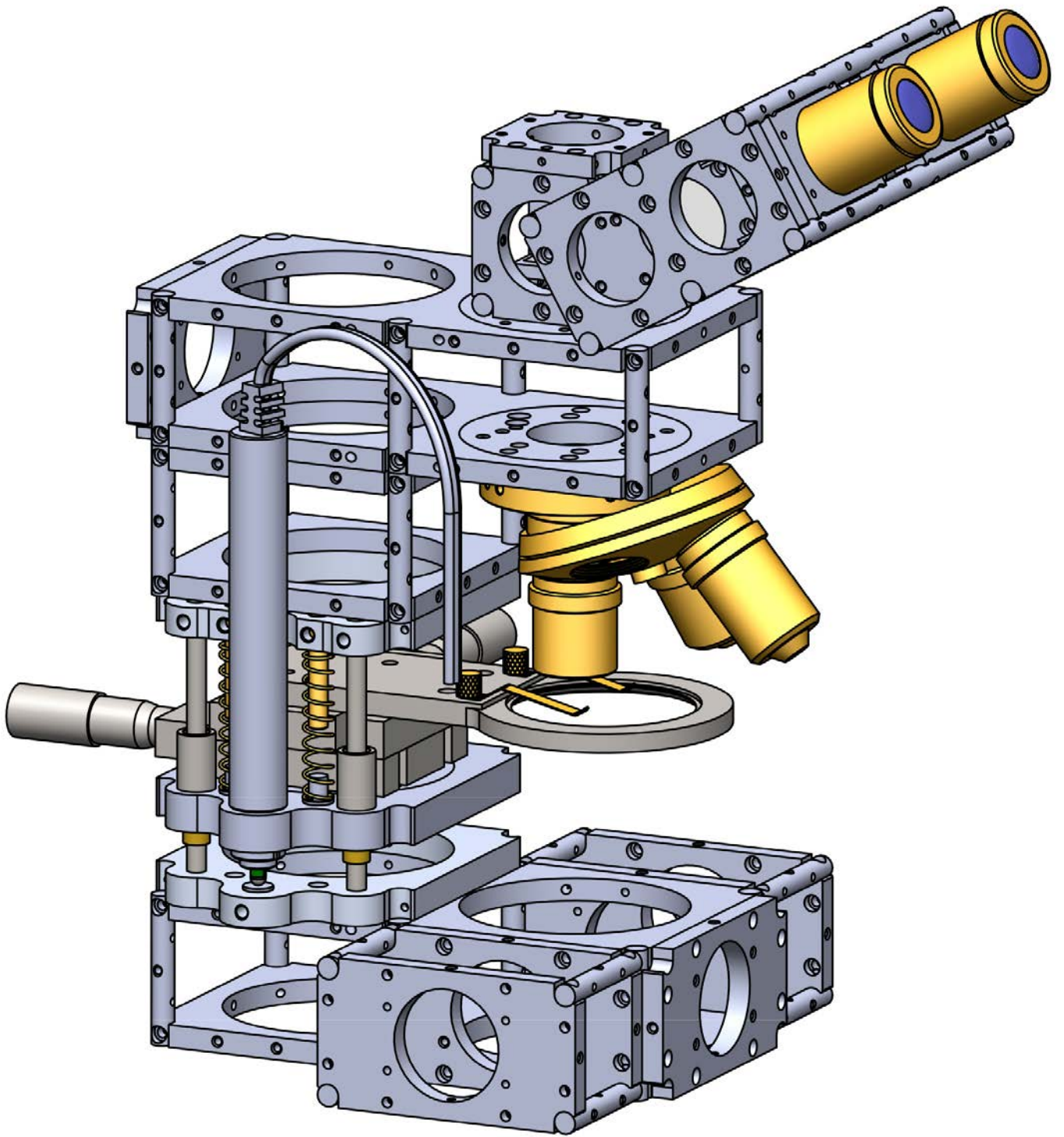
Optomechanix

Bringing your ideas to life
Learning Toy Optics Design
Building a Binocular Microscope
Disassembling Binocular Optics
Build an X-Ray Camera
Understanding Enneagram
Optoform Lab Projects

Oct - Dec 2020



Technical journal of OMiD, Opto-Mechanical Institute of Design



A fully functional binocular microscope built with new Optoform construction system. See page 8 for details.

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Hawking with wife Jane Wilde



With 2 of his 3 children Robert, and Lucy

This issue Dedicated to:

Steven Hawking One of the foremost contemporary physicists, became famous with his first book: “A Brief History of Time”. His book appeared on the Sunday Times bestseller list for a record-breaking 237 weeks.

Hawking's scientific works included a collaboration with Roger Penrose on gravitational singularity theorems in the framework of general relativity and the theoretical prediction that black holes emit radiation, often called Hawking radiation.

Hawking was a Fellow of the Royal Society, a lifetime member of the Pontifical Academy of Sciences, and a recipient of the Presidential Medal of Freedom, the highest civilian award in the United States. In 2002, Hawking was ranked number 25 in the BBC's poll of the 100 Greatest Britons. He died on 14 March 2018 at the age of 76, after living with motor neuron disease for more than 50 years.

Source: Wikipedia.com



Experiencing zero gravity weightlessness, Hawking's million-dollar smile, in January 2007 by the efforts of business man Nicholas Branson.

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Optomechanix is a quarterly journal of Opto-Mechanical Institute of Design (OMiD), with technical articles for practical, hands-on opto-mechanical engineers. This magazine is privately founded.

Cover page photo: Koi fish in breeding tank

Front back: Binocular microscope built entirely with Optoform

Bringing Your Ideas to Life

I have always had a cure for prototyping, and it's called Optoform! The thing I am passionate about is to help people build their ideas with off the shelf components, and to do it professionally. I also wish to empower the youth to have self confidence in bringing their ideas to life, and make a product out of it. Not everyone is made to be an entrepreneur, and not everyone is destined to be an employee, but the fear of getting started puts off many people from having a shot at what they really want in life. I had dedicated a small section at the end of each issue to help people get rid of fear, and to build self esteem, and it was called: "The ambiguity of spiritual path". Business, and marketing are fruits of self worth, and self knowledge, because without it, we'll stop half way. Today's business is so challenging, and demands so much dedication that you can't do it without a high level of life purpose. A new series will start with this issue titled: "The psychology of Achievement". Brian Tracy gave this a kick start thirty years ago under the same title.



While patenting my inventions, I have seen so many good ideas that are just sitting somewhere collecting dust. What gives your ideas life is a prototype, and then marketing. There is a famous line from Stella Adler, who was a world renowned acting teacher: “You act with your soul. That’s why you want to be actors, because your soul is not used up by life”. Once I heard that, I thought wow, the same is true about product development, and marketing. You really develop, and market a product with your soul, and you do that because your soul isn’t used up by an ordinary life. Product development is not a joke. It means a whole lot to those who believe in it.

We live, and die with good products. I sometimes arrive early morning to park next to a MacDonald’s and happen to watch their huge truck bringing in the bread loafs, and all the other supplies that the fast food industry needs to serve its customers. It’s an amazing scene to watch how someone’s vision kick started this in the whole world. On my last visit to Paris, I saw a MacDonald’s in Shanzelize street filled with customers. Marketing is really an art. I hope to kick start many products with my influence on people to show how easy it is to validate their ideas, and perhaps encourage them to succeed in marketing them.

The difference between people who enjoy what they do, and just do what they do is the ambitions they had or not had. You don’t need to be extraordinarily talented to succeed in your product. You just need to find a niche market you could serve. In life, you are so lucky if you think you could change the world, and don’t know enough to see that you can’t. It lights up a candle in darkness, helping so many to start seeing where they are going. Have you looked at the birds flying in the skies above? Someone taught them how to fly, but no one knows who has been feeding them since!

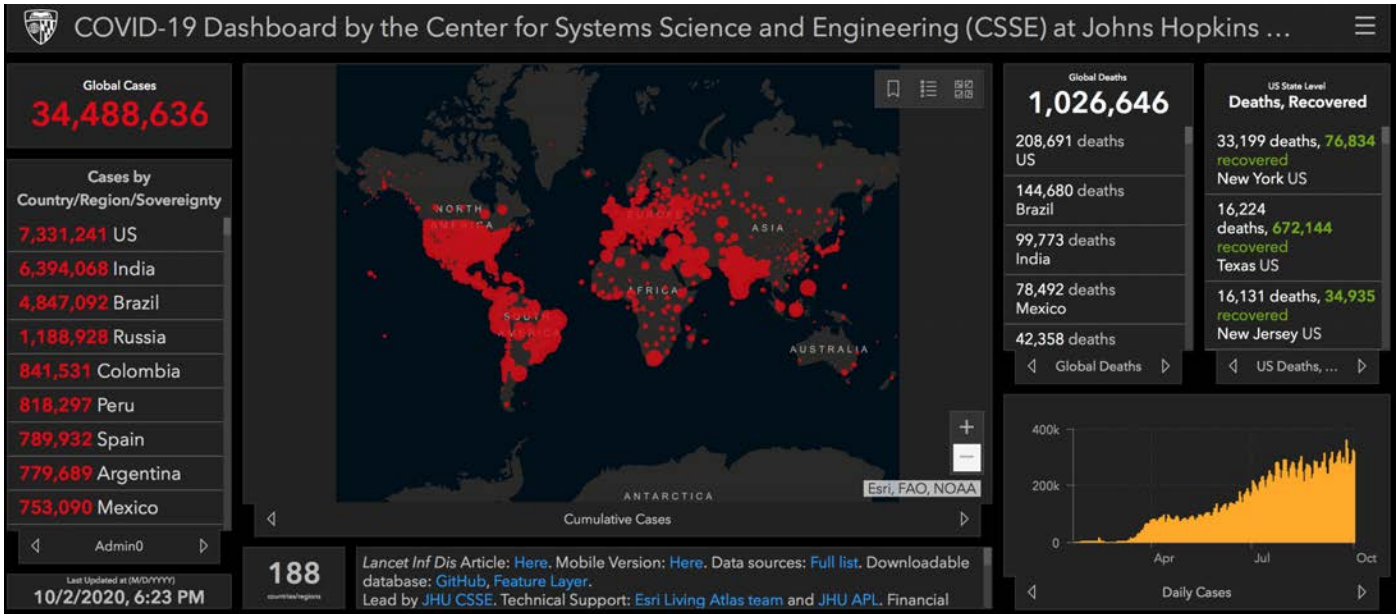
Ali Afshari
Editor in Chief
Optomechanix



Scenes from Chaplin’s: “City Lights”

The Global Effects of Corona Virus

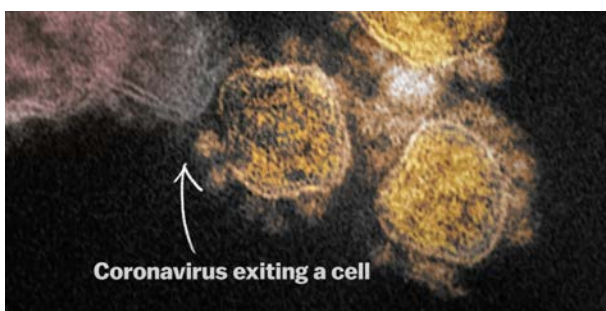
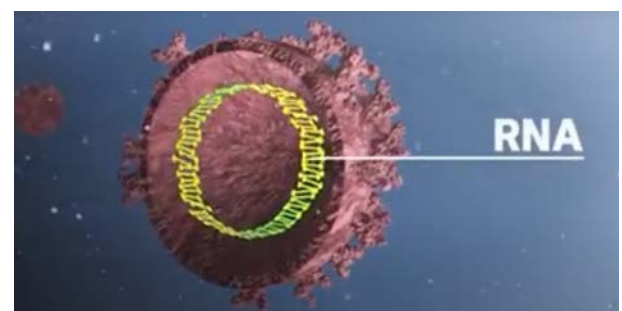
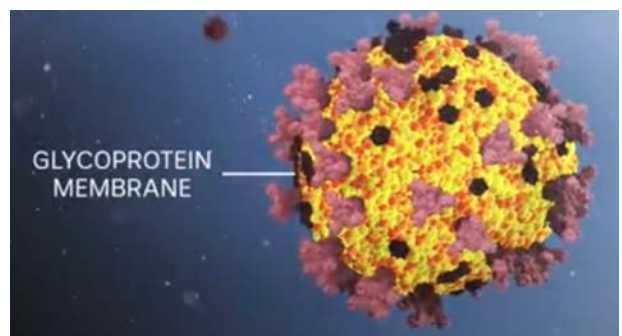
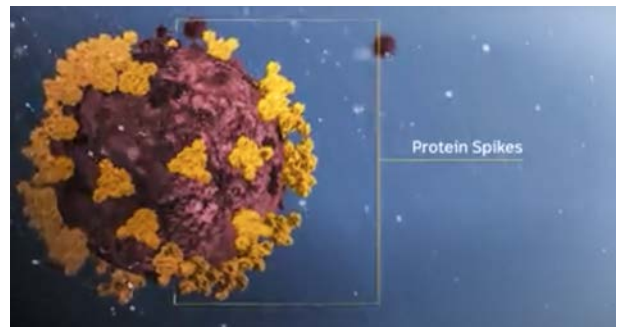
It has been almost a year since the landing of Covid UFOs on earth. At first we thought they were ordinary guests but these tiny microscopic flying saucers proved to be our lethal enemy. They have forced everyone to take shelter, and caused most public places, and government offices to shut down. They could fly from one recipient to the other through coughing, or physical contact. This is an enemy no army could fight. No guided missiles could be launched or no atom bombs that so many countries are so fond of could fight them. The only way is to devise new Microscopy techniques to be able to see these tiny creatures, and come up with an idea to harness them.



Recent global report of Covid 19 death tolls by Jons Hopkins University. Oct 2nd, 2020

The optics industry (and Electron microscopy) has been at the forefront of this struggle because it provides the visual input to every biotech lab looking for its vaccine. The problem with high magnification microscopy is by the time you are able to see the virus, it's already dead. This is true for all electron microscope images we have seen.

A Corona Virus single cell measures just 120 nm in diameter, can only be seen through 12 million times magnification (right). Outside the cell is covered with protein spikes (crowns), but it's fatty lighter skin is made of Glycoprotein, very vulnerable to a simple wash by soap. The deadly part of the virus is its inner RNA (Ribonucleic Acid). It carries the cell's genetic code, allowing it to multiply, leading to infection. The virus first attaches itself to cells in our respiratory system using its protein spikes. It then releases its RNA to enter the cell, and dismantles its immune system to begin its reproduction inside our body. Researchers are trying to produce antibodies to stick to the protein spikes of Covid-19 so they can't attach themselves to the cells after entering our body.



Learning Toy Optics Design

Good design is like making a good movie for the general public. The ingredients to making a good movie is to have a few good ideas, but then at the very end, exceed viewer's expectations by giving something extra they hadn't anticipated. That's at least true for civilian design. Most military designs turn out ugly in the most part because it starts with a contract, and people whom it is delivered to have simply no taste. You'd never design an iPod for the military! Nothing is more risky, and challenging than pleasing the public. They could criticize you, ridicule you, or completely ignore your work, but most people would appreciate your values. So I would often spend hours studying a toy telescope or microscope while easily passing by the design of a tank, for example (I have never been near one!). Toys are to please children, and the best way is to treat them like little engineers. We don't treat children that serious any more. Old Erector set manuals contained more nicely illustrated engineering drawings than today's instructional manuals for adults.



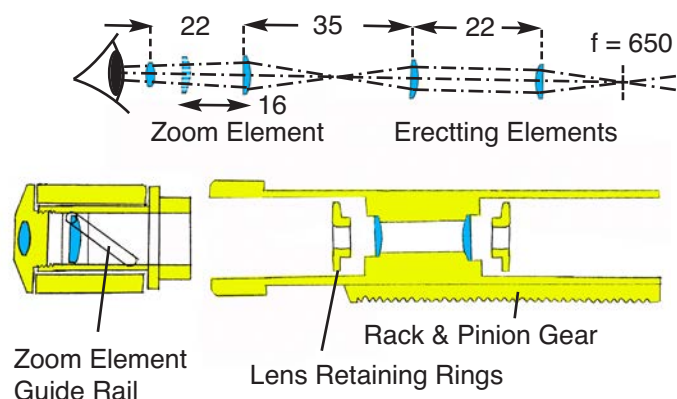
Telescope assembly is straight forward. The singlet glass objective lens is drastically stopped down for color correction.

Getting accustomed with high quality optics makes us ignorant to think of these toy telescopes as something worth to look through. I was actually amazed with the optical quality of this telescope. It utilizes all glass optics, and the injection molding of plastic parts, and how it was put together are well designed. It has a professional feeling to it when you focus the image through the eyepiece. The finder scope provides a good image with a rather thick reticule.

Each element is correctly mounted using a retaining ring except instead of being threaded, they are glued in place. I think getting this telescope for a first grader would be a great idea. They could see the craters on the moon, the ring of Saturn, and the four main moons of Jupiter. The tripod would stand up to the full height of an 8 year old, and it's as good as an ordinary camera tripod. The 53 mm diameter front lens is a singlet, and is drastically closed down by a 24 mm aperture to reduce its chromatic aberration. There is also a mid-barrel aperture stop to reduce ghost images produced by light sources near the field of view. The telescope features a metal tube, and 10 assembly screws allowing it to be dismantled for cleaning.



The long finder scope houses four elements to provide upright image for nature use.



Focusing barrel with two erecting, and two zoom elements (no compensating element for the zoom).



Aluminium legs, and telescope mount are nicely designed, and constructed with reasonable quality.

Designing, and Building a Binocular Microscope (Part 2)

In the last issue, I sketched the concept to constructed a biological microscope by combining pre-assembled modules. I also described what modules should be like: Simplified as possible, low cost, and to allow chain connections. What I'll demonstrate in this issue is we have come a long way from building prototypes with discrete components. Building complex opto-mechanical instruments requires preassembled sub-modules, otherwise you'll be spending days designing it with solidworks or catia. Optoform speeds up the process with direct upward/downward compatible modules. If you decide to assemble them in a computer, you'd be also putting together predesigned modules.

In any case, let's get started from where we left off last time by finishing the Binocular viewfinder assembly. You could order this viewfinder, as it will be an available module for the system. To adjust for the eye distance in a binocular head, sliding mounts 40-110 are designed to perform this task. The optical path inside the virwfinder is first bent 30 degrees via a Littrow prism for inclined viewing, and is split into two paths via a beamsplitter. Three additional right angle prisms produce the proper separation between the two beams for binocular viewing. A pair of specially designed 40-120, and 40-126 mounts are utilized to construct this assembly in its bent form. Sliding mounts 40-110 ride on a two 125 mm support rods, that construct this compact 125 x 40 x 114 mm assembly.

While designing this somewhat complex arrangement, two new mounts, and a 125 mm long rod has to be added. This is not a problem. Each module may contain specially designed mounts to perform a specific function. Mounts 40-126 are designed to be reversible, hence reducing the number of necessary parts. Rod spacing in Optoform 40 would become unconventional. Figure 1 shows two mounts 40-100 side mounted to create a combination mount. This arrangement isn't the most efficient way to do it. A better alternative would be to share the inner rods (Fig.2) to create a more compact mount 40-120.

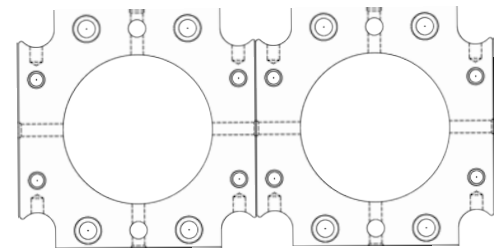
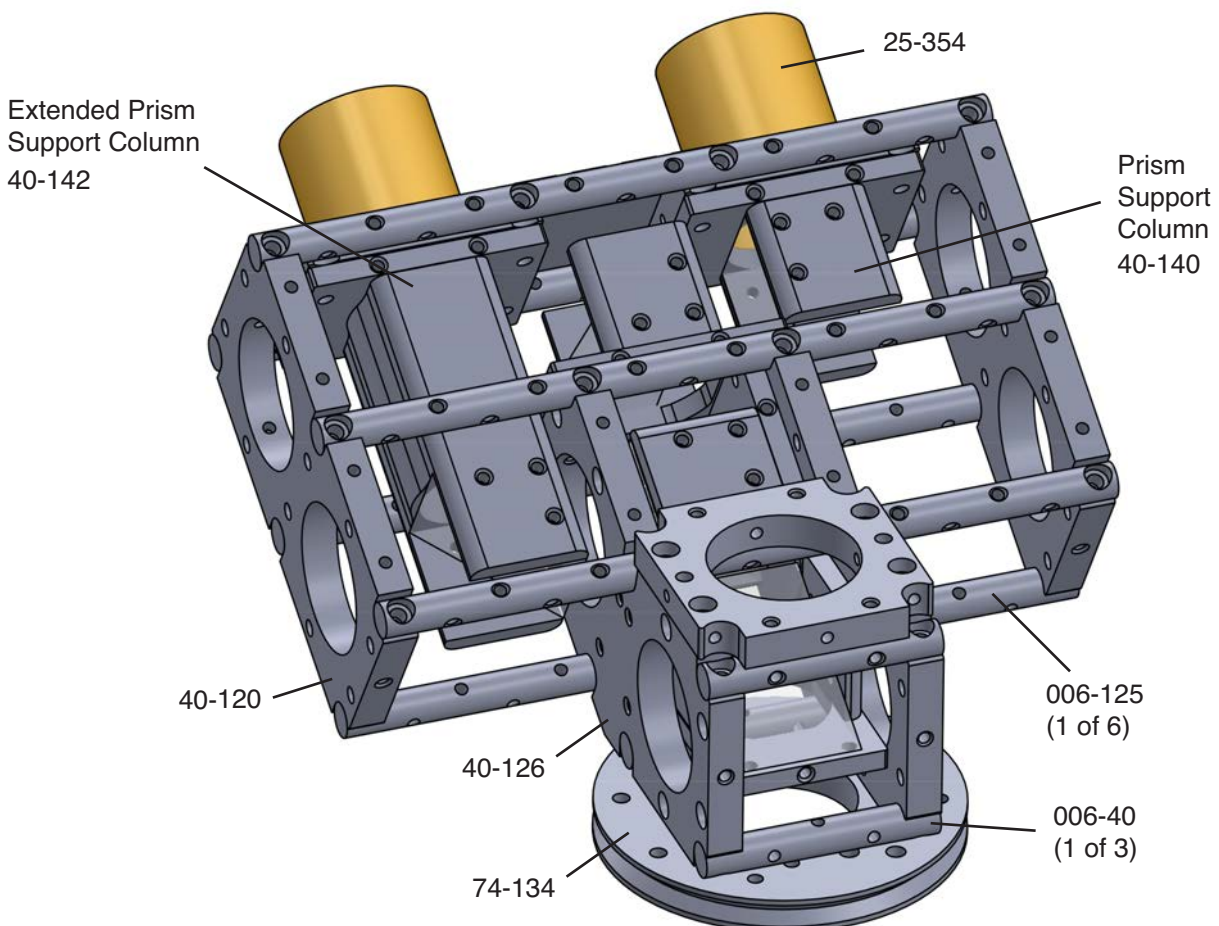


Fig.1 Two side by side mounts 40-100

The same idea would apply when designing mount 40-126. This mount is designed specifically to construct the 30 deg. inclined head (Fig.3). These basic building blocks will be utilized later to construct the rest of the microscopy assembly. The viewing head is now ready to be built.



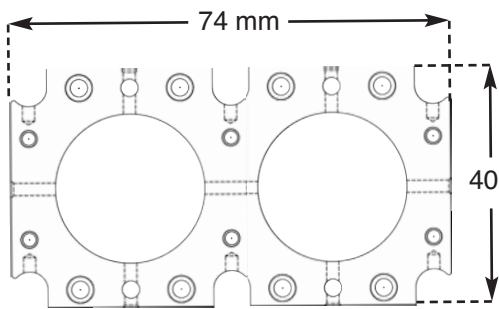


Fig.2 Combination Mount 40-120

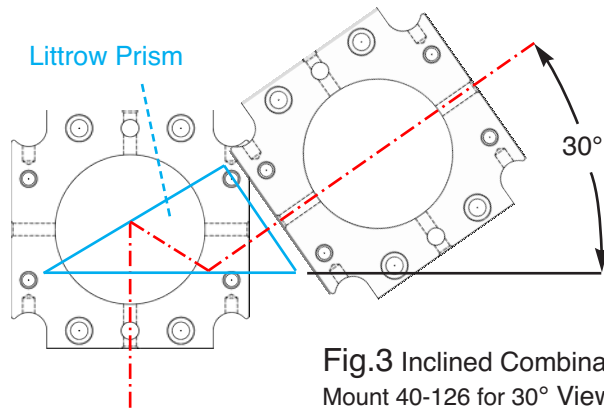
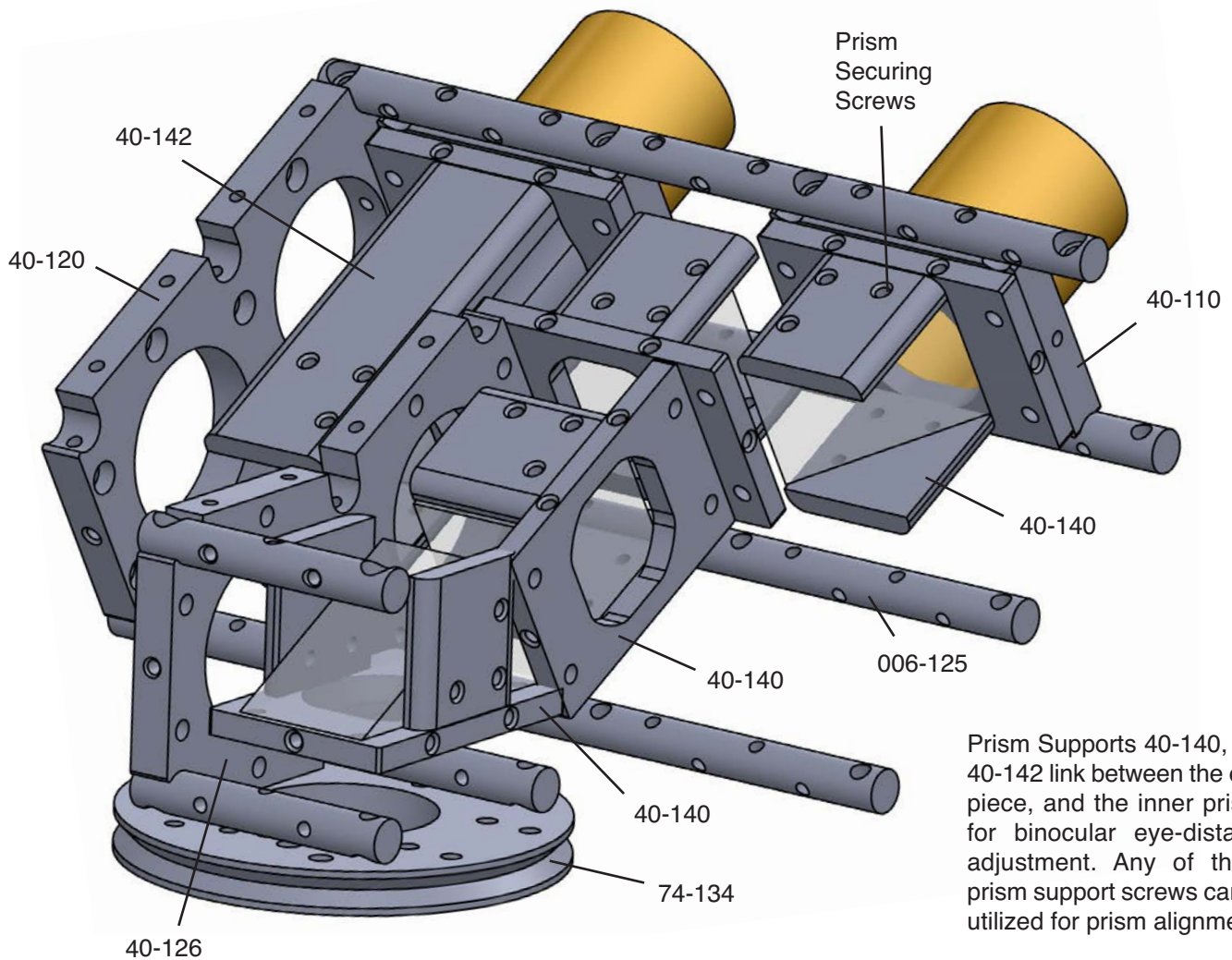


Fig.3 Inclined Combination Mount 40-126 for 30° Viewing

If you are an optics fan, you'd appreciate what we are about to do. We have all used binoculars before but have you ever built one yourself? What it takes is a system capable of constructing it. While we were children, we used the Erector set to make anything we wanted but as we grew up, we were told everything was too complicated. To build a binocular, you'll need to go to Zeiss or Leitz factory, and they'll tell to sit behind an assembly line, or work with machinists to build its already designed parts. With Optoform, you don't have to. If you are able to create form, we'll make it functional. That's really our goal.

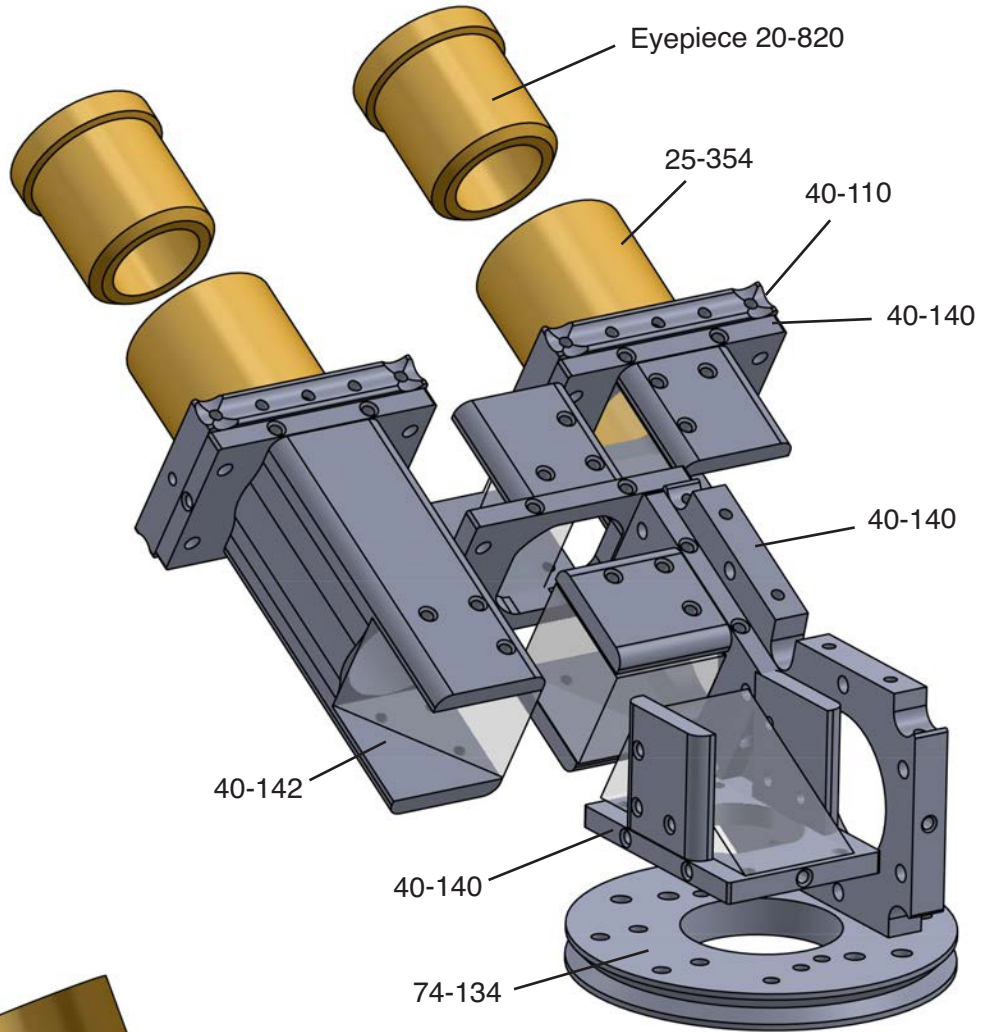


Prism Supports 40-140, and 40-142 link between the eyepiece, and the inner prisms for binocular eye-distance adjustment. Any of the 3 prism support screws can be utilized for prism alignment.

Mounting Prisms

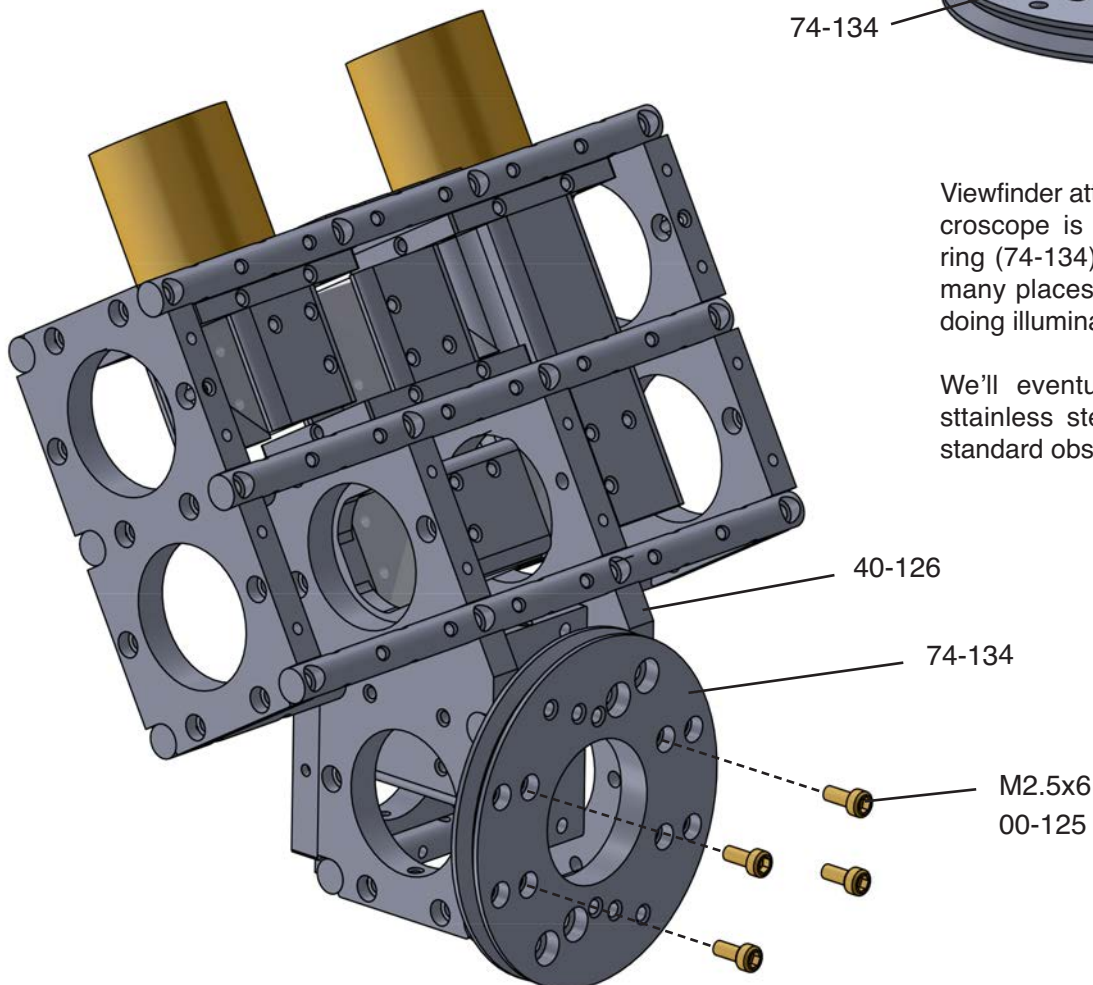
Detail of prism mounts inside the binocular head. What you experience in this assembly is more playful, and more fulfilling than being an assembler who works at Zeiss or Leica microscope factories. They aren't allowed to play, but you can!

Why not use an off the shelf viewfinder? You sure can, but these compact viewfinders have been replaced with large housings that cost too much. You may also have your own idea of adding a CCD camera inside it, or change the design to something that is more suitable for an upright microscope (light coming from above). In either case, Optoform gives you the freedom to implement it.



Viewfinder attachment ring to the microscope is this versatile centering ring (74-134). You'll see it utilized in many places to secure mounts, and doing illumination work.

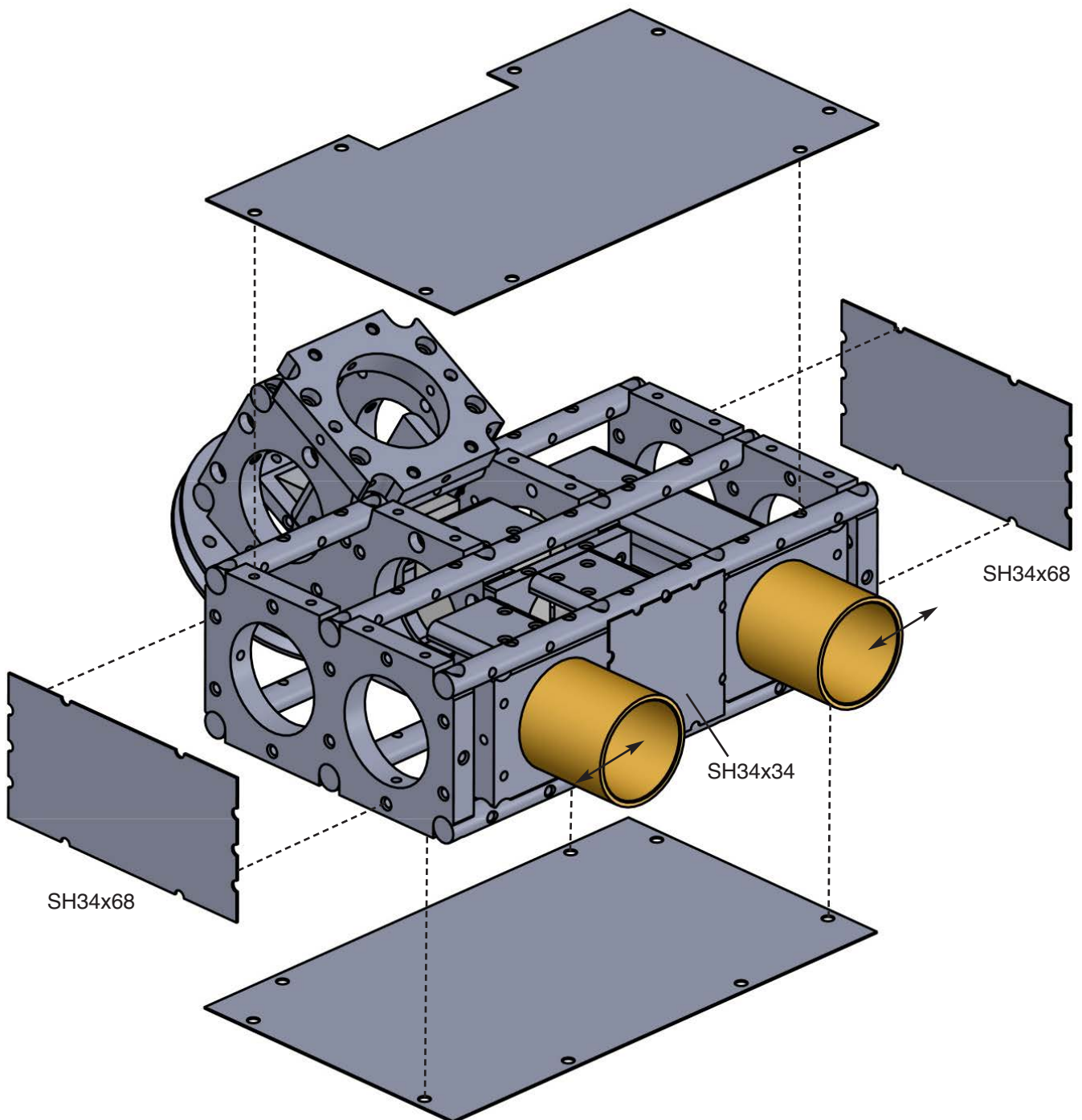
We'll eventually replace it with a stainless steel dovetail ring like in standard observation heads.



Sheet Covering

Sheet covers were introduced in the last issue. The idea is to be able to cut off extraneous light, and to prevent dust from entering the optics. For the moving parts sometimes you get lucky. The two eyepiece holders held by sliding mounts 40-110, can slide beneath a single cover sheet (SH-34x34, below) like an off the shelf viewfinder. As you can tell, the part number for sheet metal coverings includes their size information. You could also see the edges in Optoform 40 assemblies are round.

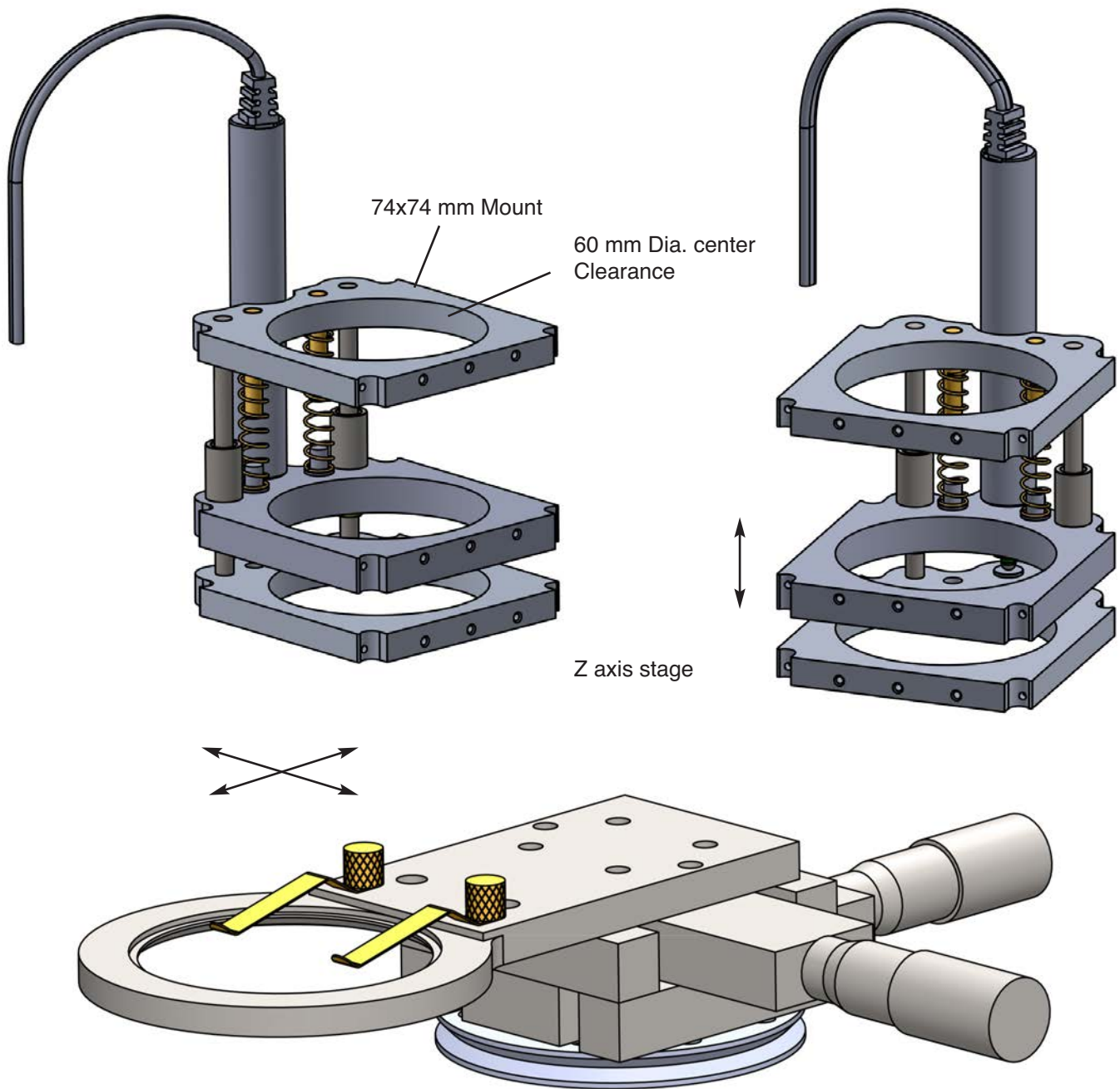
The top, and bottom sheet covers are custom made. We'd offer you the entire unit, and you could either use it as what it is designed for, or disassemble it to make modifications. The prisms are held in place with three set screws which could also be utilized for alignment. There are thin brass sheets to protect the glass, also a thin cardboard packing as cushion.



Designing the focusing Module

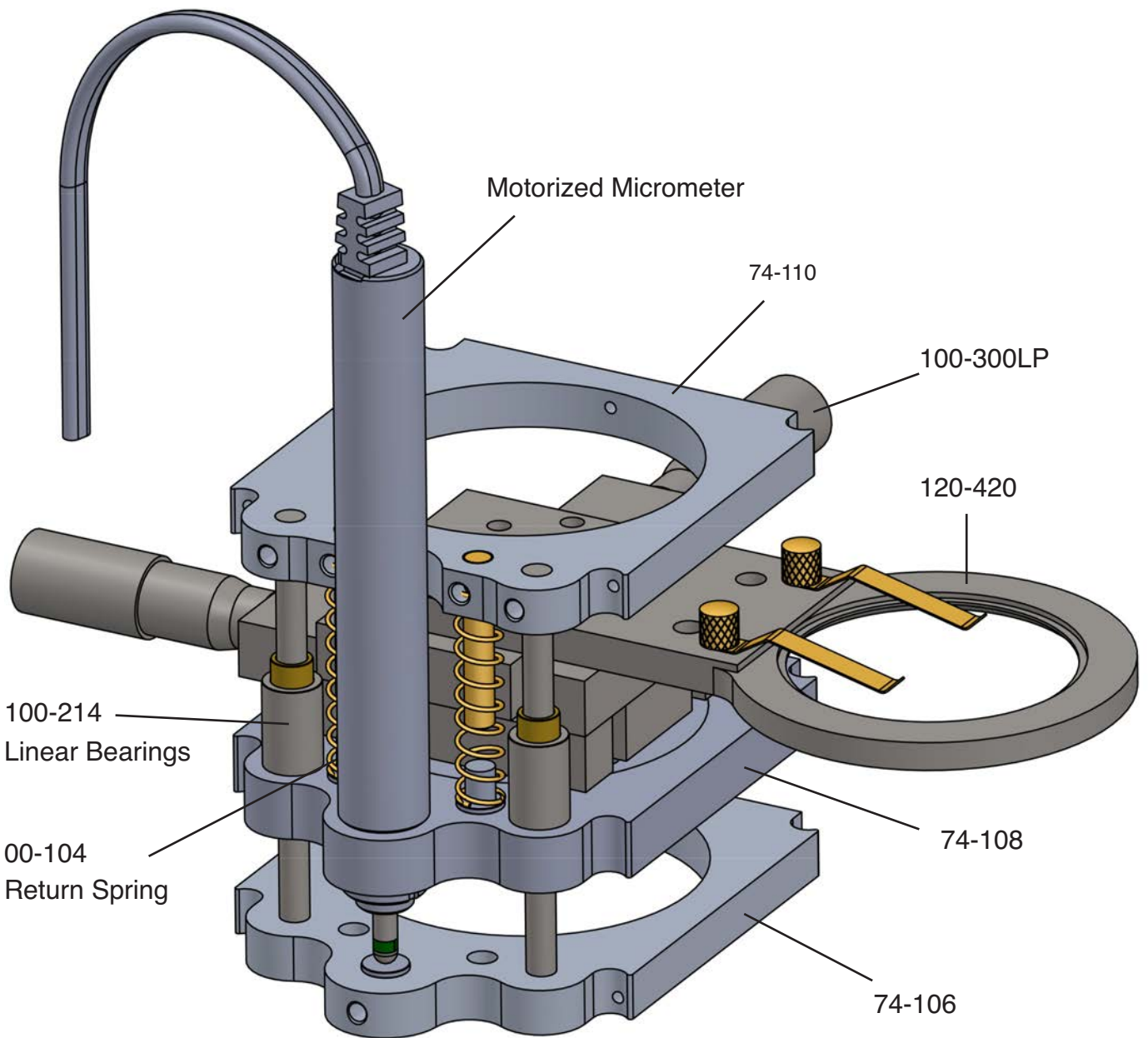
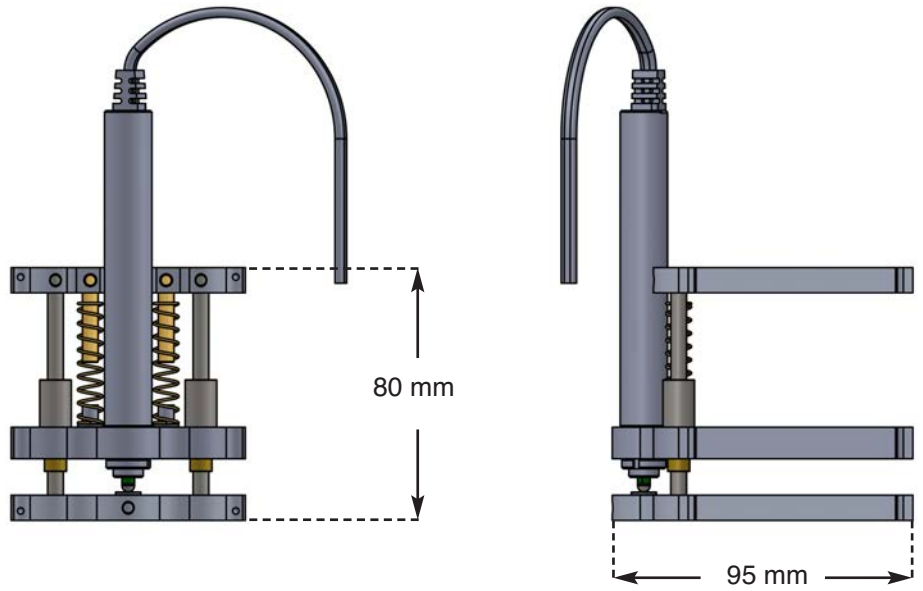
The focusing module is a tricky one. Under high magnification, it should perform precisely without image drift, while under low magnification, it should have a wide travel range to accommodate objectives that are not necessarily parfocal. We will design an elaborate XYZ stage for the sample but for now, let's design a simple, motorizable system (switchable between manual, and motorized micrometers) utilizing classical Optoform's linear bearing concept.

In its classical design, two linear bearings support the sample platform while a combination of a lift micrometer, and a return spring would precisely position the stage. The design is kept symmetrical to provide backlash free Z axis positioning. Four rods, and cover sheets support this 80x95x74 mm module. Because these modules are stackable, and the rods are side mounted, all the mating plates need to be paralleled (identical height on all four corners). With linear bearings, the mounts are already parallel, but for all other assemblies you'll need to adjust for parallelism. I'll show you how it's done.



Compact XY stage 100-300LP may be motorized by replacing its micrometers.

The XYZ stage assembly will have sheet covering to protect its inner components. The design of new Optoform modules allows chain connections. You'll see how this piece will fit to the rest of the system without any obstruction. The standard configuration is supplied with 13 mm micrometers which may be replaced with motorized micrometers as shown. Custom 80 mm long rods support the assembly. The rod system is fully compatible with mounts 74.



Expanding Optoform to Larger Mounts

As you see for constructing the rest of the microscope, we'll need more modules. In classic Optoform, we increased size and thickness of mounts, and support rods as the scale got bigger, but in new Optoform, we'll keep them the same! This is unheard of in Optomechanics. The advantage we have is full compatibility between every individual part in the system. What is allowing us to do this in module design is we could utilize sheet covering, and anything else that is necessary to achieve mechanical rigidity. Also in larger mounts, we could utilize as many rods as we need, which could have any shape necessary. This would be impossible to accomplish with prior art.

The next size up is mount 74. This mount is a combination of 4 pieces of mount 40-100 (Fig.4). The combination mount will always share rods between them. You'll see how this idea will allow construction of assemblies with extreme complexity. Again, the end user would just combine modules, while we'll handle the complexity for you. Our goal is to offer you a construction system that you could also use to house your electronics. Optomechanics comes included. Say you want to house the power supply: The stand-off for the electronics board, and the box could be built with Optoform. Every rod is 6 mm in diameter, and every mount is 6 mm thick, ready to be assembled. Your control panel would be one of the sides of the housing, while the box height could range from 20 to 250 mm in height. Optoform mounts, and rods, and cover sheets could be on your electronics parts bin next to your soldering iron. You got the idea.

Parallelism

So far, the mechanical geometry of optoform has been 40x40, and now we are adding the next larger size: 74x74 mm. The combination mount for 74x74 would naturally be 74x142 mm. Our next size up would be 142x142 mm. How would you make all these sides parallel, and not come up with another eiffel tower?!

You could use a digital caliper to measure each side. Rod lengths are made with 0.01 mm accuracy but you could always press the assembly against a flat surface before tightening the screws, and you'll have good parallelism.

You could also use a height gauge or dial indicator as shown below. All four corners should be within 0.02 mm error. The Aluminum cover sheets would give structural rigidity to the assemblies. Before covering the space frame with sheet covering, the plates could be pressed against a flat surface on every corner before tightening rod securing screws.

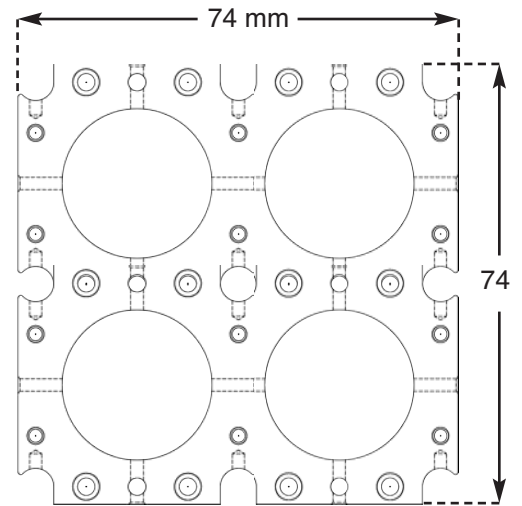
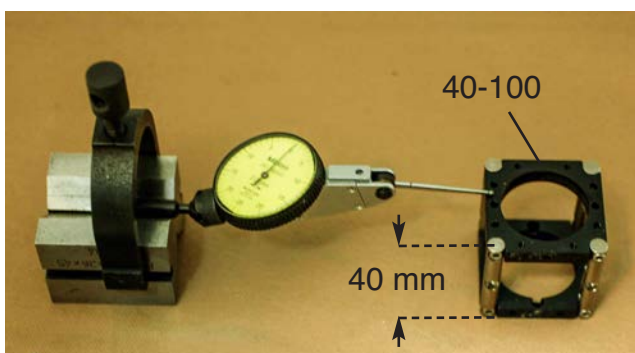
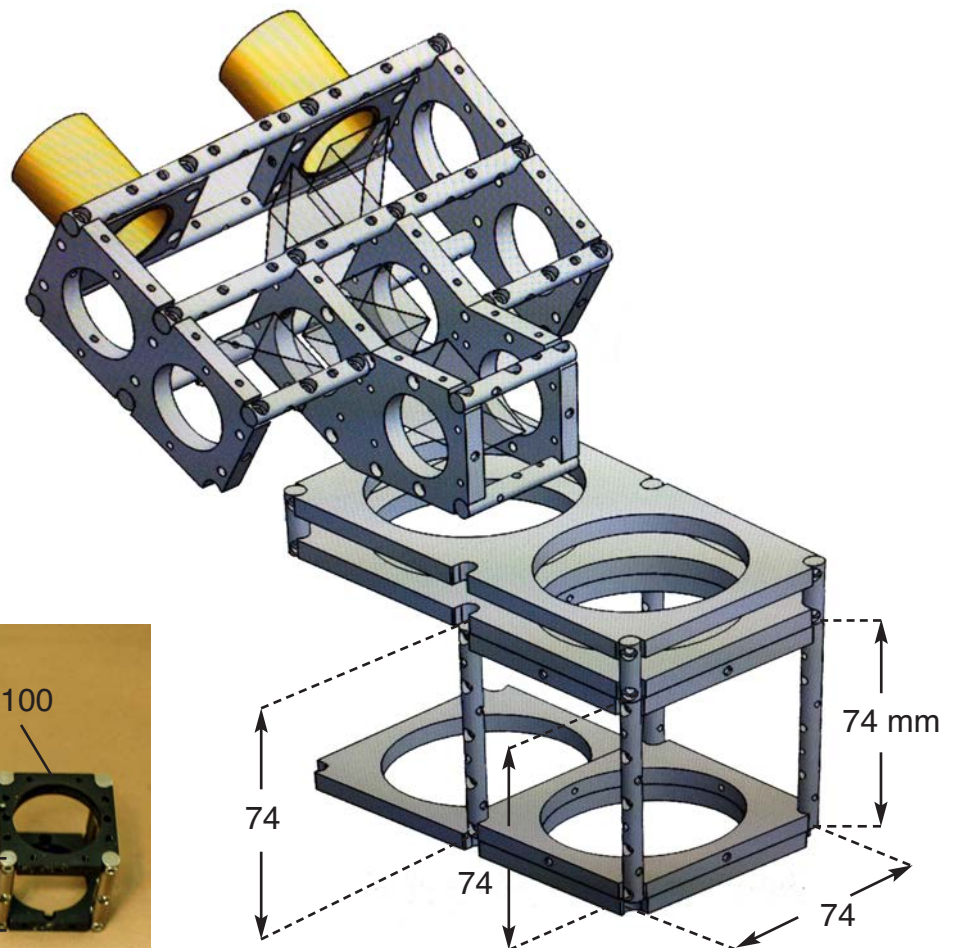


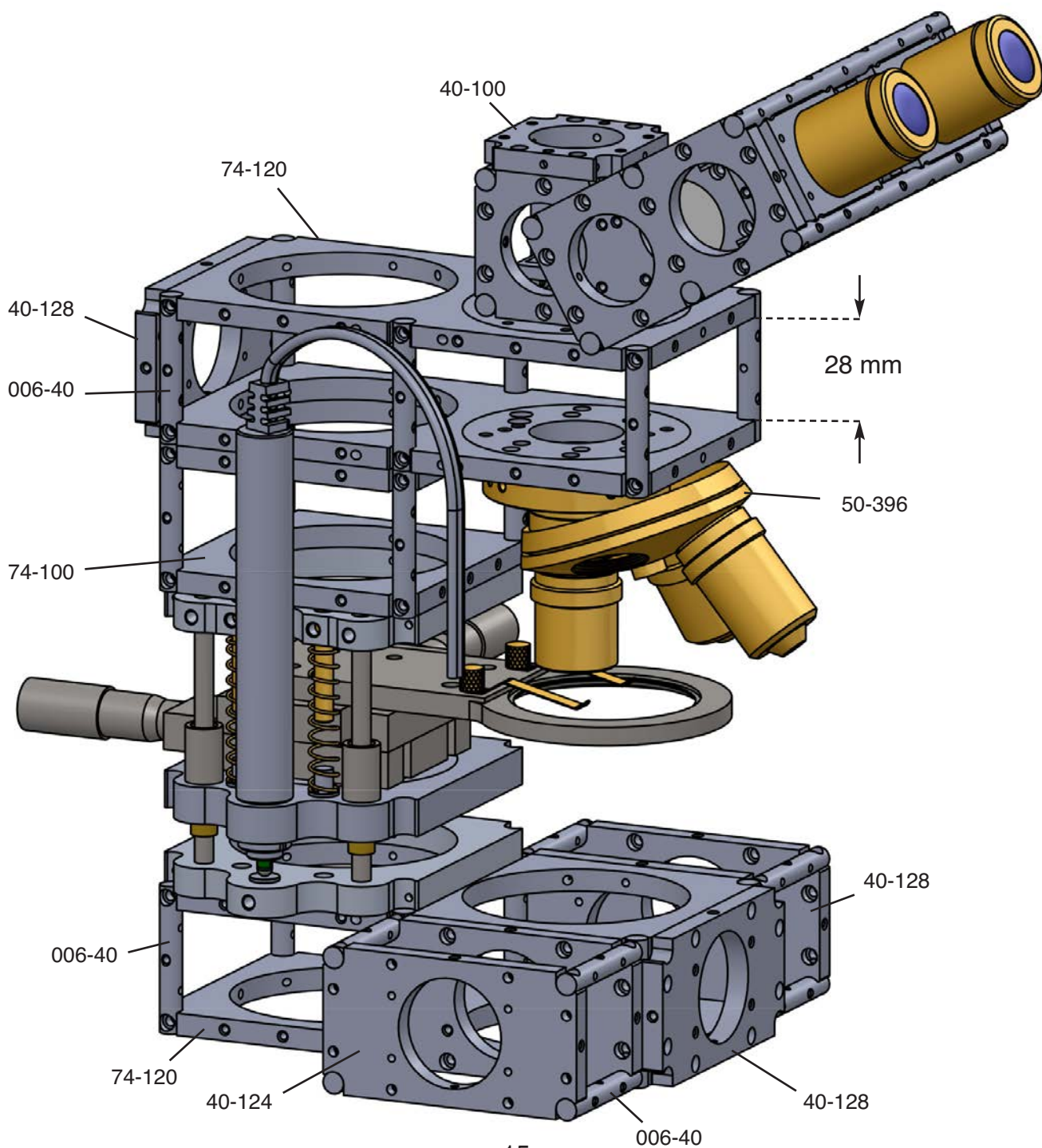
Fig.4 Geometry of Combination Mount 74

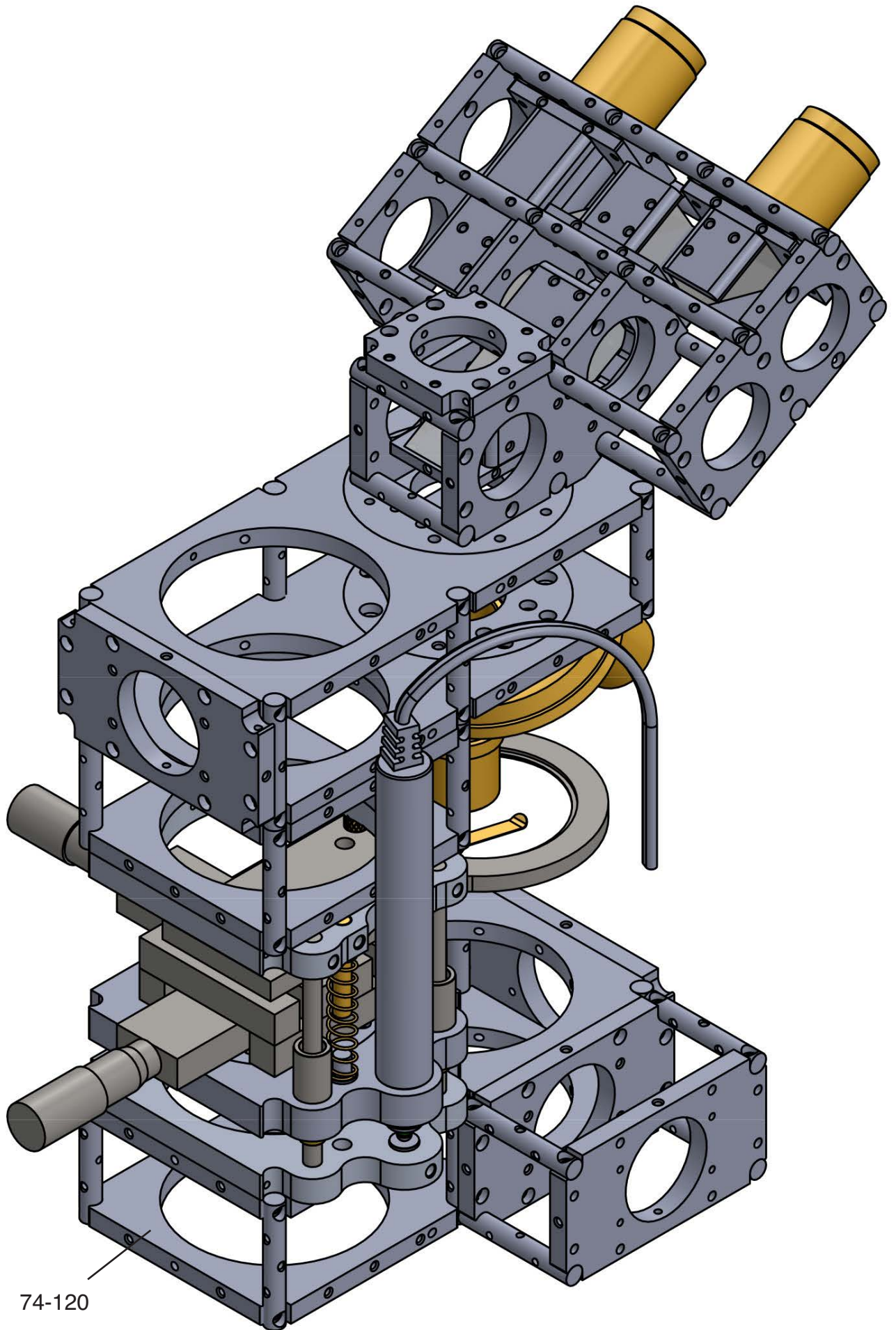


Integrating the Modules

The current configuration allows implementation of both incident, and transmission illumination. The spacing between mounts 74-120 is 28 mm, and a new mount is added to fit in between these mounts for securing all the necessary beam-splitters, and optical elements that are utilized in designing a Kohler illumination or an Epi-Luminiscent scheme. Again, the illumination optics is a stand alone module that could be separated from the microscope to be replaced by an alternate design.

The base platform is currently designed in a T-shaped space that could hold some electronics. As the mounts get larger, their size to thickness ratio increases, and in larger mounts, they are not any thicker than electronics enclosures with good heat dissipation. I will have to give you a few examples till you see what I mean by this. But for now, take my word for it: The new Optoform assemblies are perfect for wire routing, and electronic parts integration into the optics housing. I guess the easiest example would be housing a large CCD camera, mounted on 40-100 plate on top of the microscope. We'll construct one later. But what's missing in this microscope is the illumination optics. I'll explain that next. We have designed a special mount for this purpose (40-128). It is mounted at several places around the microscope to show various light source mounting possibilities.





74-120

Support Base

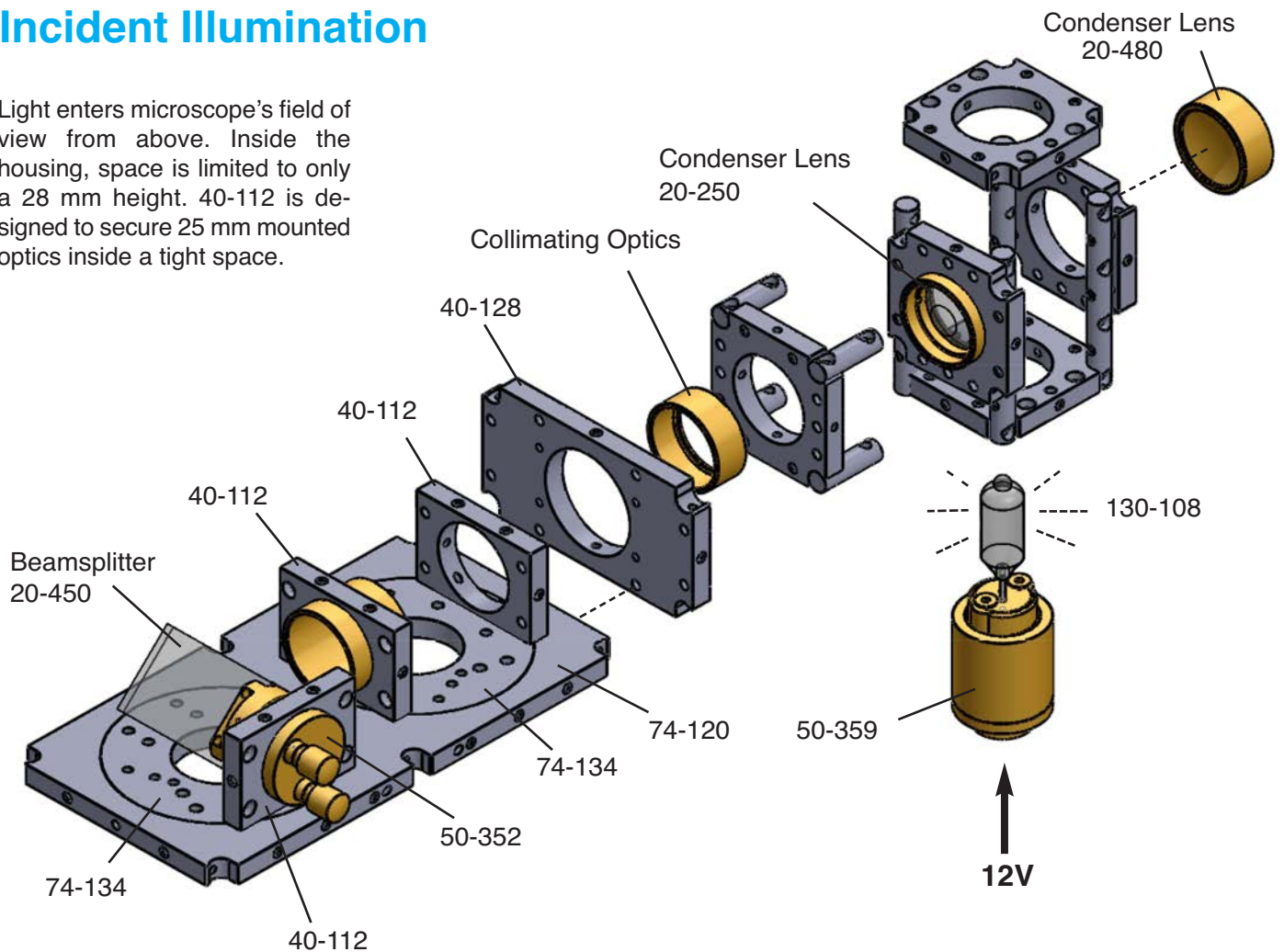
The microscope base is desired to have as low profile as possible, but it has to be thick enough to house the illumination optics if the light comes from below the sample. In this example, we'll utilize 40 mm rods to minimize the height. If we decide not to have the base to house the optics, we could house a switching power supply board there.

Illumination Optics

There are several optical paths the illumination optics could take form. It could be an inverted arrangement or in this example, the standard upright design. For epilluminescence illumination, let's utilize our Halogern lamp module connected to microscope's rear end. To accomplish this, we would populate the 74-120 mount with an assortment of optical elements to collimate, and focus the beam onto the sample (below). There are two 74-134 centering rings mounted on combination mount 74-120: One secures the beamsplitter holder below the binocular head while the other secures the illumination optics of the lamp housing side the microscope.

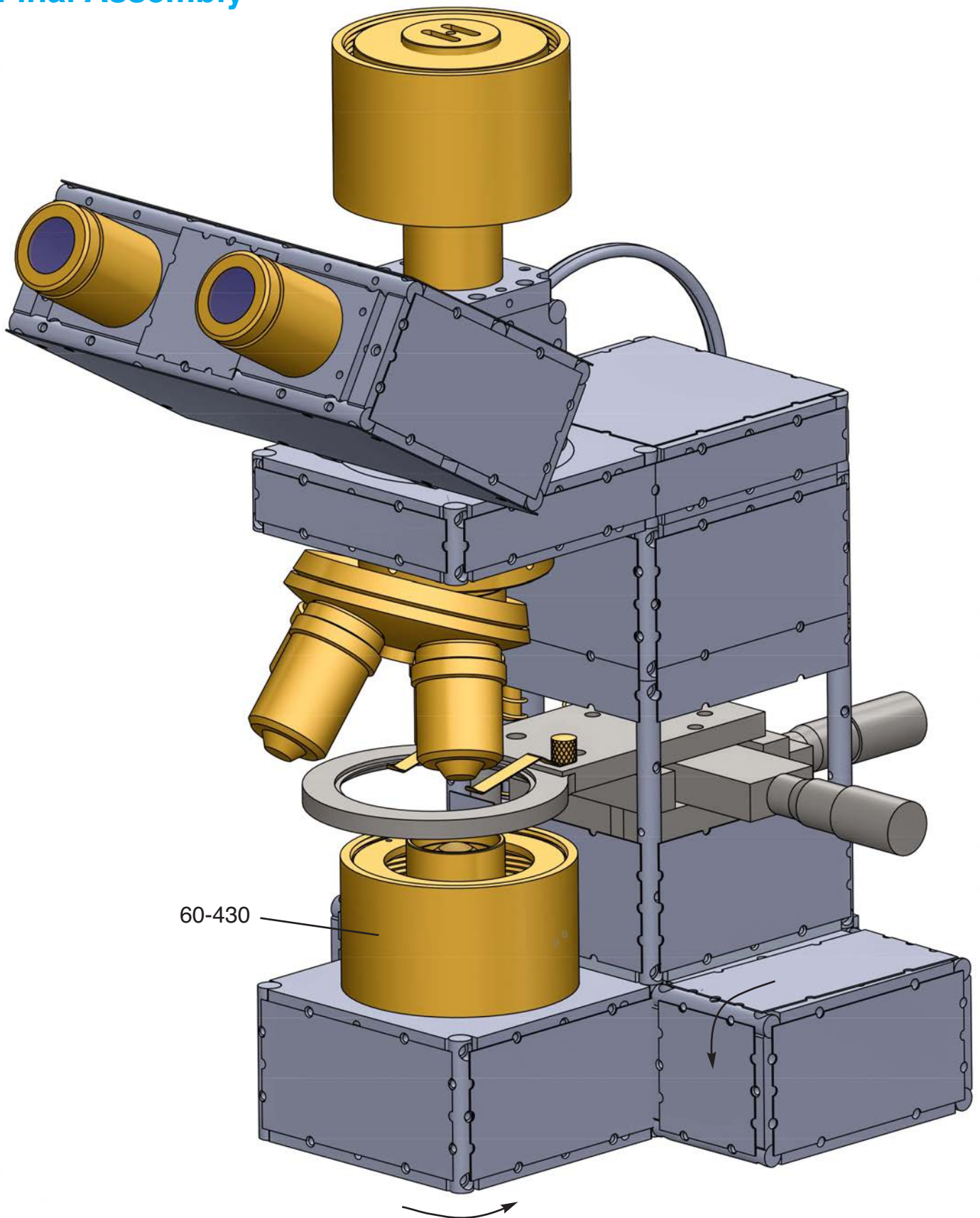
Incident Illumination

Light enters microscope's field of view from above. Inside the housing, space is limited to only a 28 mm height. 40-112 is designed to secure 25 mm mounted optics inside a tight space.



Various illumination schemes could be implemented in between two 74-120 mounts. Although discrete components are shown, the illumination assembly actually consists of two modules: The lamp housing (right), and the illumination optics housing sitting below the binocular head. Note the illumination path is shown from right to left for clarity (opposite of its orientation inside the microscope on the previous page).

Final Assembly



The final assembly is to cover the instrument with sheet metal shell. With new Optoform this is easy because there are plenty of inexpensive pre-cut anodized Aluminum cover shell you could get to cover it. Note where there are vertical rods, there are vertical curves around the body, and horizontal rods would result in horizontal curves on the housing contour. If you have conflict between two cover sheets, just cut them with scissors. Office scissors do much

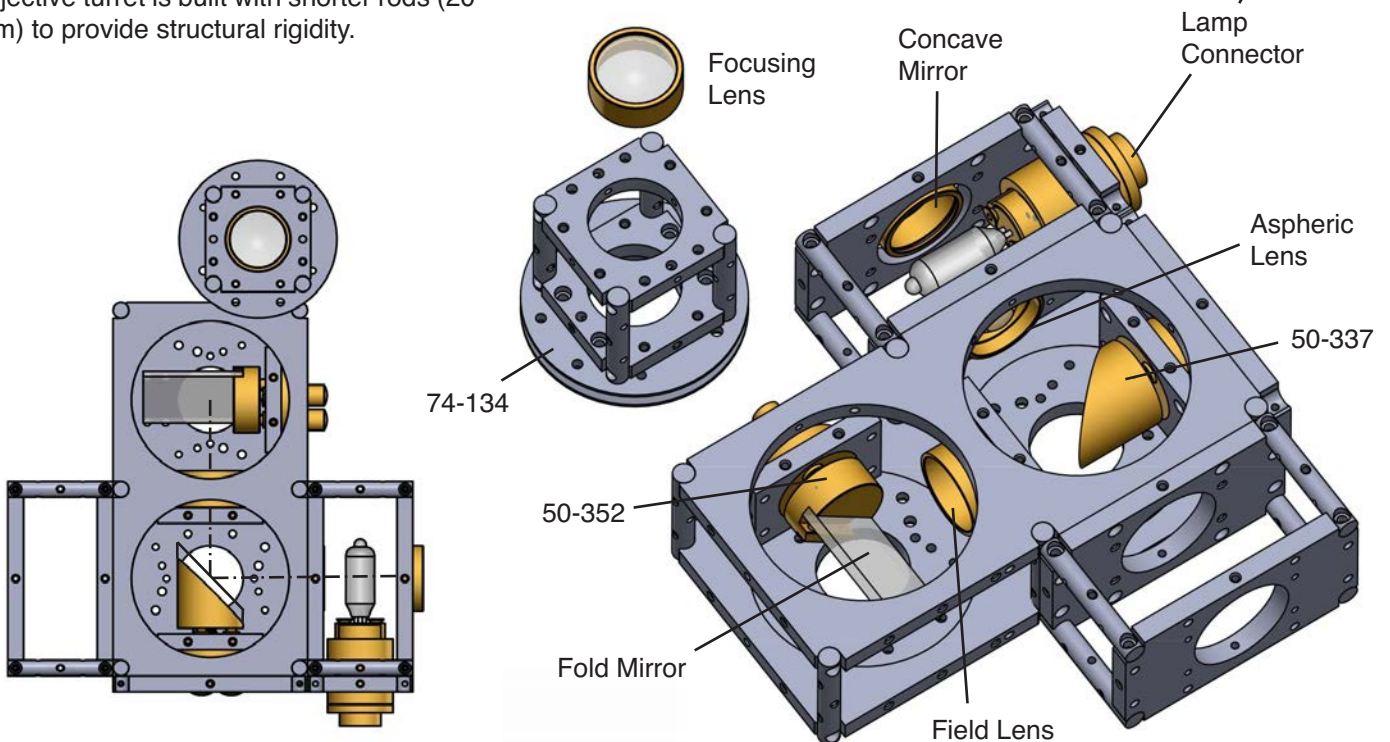
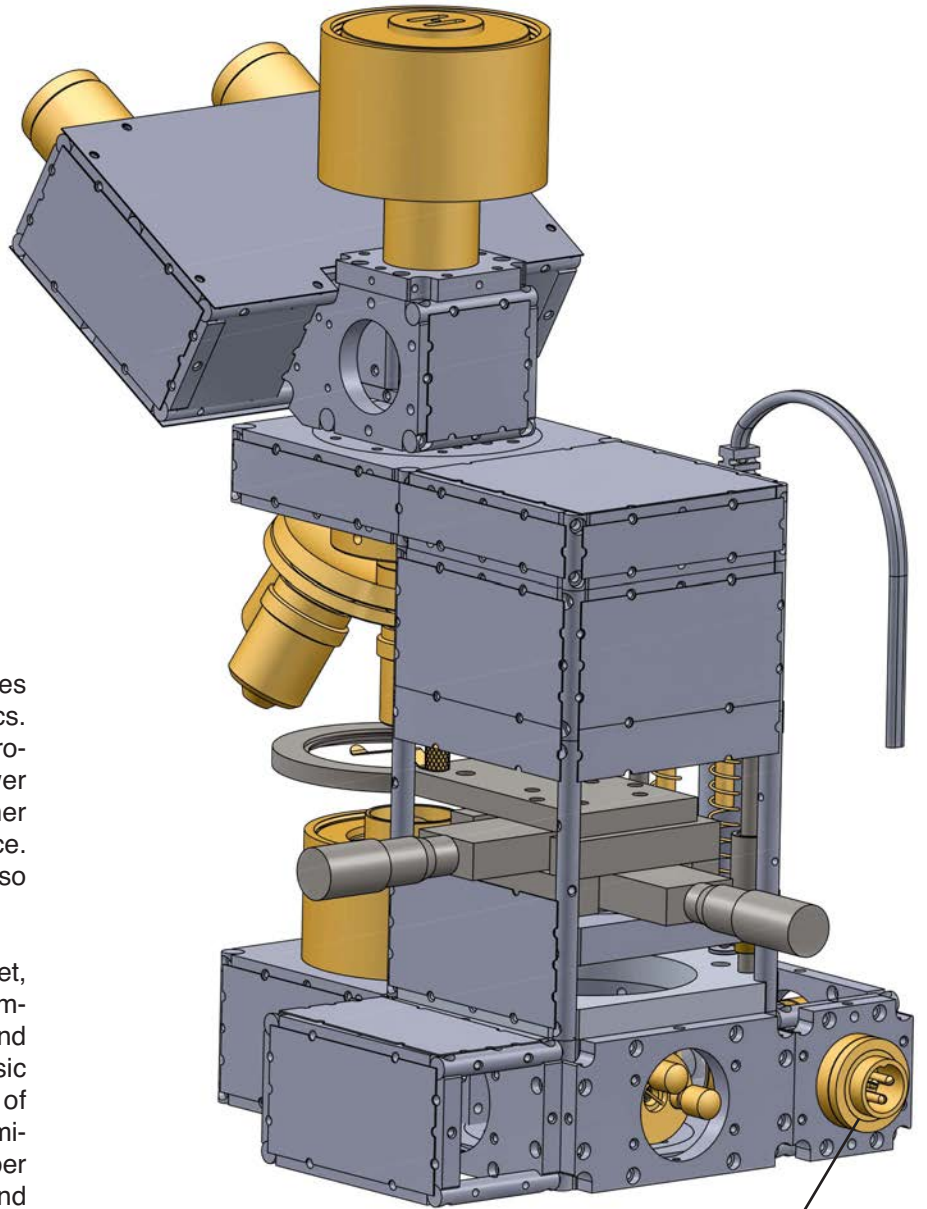
better cuts on thin Aluminum sheets than heavy duty cutters. In any case, you'd also notice the focusing barrel below the sample (60-430) is built with Micromax 60. This is an exact match to the inside clearance aperture of mount 74's.

Micromax 60 accommodates much bigger lenses. It is perfect for constructing condenser optics for illumination purposes. The Littrow prism can be replaced with a specially cemented version to convert the binocular head to a trinocular observation head as show in this example.

Back Illumination

The microscope base in most microscopes are occupied by power supply electronics. This worked well for older generation microscopes because the weight of the power supply with its wire wound transformer would give the microscope a good balance. Today's switching power supplies are so light; they could be housed anywhere.

We haven't reached the electronics part yet, so it's pure optics for now. Most of the components like the lamp housing, mirrors, and tilt stages are borrowed from our classic Optoform parts catalog. Several views of the illumination optics housed inside the microscope's base is shown here. The upper platform securing the trinocular head, and objective turret is built with shorter rods (20 mm) to provide structural rigidity.



Disassembling Binocular Optics

Speaking of assembling binoculars in Leica, and Zeiss factories, have you ever wished to open one? If you look for screws in these fine instruments, you won't find any. So what's the secret in opening one of these?

Having a camera background, and some of the tools, and trade secrets in camera repair, I just opened one of these. I am not an expert in binocular design but here is what I was able to take apart for you to see. We have a good inventory of binoculars at OMiD museum. I took apart a Leica 10x25 BCA.



Zeiss 8x30B

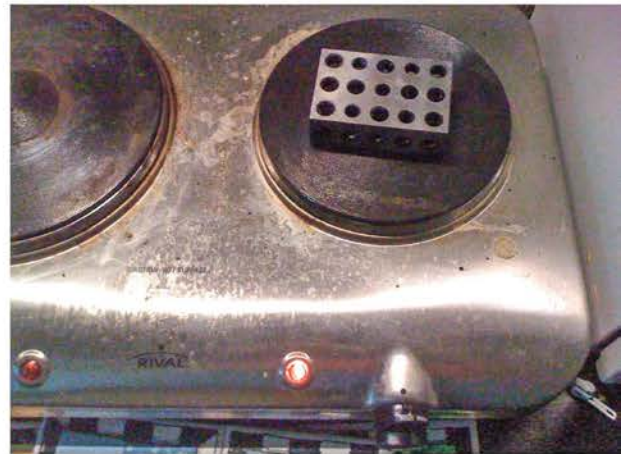


Leica 8x50 BA

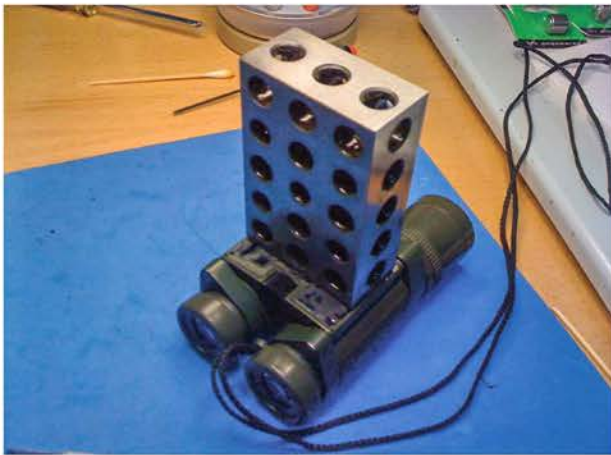




Remove the top cover letherette by a straight edge X-Acto knife. Use alchohol to soften the glue as you progress removing it in small stripes at a time.



Heat up a steel block on the oven (moderate heat).



Place it on the metal cover to loosen old adhesive.



Lift the edge by a straight edge X-Acto knife.



Remove cover.



You can cool down the block.



Next step is to remove the focusing knob screw. This is loctited in place.



Use the tip of the soldering iron to start heating it up.



Hold until the lockite softens.



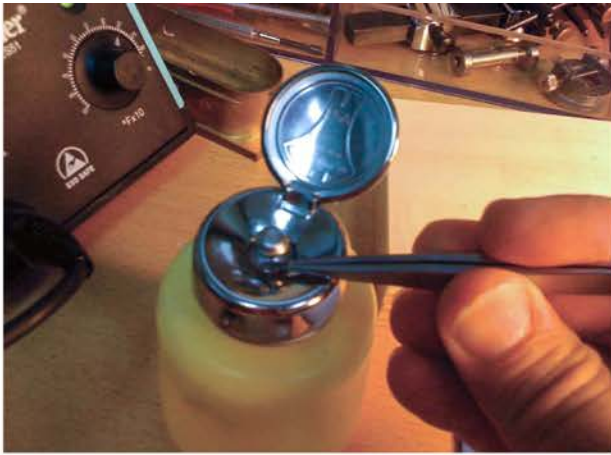
Remove the screw (you need to grab the focusing knob using a 1/8" rubber sheet).



Unscrew the focusing knob, and pull it out.



Remove focusing knot assembly.



You can use tweezers to transfer alcohol for removing cemented covers.



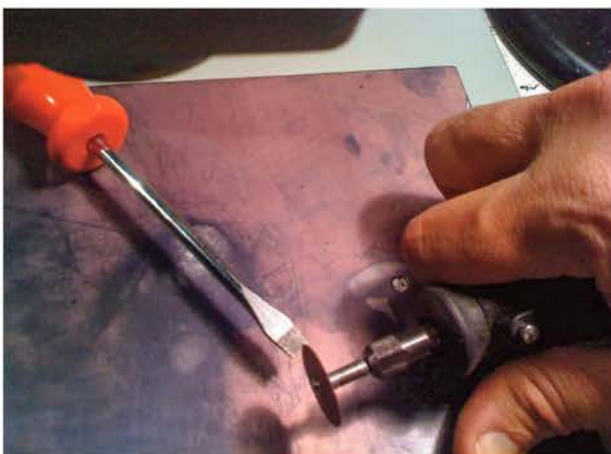
Apply alcohol to the plastic hinge cover. The lock screw is right beneath it.



Start moving the cover until it is loose, then remove it using a sharp edge X-Acto knife. The hinge mechanism locking screw is now exposed.



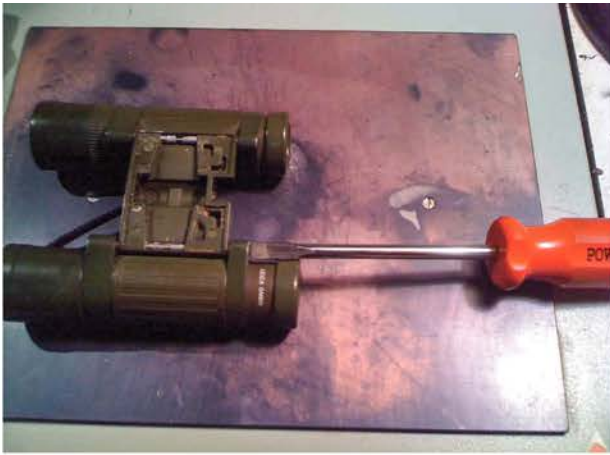
It's time to make a special tool. You need a Dremel with a cut-off wheel attached, and a flat-edge screw driver to sacrifice. Work under a stereo microscope.



Start forming/shaping the inner edge of the screw driver blade to make the spanner wrench.



Sand off the outer edge by rotating the entire screw-driver blade. Sand it down slightly less than the diameter of lock screw.



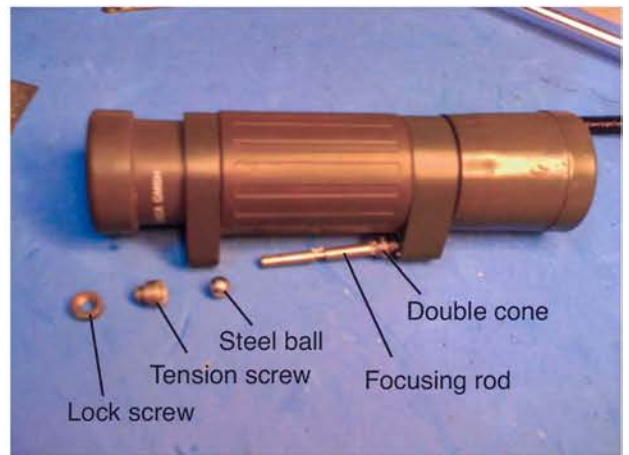
Now you'll need to use the Dremel to reduce the thickness of the front edge of blade. If too thin, it could brake. If too fat, it will slip, and cause scratches.



Try out the spanner tool to see if it works well. It should be slightly smaller than the locking screw diameter to prevent scratching the fine screw walls.



After removing the locking screw use a flat head screw to remove the hinge ball.



The hinge mechanism consists of a steel ball, and a tension screw on one side, and a cone on the other end that slides along the focusing rod.



The focusing rod may be tilted, and taken out. The L-side of the rod couples with the internal focusing lens barrel.



To remove the other Objective, slide out the rubber armor cover.



You can heat up the cemented screw via the tip of a soldering iron. This screw secures a guide knot that prevents the focusing lens barrel from rotating.



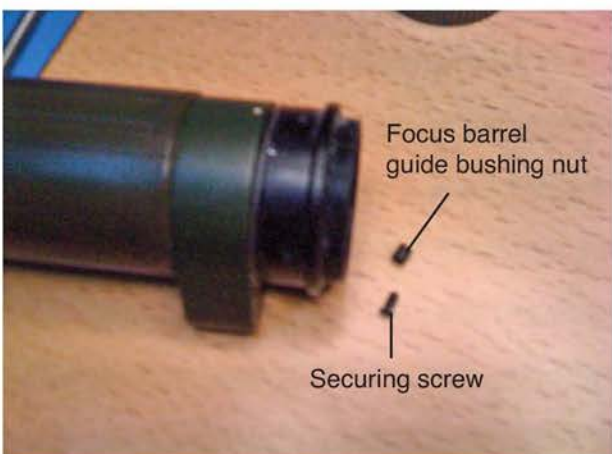
A more powerful solvent can also be used to loosen the screw.



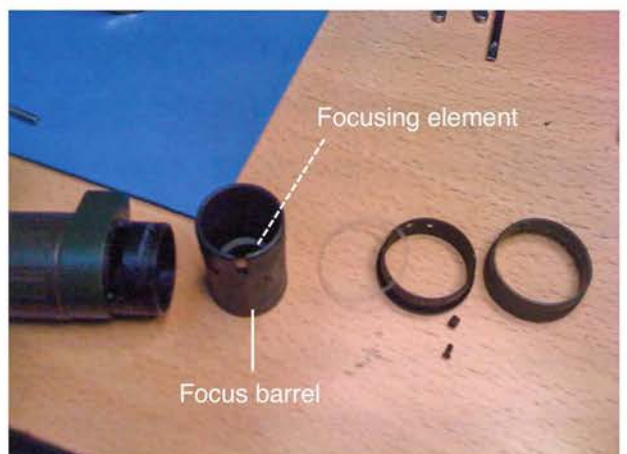
Use tweezers to apply the solvent. This screw rotates freely after it is loose. So it can't be taken out unless the nut is held first on the other side.



Unscrew, and remove the objective on the other side. Slide off the rubberized diopter focuser from its metal ring.



A similar screw is on this side. The reason the other screw rotates freely is now revealed: There is a nut inside that needs to be grabbed first to remove screw.

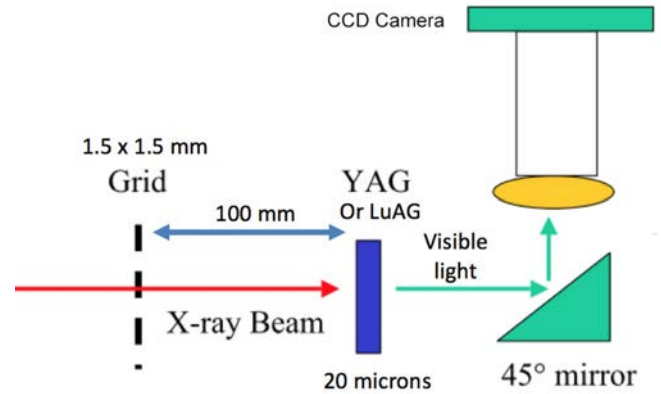
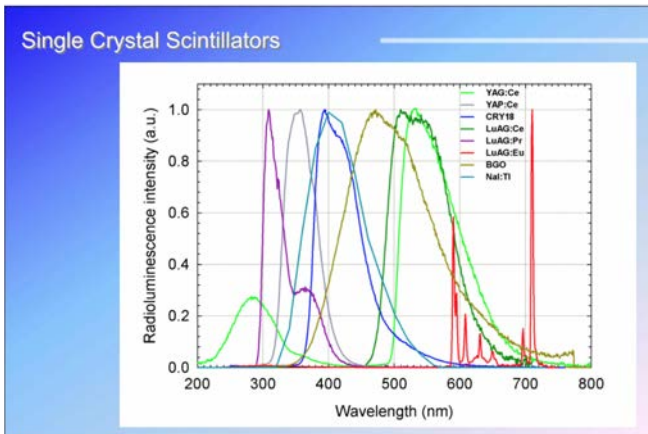


The diopter focus lens barrel is now fully disassembled. The inner prism is now revealed, and the entire internal optical system is exposed for repairs, etc.

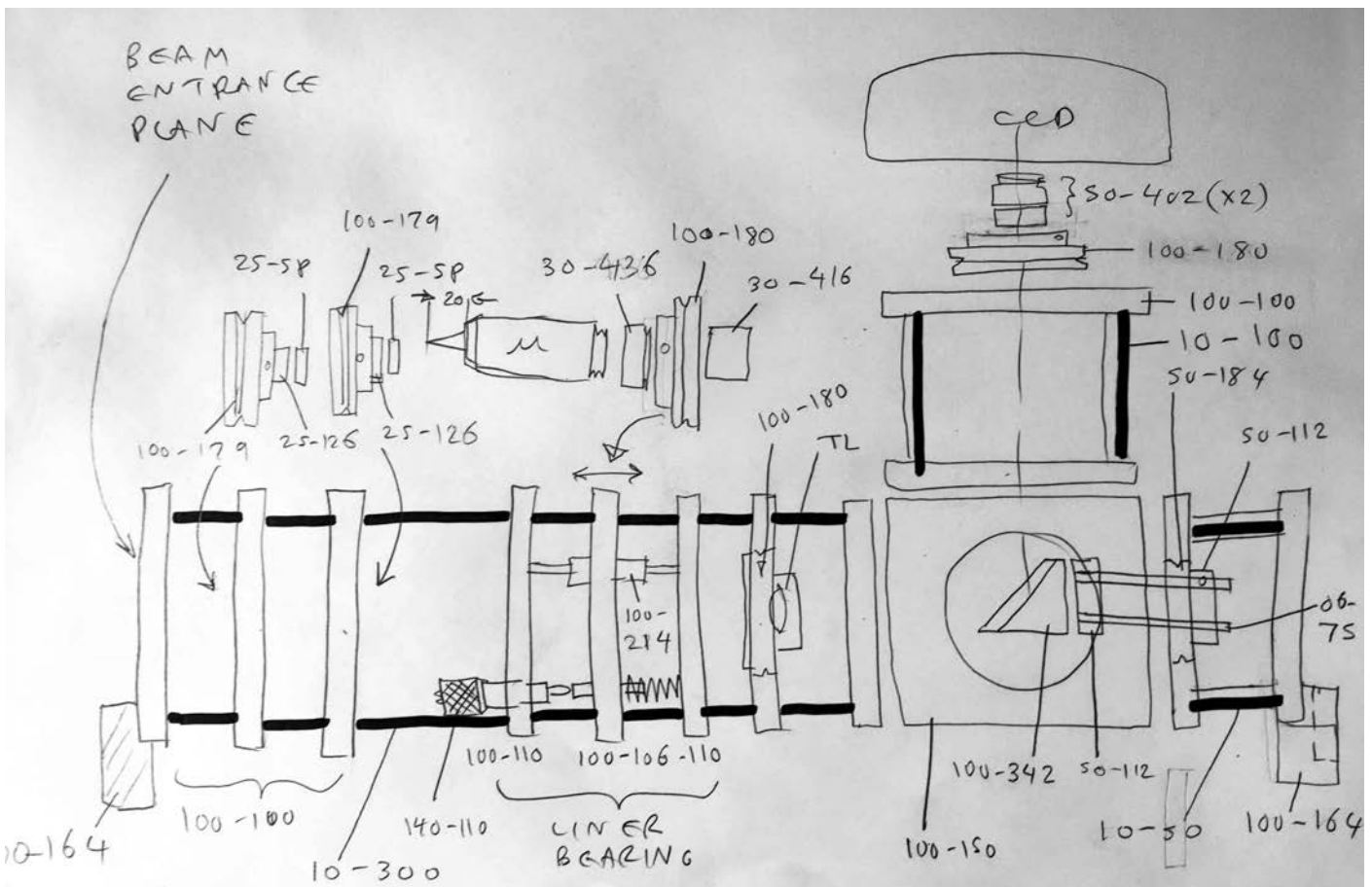
Designing a YAG camera to view a Target in the X-Ray Region

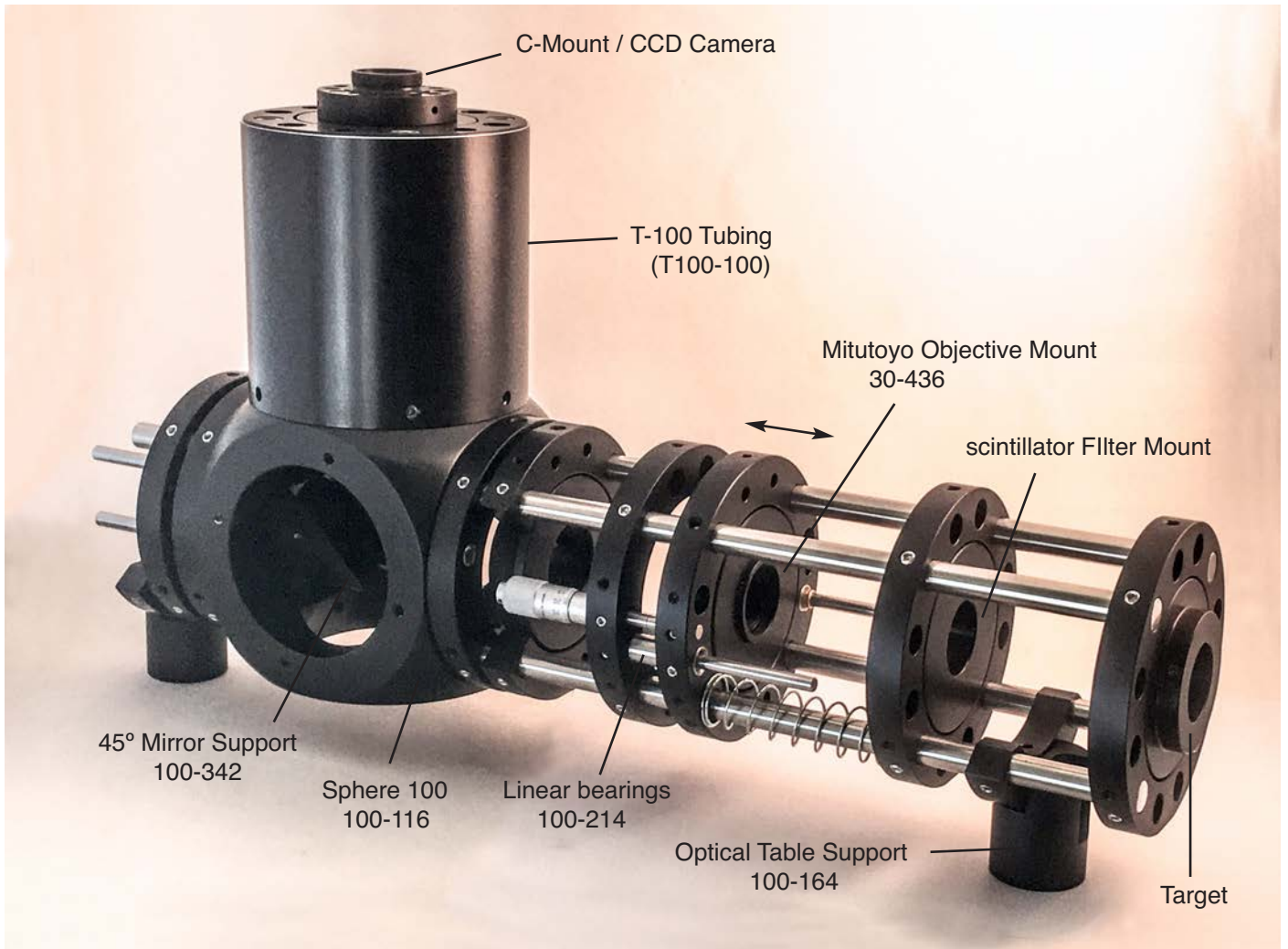
Optoform is a product that few manufacturers would be willing to carry. The plain simple reason is it would take a knowledgeable support group to help customers implement their ideas. I have been the technical support for Optoform for 20 years, and I know how much time, and dedication it needs. When Thorlabs copied Microbench, they understood the needs of the users, and started adding their own line of accessories to it. In a way, they made it their own product, and that's why they had the synergy to support it. So it is not enough to have a good product. It takes dedicated support, and most companies lack that feeling of purpose, and motivation to do it.

In this particular design, the customer needed an instrument to be positioned in front of an X-ray beam, with a target in front, to project its image onto a CCD camera. It started with the conceptual sketch by the customer (right), then my hand sketch drawing (below) to suggest the parts he would need to set it up. The tubing slides over the round mounts to light seal the system. The large CCD camera in this case could be supported by lowering it to lean at the end of rods.



Basic principal of the X-Ray camera: It consists of A scintillator filter that converts X-Rays to visible light (see choice of filters above, left). The X-rays project a shadow of the grid onto the filter, and the microscope objective projects the image on the CCD camera for viewing. A linear bearing arrangement is utilized to micro-position the objective lens.



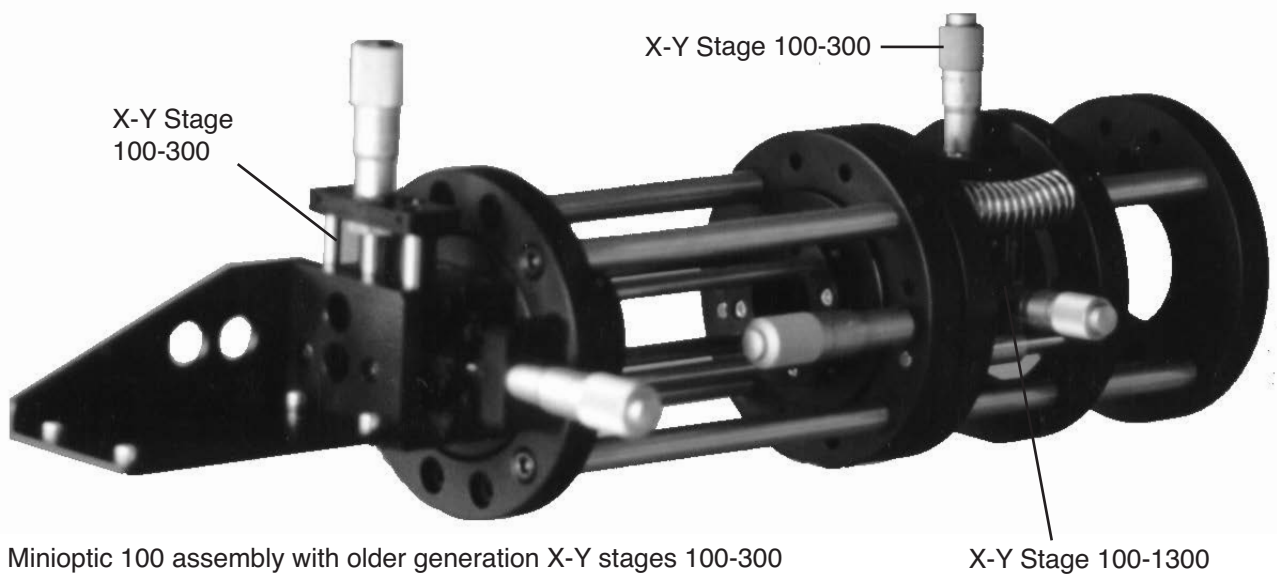


Designing a New X-Y Stage for Minioptic 100 (cLassical Optoform)

Back in the days, Stanford University had asked me to design an Optoform assembly that would project a laser beam on a CCD device inside a vacuum chamber. Well, the support assembly was straight forward: Since the vacuum chamber window was around 100 mm \varnothing , I suggested using Miniopic 100 mounts to build the assembly. They utilized a long working distance Mitutoyo objective to focus the laser beam on to the device through the thick quartz glass window. Everything worked out nice as illustrated below.

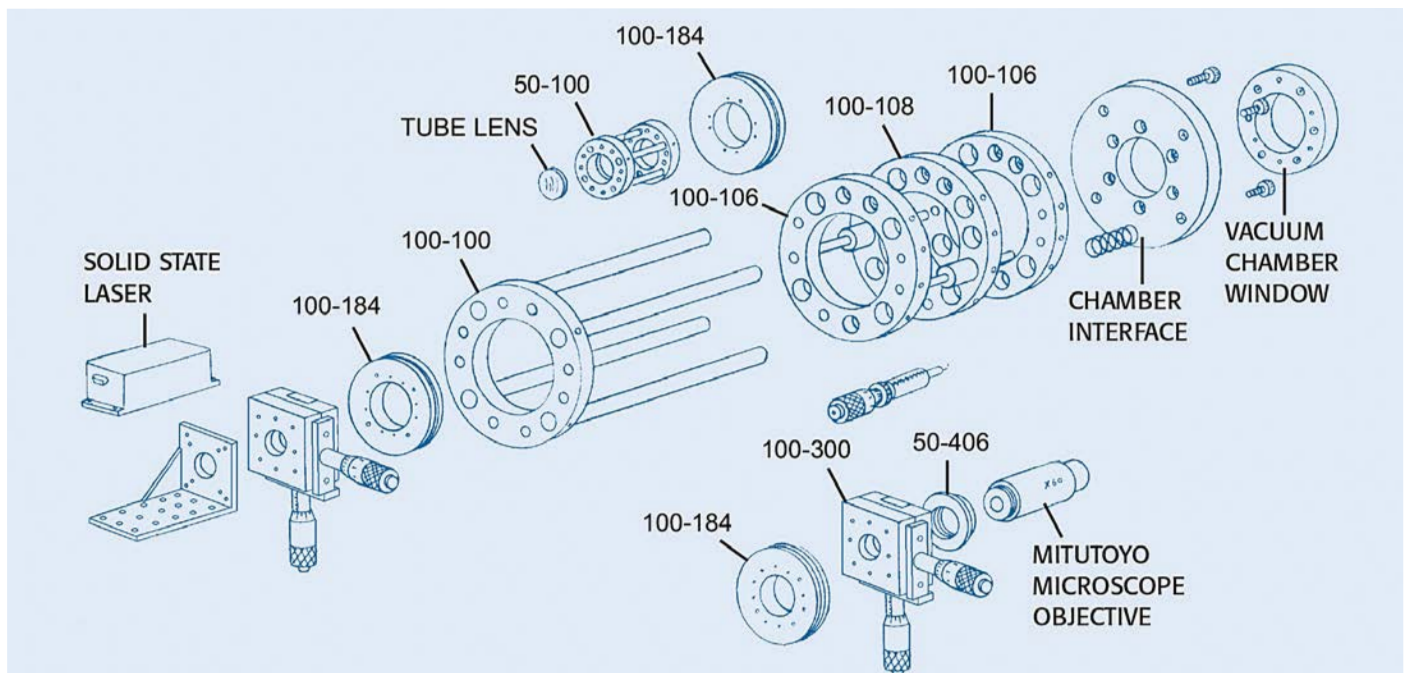
Recently, a customer asked me to build a similar assembly but no matter how much I played with the setup, I couldn't fit the X-Y stage, securing the microscope objective inside the linear bearing assembly (see bottom drawing). The linear bearing rods couldn't allow the standard X-Y stage 100-300 to be installed. So I had to design a compact stage to fit in between two closely spaced linear bearing rods.

The new design was a challenge because the retaining screws for the micrometer mount, and spring plunger were so close together. As it turned out, there was enough space to insert the mounting screws and having sufficient width to support the micrometer, and the plunger (opposite page). The new design allows X-Y-Z stage setups to be constructed without mechanical constraints. This design change was to fulfill the needs of one customer.

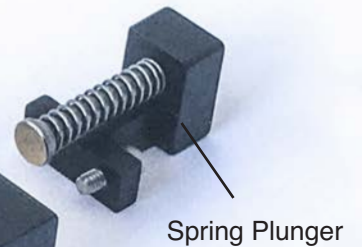
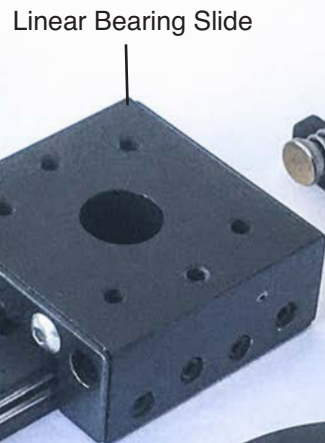
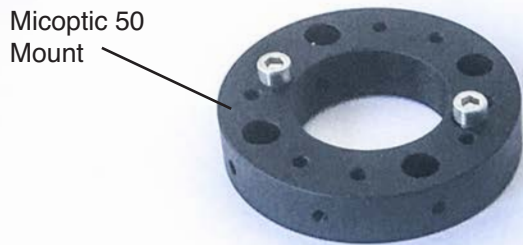
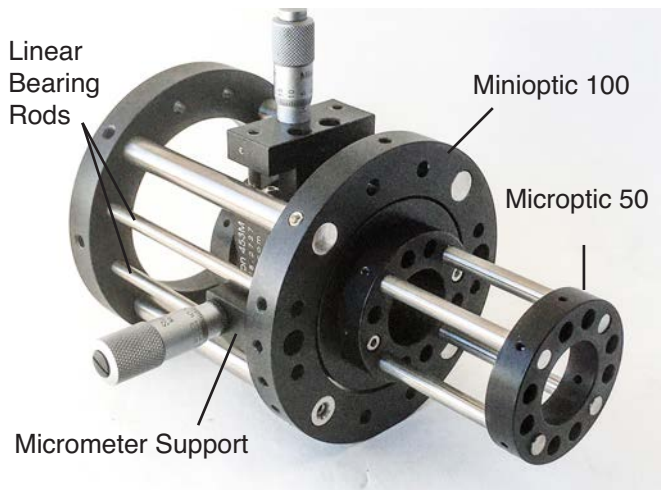
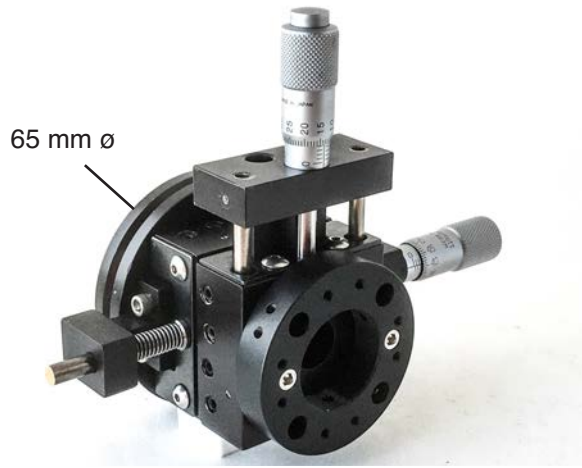


Miniopic 100 assembly with older generation X-Y stages 100-300

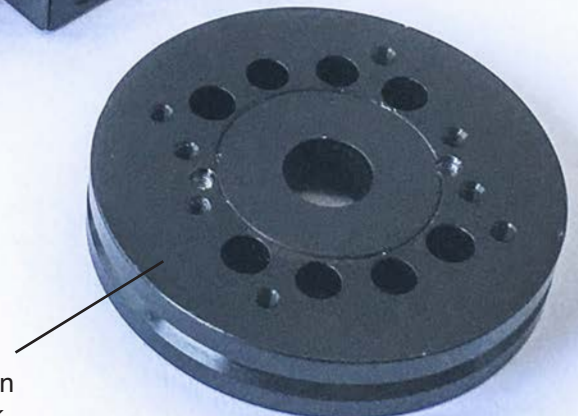
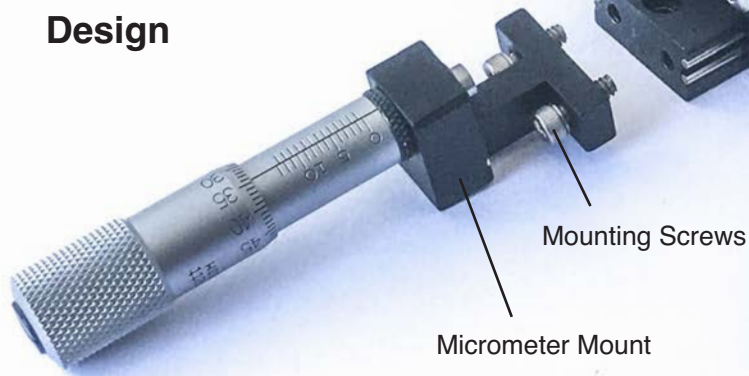
X-Y Stage 100-1300



Exploded View of optical assembly utilizing 100-106/100-108 linear bearings, and X-Y stage 100-300.



New 100-300 Design

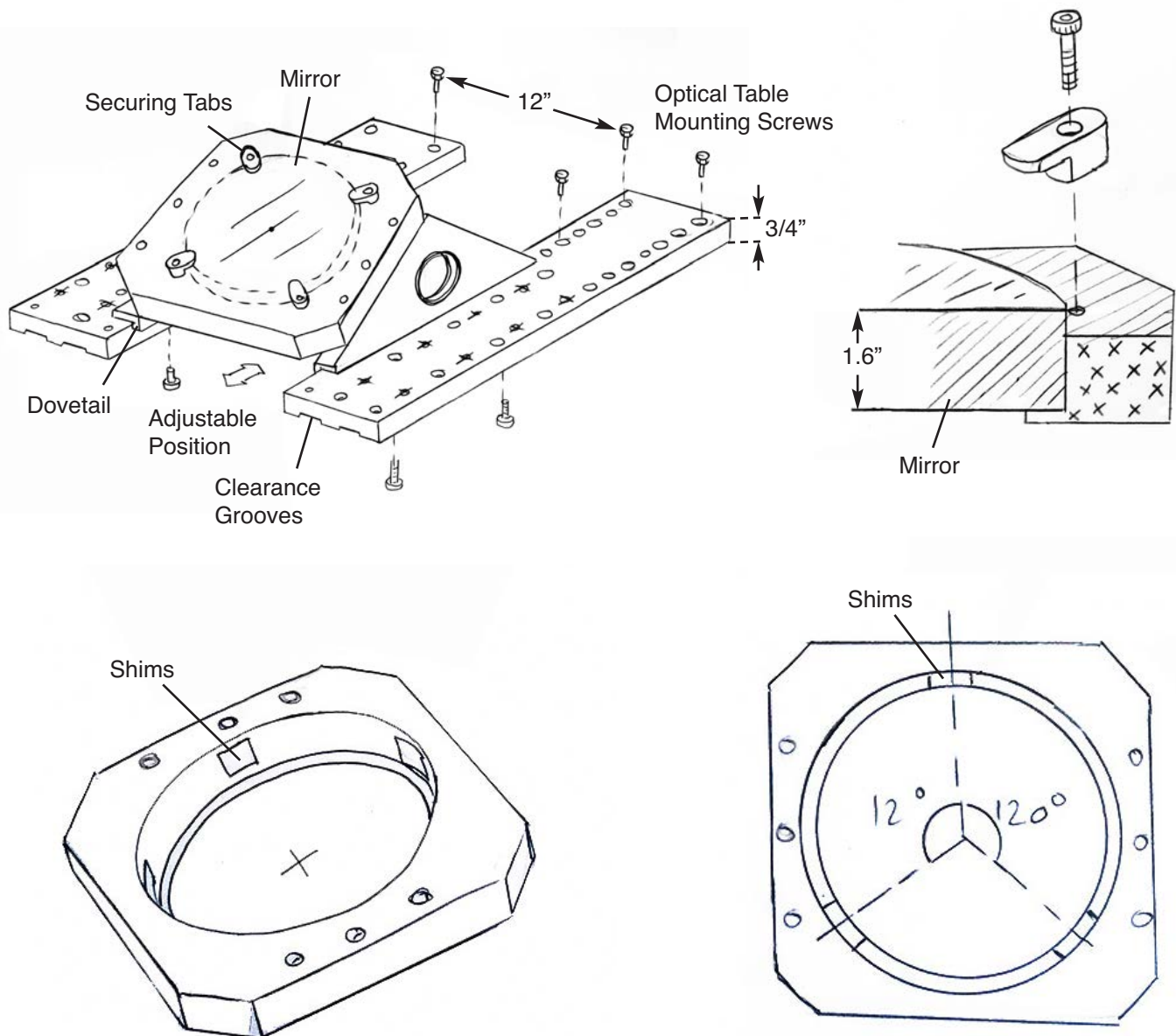


Centering Disc 65 with Microoptic 50 bore pattern allows securing Microoptic assemblies on the back

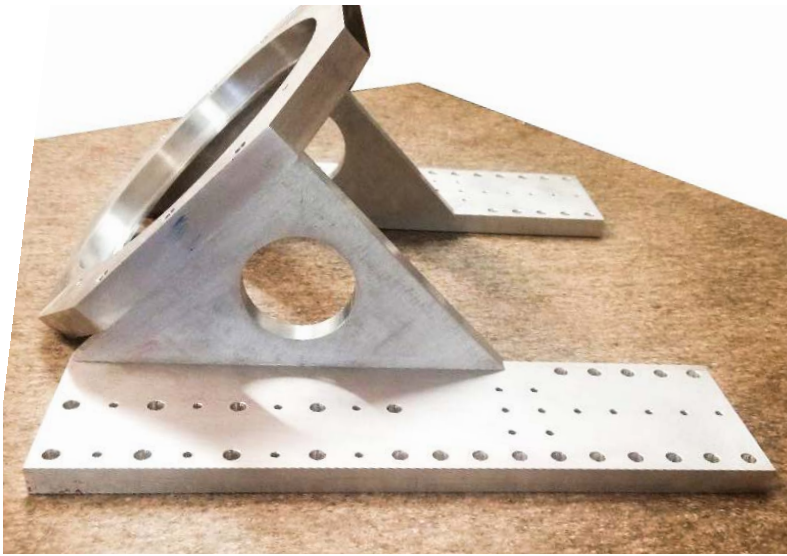
Zygo Fold Mirror Design

I was recently assigned the design of a 45° fold mirror for a Zygo interferometer to look down at a sample at the side of an optical table. I have arranged multiple optical tables before, and it's a nightmare to spread an experiment on two separate optical tables so I imagined the user would eventually decide to hang their sample on the fold mirror platform. That's why a number of mounting bores were added on the mirror extension arms to allow future upgrades. Secondly, I thought they would need some flexibility in their arrangement so I included a bore pattern, allowing the mirror to be secured in various locations. As an added value, I thought why not a dovetail design to allow the mirror to slide back and forth without falling off? There were also the contact surfaces below the extension plates that had to be partially machined off to insure proper mounting of the assembly on top of the optical table (see the drawing). So here it is from sketch drawings to the finished assembly:

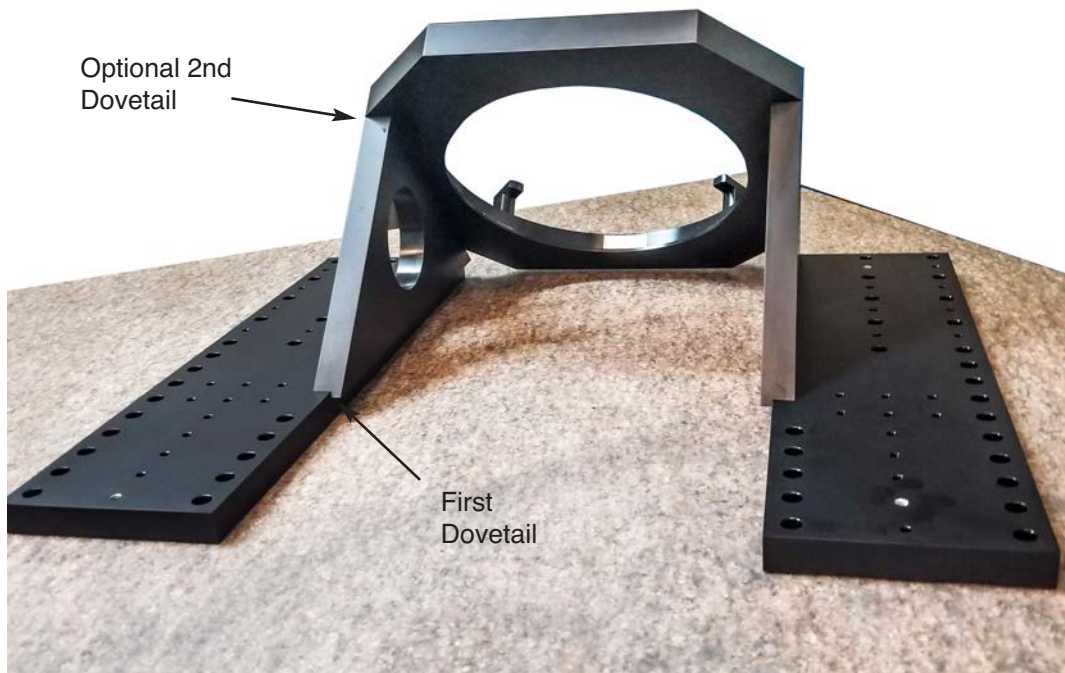
Designing large assemblies requires paying attention to crucial details. In every opto-mechanical assembly, there is a main frame structure that holds everything together. There are also crucial details that makes it work. In this case, the 10" mirror's seating plane was critical, and it required paying attention to how it was being secured in place. If you note the two triangles securing the mirror have a dovetail on their base which allow the mirror mount to slide back and forth like being on rails (dovetail is used here for the lack of a better word). Machining of these two triangles was so critical because with the slightest mismatch, it would cause the mirror seating plane to warp. Three shims were also put in place below the mirror surface to insure its original flatness without deflection.



Designing to Impress



I have seen European designs where both the base of triangle, and the mirror mounting plane are dovetailed (see below). This would allow the mirror mount to also climb up, and down without falling off. This would have been a much more impressive design. In design never try to impress anybody! The current design allows some adjustability, but the additional dovetail would have made the assembly less practical in overlapping the mounting bores with the tapped holes on the optical table. Double dovetail would have also made the triangles more difficult to machine, perhaps risking the mirror's seating plane to bend.



Psychology of Achievement: The shark in the fish tank

By Ali Afshari

In past issues, I wrote extensively about finding your spiritual path. It's so essential to find your own path in life because corporations don't seem to be interested in your soul. I could go on, and on talking about spirituality but I feel I am not providing you with proper armor to survive in this crazy world. As Omar Khayam puts it: "Be happy for this moment. This moment is your life", so don't miss living it by looking for its meaning too much. Let's first build a solid foundation of who we are, and where we are at in life. I have watched so many inventors undersell themselves because they think they aren't prepared to cope with the complexities of the business world. As Steve Jobs put it; "Every big business you see out there, started at one time, by someone not much smarter than yourself". The first thing you need to know is to get to know the self, it starts with understanding your optics! There are gravitational lenses, and there are mind lenses.

Our personality is a lens made of thought, through which we view the world. Once we learn this lens we look though is simply thought, we could get to know ourselves, and learn to view the world with new eyes. Let's start from the very beginning. The story of creation is mentioned in Judaism, Christianity, and Islam in a similar metaphorical way: Upon creation of human being, God asked all angles to bow to him. All angels did except Satan. He said: "You made him out of clay (matter) but made me from fire." So he didn't bow, and that's how he was cast out.



This is the same as the first part, isn't it?



It doesn't really work, Couldn't we try ...



This works better, what do you think?



Gracias senior!

In the movie Amadeus, this is so vividly illustrated. Salieri, kept pleading to God to make him the best composer of his time but God chose, an inferior being to be his subject. The film is not so historically accurate, but I want to illustrate a point. There is a scene that he looks at Mozart's work, and says: "God was speaking through this man. But why had he chosen such unworthy creature over me?" To make this more complex, there is a passage in Rumi, that says before making his grand creation, God took Satan aside, and asked him not to bow! So just like in "Charlie, and the Chocolate Factory", Mr. Wilkinson actually works for Willi Wonka: "How far that little candle throws his beams! So shines a good deed in a weary world" by W.S. But why? It would only make sense if we viewed this world like an elementary school.



Mr. Wonka ..



So shines a good deed in a weary world ..

Courtesy, Warner Brothers

Courtesy, Paramount Pictures



These are originals?



It was astounding, beyond belief ...



It didn't show any correction whatsoever. It was as if he was taking dictation!



I was staring through the cage of those meticulous ink-strokes at an absolute beauty.

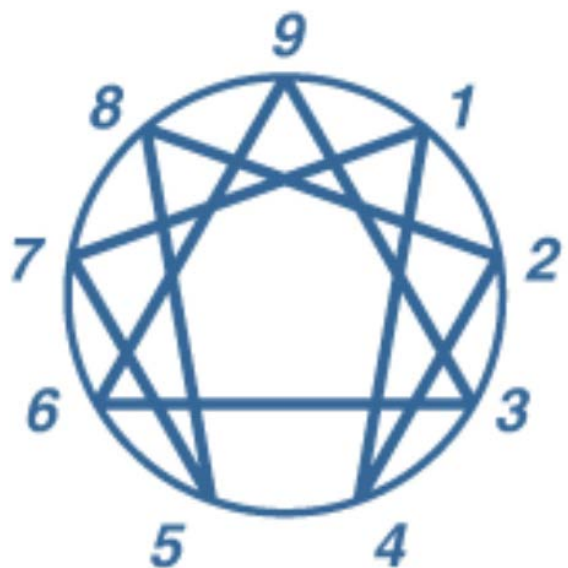
Courtesy, Warner Brothers

It's just like breeding Koi fish in artificial tanks (cover page). You see, Japanese eat a lot of fish, and they grow them in safe heavens to produce a lot of them. What they realized in the beginning was the fish wasn't tasting as good as those caught from the wild. One solution they found was to throw a shark in the tank. The shark would eat a number of fish, of course, but the rest would taste so much better because they'd be moving around! If you look at life in this way, it would be much easier to understand hardship, pain, and suffering. Without it, we won't grow. I think we owe it all to our ancestors Adam, and Eve. They were bored in heaven, so they asked themselves what's there to do around here to get us out?! Ever since we arrived on earth, look how much we grew. Other souls haven't grown as much as we have.

There is a need to have a mixture of personality types to help us grow. I have often quoted from Rumi, as he covers these personality types in his book: "Masnavi". In the west, they are developed as a concept known as Enneagram. Understanding Enneagram starts from understanding the basic personality types you have known in your past, and present, and expanding it to everyone else you are going to meet in life. It would take a few years to master it. Once you learn it, it's a philosophy that could guide or misguide you. I would highly recommend a teacher, or a lot of reading before you start changing your mind about life. I highly recommend visiting enneagraminstitute.com, and listen to each personality type explained by Don Riso. Let's first get a glimpse of what it is.

According to enneagram, there are 9 personality types:

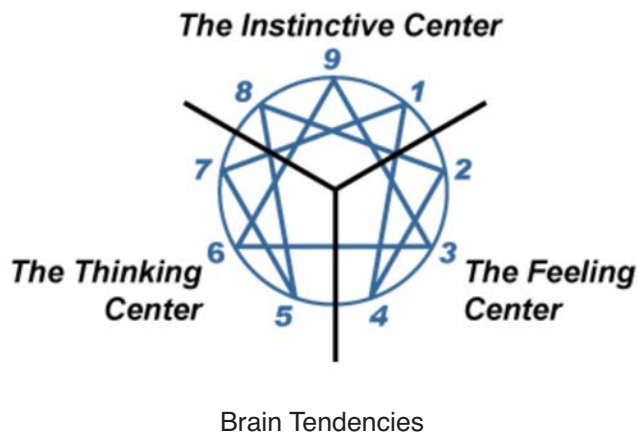
- 1) The Reformer (Mahatma Gandhi)
Principled, purposeful, self-controlled, and perfectionistic.
- 2) The Helper (Mother Theresa, Amelie!)
Generous, demonstrative, people-pleasing, and possessive.
- 3) the Achiever (Tony Robins, Salieri)
Adaptable, excelling, driven, and image-conscious.
- 4) The Individualist (Michael Jackson, Steve Jobs, Mozart)
Expressive, dramatic, self-absorbed, and temperamental.
- 5) The Investigator (Albert Einstein, the Maverick)
Perceptive, innovative, secretive, and isolated.
- 6) The Loyalist (Malcolm X before his visit to Hajj)
Engaging, responsible, anxious, and suspicious.
- 7) The Enthusiast (Robbin Williams)
Spontaneous, versatile, acquisitive, and scattered.
- 8) The Challenger (Paublo Picasso, Martin Luther King)
Self-confident, decisive, willful, and confrontational.
- 9) The Peacemaker (Mister Rogers)
Receptive, reassuring, complacent, and resigned.



The Enneagram Chart

You can start to first get to know who you are, and then look around to recognize which personality types you are surrounded with. Once you learn and get to know these personality types, it would drastically change your perspective of past, and present, and everything else you have learned in your business, and love relationships.

To get you started, I'll start with unhealthy types. The healthy types are the best companions you could find, and they will help you grow, and succeed. For unhealthy type, let's begin with **type 3** because I am sure you have come across them since early childhood. I'll be less sympathetic as the general description for type 3's because you'd most likely be their victim than gaining from them. They have three main characters: Achiever, opportunist, liar. If you are in a relationship, and he or she is too perfect, it's most likely a type 3 you are dealing with. This is because could play all the 9 types (mirror you), depending which type you are. They have great appeal, and charm, and have huge level of self confidence. You'd never win an argument with them, so don't bother trying. Type 3's use the love, and support of type 2's, and gain the knowledge of type 5's to go up in the ladder. They are usually so jealous, and that's what drives them to succeed. They'd usually get to their healthy side if they get rich, and famous. On the healthy side, they are the smartest, and most useful friends who could show you how to get ahead in life. Enneagram website describes the unhealthy type 8 as what I just described as type 3, but I don't think type 8's have the smarts. I always think of type 8's, vs 3's as George Foreman versus Mohammed Ali. If you want to see type 8's marriage with type 2 (the worst relationship), watch Ferlini's "La Stradea". There is also a type 7 in that movie. The best way to learn Enneagram is by identifying each type, and remembering their characters.



The **1st type** are the Reformers. They are the rational, idealistic type, and usually work long hours. They usually don't lie, and have strong convictions on what they believe. They get so angry when criticized. If you are in a relationship with type 1, they'd show their love by criticizing you. This stems from their perfectionist minds. They take work so seriously. Germans, and Japanese are type 1 at the national level. I remember co exhibiting with Micos GmbH, and while setting up the booth with their sales engineer Charly Maucher who didn't know me well at the time. I soon learned he didn't like to joke around while working! If you joke around, they'd interpret it as you are not working.

Then there is **type 2**: They are the helper, caring type. If your mom was type two, consider yourself lucky to have received all the unconditional love from them. If you have type 2 spouse, they're constantly looking for ways to please you, making you feel special. There is a scene in "City Lights" that illustrates type 2 in a big way. Type 2's are the most vulnerable members of society. Later in life, they suffer from regrets because they feel they were taken advantage of. Healthy type 2's would have moved towards 8 (learn to say no), and 4 (to improve self esteem through learning the arts, and earning money with it).



Courtesy, Chaplin

Type 4's are the artists, and actors who want to be seen, and noticed. You could always spot them by the way they are dressed. They'd keep switching their interests. They'd buy roller blades, and after learning it, they'd put them aside, and never use them. They have mood swings from very happy to tears. **Type 5** is the "Investigator type", who sits silent at gatherings without being noticed. They are well read, or extremely knowledgeable about a subject, making them experts in their field. **Type 6** is the secretive, suspicious type, with many fears. It would take time to gain their trust. When people have psychotic issues, type 6's are the most vulnerable type because they would refuse to take their medication, not trusting their doctor: They'd end up bums in the streets! **Type 7's** are the relaxed type who have had great childhood, and they are usually flexible about their beliefs. They believe in having fun in life, but get board easily. They'd switch careers unless their job is challenging or fun, like dentistry, etc. **Type 8's** are the rigid, and angry type. Don't get in an argument with type 8 because if they feel they are not in control, they might hit you! **Type 9's** get along with everyone, and have tendency to easily trusting others. They need to be pushed to do anything, and are in general, extremely laid back.

So how could people grow out of their type? Malcolm X is a good example, since his view of racism changed drastically after his visit to Hajj. One day, a meek asked a prophet why God has forgotten about us. God doesn't seem to see us. The prophet said: "No, in God's eyes, everyone is poor. The rich are even poorer." The wisdom tales in Rumi guide the spiritual seeker towards growth rather than comfort." Here's a story from Rumi's book, "Masnavi" that touches on this:

There were two brothers: One, a servant residing at king's place, and the other living in the mountains. The one who lived in the mountains came to see his brother. He gave him a tour of his comfortable lifestyle, and offered him a place to stay: "Why not come and live with me to enjoy all this comfort? You're hurting your back every day by carrying logs from the mountains while in here, you could live so comfortably by just serving the king". His brother replied: Why not come and join me yourself? Yes, your back might be hurt by carrying the log but you'll learn to live like a free man!

The increasing gap we have between have, and have not's, the wealthy getting wealthier, and poor getting poorer has a lot to do with the structural injustice. Once you get to know who you are, you are better prepared to not only excel in your life but you'd also have a better chance in making this world a more even playing field. For the first few months, you'll be judging everyone around you, and say to yourself: "He's a type 3, or she's type 2, oh he's definitely type 8, etc." But let me not deceive you. If you try sharing this knowledge with others, you'll find people are not willing to change, and you'll suffer watching them live below their full potential. You'll soon learn about how you think, and how your own thought patterns are, but changing yourself takes mastery. It would take years to reach mastery.

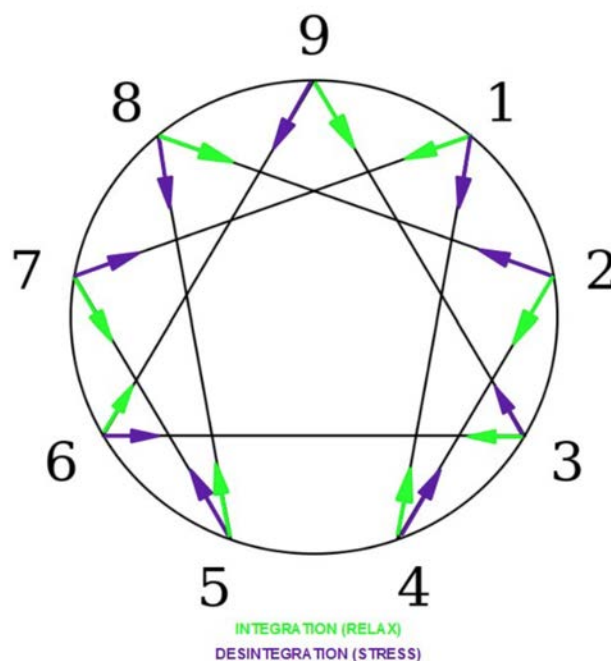
Wings

Although people fall under distinct personality types, they also have wings, or tendencies towards their neighboring type, such as type 1 with type 2 wing, or having a wing 9. A type 3 with wing 2 is like Bill Gates spending his wealth on charity, and giving funds towards medical research. You could have also gained certain habits from your parents, but you have your own specific type, and you are not them.

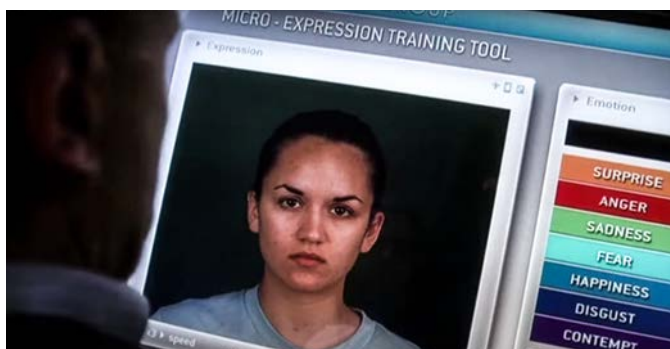
Direction

Referring to the diagram on the right, direction of improvement for each personality type is revealed: For example, for type 1, moving towards 7 means stop being so rigid on their beliefs, and to work less hours. Moving towards 4 for type 1 means to learn to express their feelings through learning the arts, and music or to spend more time in nature. One character of type 1's is they remember too much to the smallest detail, and this causes them to have worn out minds. They also have a strong inner guilt voice that constantly whispers on their ears. Type 1's are always in great need of taking a break from work, and letting go of their obsessions.

Back to type 3's, one way to recognize them is you'd often find them being at the center of attention at parties, and always praising themselves. They'd always turn out to be an expert in anything one brings up. If you say you like astronomy, they'd say oh, Carl Sagan and I we buddies! They also use their spouse to support them: Carl and I used to talk for long hours. He told me everything about his work. He often said to me: "You are more expert than I am"; Isn't that true honey? Their spouse would say: "That's right". That's a type 3! Another way to identify type 3's while they are deceitful is to read their micro facial expressions. Watch "Lie to me" series to learn more about facial expressions!



Wings, and Directions



“Lie To Me” series is based on Dr. Paul Ekman’s (left) research on micro facial expressions. Don’t let it misguide you. It’s just a movie. In real life, we shouldn’t judge people like that, and we shouldn’t be suspicious of everyone we meet!

Life is a great teacher so have as much fun you can in learning, but don’t be in a hurry judging others. There is enormous information on the web, but try to find a real person as your life coach. I will further explain the servo mechanism, and advanced Enneagram on the next issue. Enneagram is part of a much broader psychological treatment method called NLP (Neuro-linguistic programming), which is the most powerful technique to master your mind.

Many good products fail because people behind them lack commitment. Japanese contributed enormously to opto-mechanics by following Zen philosophy in their design, and marketing but many firms with Japanese leadership changed their course towards type 3, and I hope they will find their way back. In his memoir, Mr. Maitani (designer of Olympus OM system) praised his boss’s vision during his fruitful career at Olympus. Somehow that vision was lost, and the sustenance of one of the most successful Opto-mechanical design firms in Japan now came to an end.

Becoming an inventor, and an entrepreneur takes a lot of hard work to succeed, and it hasn’t changed since Thomas Edison. Inexperienced inventors consider the patent process as if there are people standing in line behind their door waiting to get it in their hands, and marketing it. In most cases, you’ll need to go all the way to making it succeed. As for people who made it big in America, don’t think they had it easy. Bill Gates slept in his office at one time, and that’s what Steve Jobs did, and so did Warren Buffet.

Speaking of whether real growth is through hardship or in comfort, we all like comfort. You show me one person who doesn’t like comfort, and I’ll tell you they aren’t real. During his fame, the world champion Mohammed Ali had a comfortable life style in his mansion in Chicago. He often complained to his wife: “I used to get up so early every morning to go to the gym to stay in shape but look how I would hardly get up early because I don’t have to”. People would go through all sorts of hardship for a big dream they might have in life but if they have money, they’ll just buy their way through. Well I also hope by now, I have made my point. If anyone thinks their self worth is because of their wealth, they assumed wrong. This is what type 3 needs to learn that life is not a race.

Unfortunately, our national tendency in US has been towards type 3 in the most part. You could also say that about China. My wife, and I took a tour in China, and they couldn’t resist wanting to sell their products throughout the tour. I don’t know what it is about entrepreneurship that gives the wrong direction to personality types. I remember while I was young, I did most of my science because it existed, and not because it would make me more well off. I remember what I was told when I began working at Teledyne Controls: “If you want a raise, you’ll have to be more visible!” Going to trade shows, and selling, as well as looking for the nicest girl in the world to be my wife transformed me the wrong way. As I look back, I say to myself well, you got all that, what now? It’s not all that simple but that’s really the truth about most of us. Well, why not separate our business life from our personal life, and stop being type 3 all the time? That’s why raising children and taking care of elderly parents become so important. This is well explained by Servo Mechanism.

Servo mechanism determines what one needs to learn based on their actions. This is a more accurate definition of Karma. Most people think Karma is if you do something wrong to others, the same thing would happen to you later in life. But servo mechanism states that life simply takes proper actions to teach the wrong doer to correct their path. For example, if one has gained unhealthy habits of any of the 9 types, the servo mechanism would invent situations along their path to correct them, or teach them a lesson.

I am a believer in the guidance of source almighty to succeed in life. Most physicists I have spoken with, believe this world is running on its own. So many sci fi movies suggest it was created by UFO’s. In spite of the widely publicized comments by Stephen Hawking to suggest he was an atheist, when he was asked about if pure physics could be running world, he said through his speaking aid: “I don’t think physics would tell you to be nice to your neighbor”. Without guidance, this world would be in ruins. To those who believe in the hereafter, life is an ongoing continuum. As a 1st grader might think, the session would resolve by the year’s end, but there are also those who believe there will be a next term, and a next. Considering what we already know, and what remains to be unknown about the universe, our short life span to learn it all is simply a joke. We are getting prepared for something far more colossal.

Utilizing Optoform pieces for other projects around the lab!

Utilizing Optoform for something else other than optics is the topic of this article.

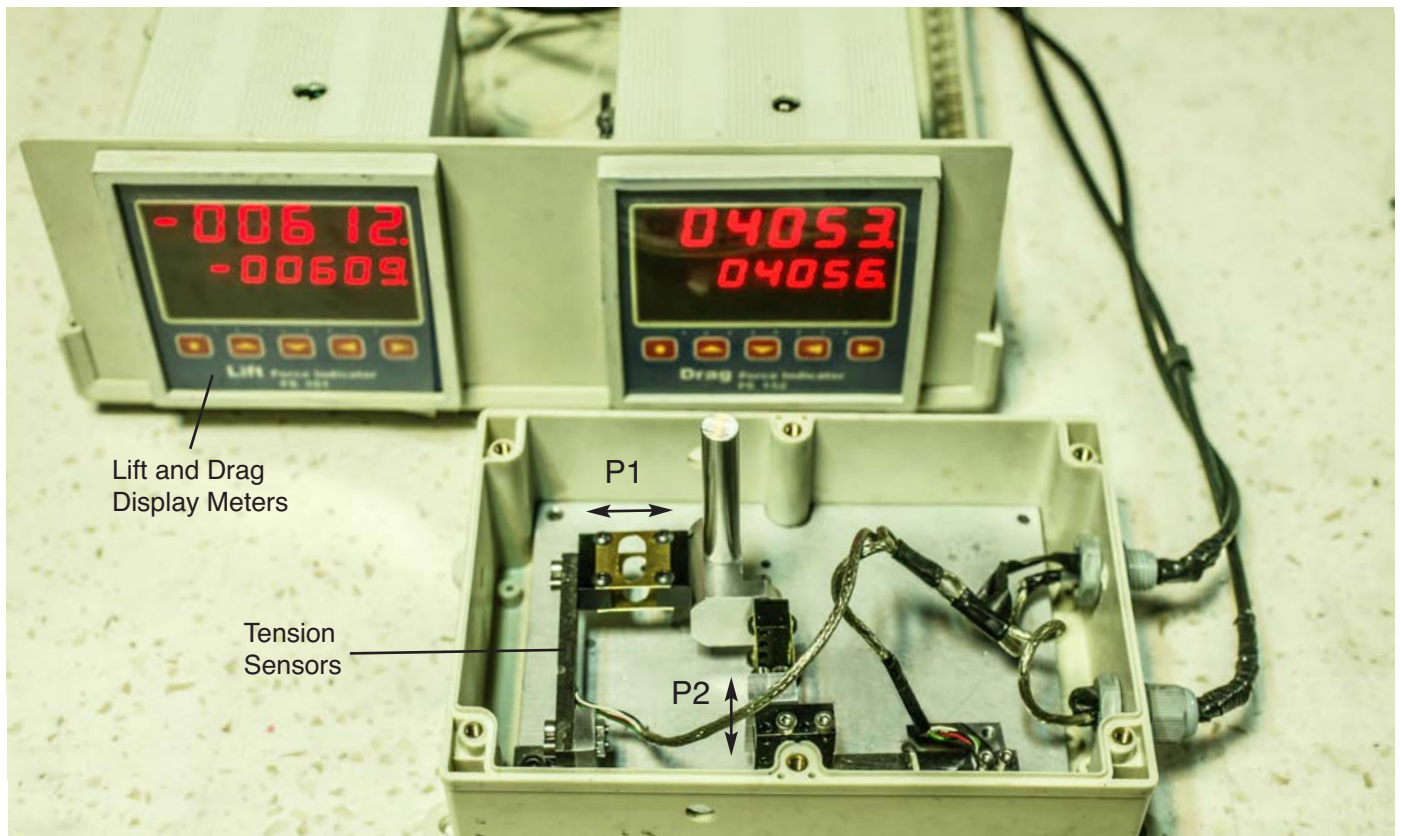
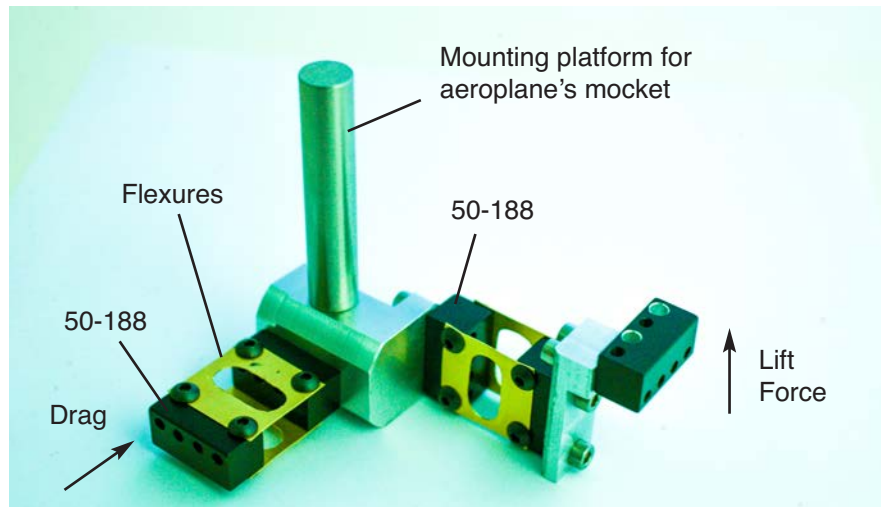
While during my consulting years, I have done mostly optics, I have occasionally done something else, or in my own experimentation, I have needed tooling that weren't available, and I found Optoform the perfect companion to implement them.

While producing Optoform in our CNC shop, we needed a stand for precision gauges to measure the internal bore diameter of the mounts. Here, we utilized some of the Micromax parts to build them.



Wind Tunnel Lift, and Drag Measurement Apparatus

The purpose of this university project was to measure the lift, and drag forces in a wind tunnel. A vertical shaft held the airplane model inside the wind tunnel, while a measurement box at the base of the rod would measure the exerted forces. The challenge was to isolate the two forces as much as possible. Two flexures were utilized to transfer the forces to two tension measurement rods. To construct this apparatus, Optoform corner connectors were utilized to make a quick prototype. The rest of the pieces shown had to be machined.



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