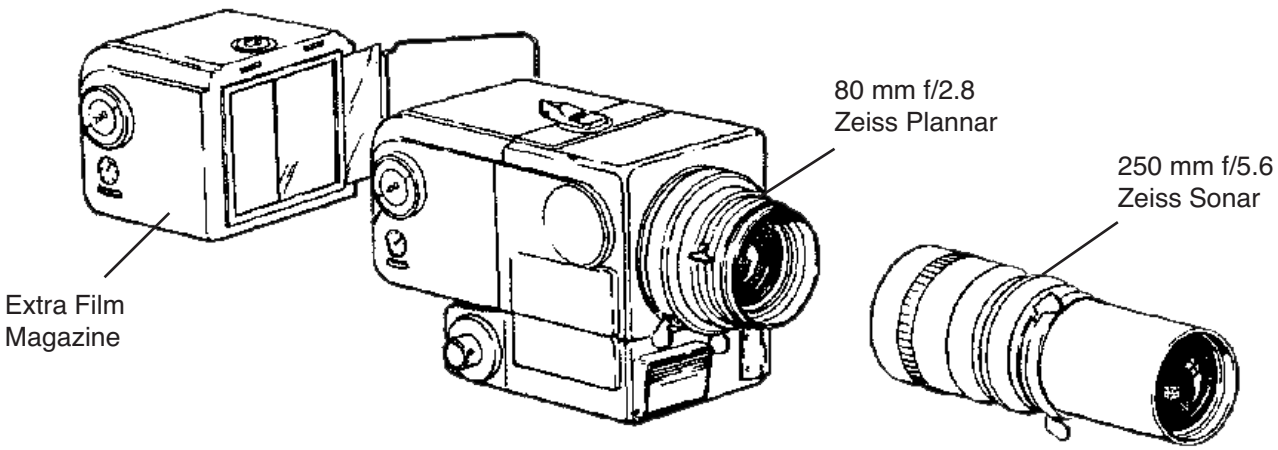
Optomechanix

Oct-Dec 2019

Hasselblad Moon Camera Part II

Technical journal of OMiD, Opto-Mechanical Institute of Design

Moon from Apollo X - 05/01/1969 - taken with HEC and Zeiss Sonnar 5,6/250 @ f/5.6



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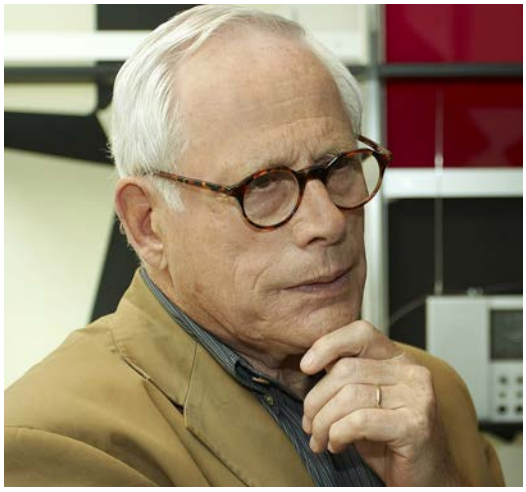

This issue Dedicated to:

Dieter Rams At age 86, he is one of the most influential product designers of the day. We all grew up using at least one of his designs, a household product such as a coffee maker by Braun. Dieter Rams born in Wiesbaden, Hessen is a German industrial designer and retired academic, designed most of Braun consumer products. His belief in "less but better" design generated a timeless quality in his products and has secured Rams a worldwide recognition, and appreciation. He is the subject of recent documentary by film maker Gary Hustwit: “Rams”.

In design, I am very much in favor of the “10 commandments of design” by Dieter Rams: In his view, a good design is: Innovative, makes a product useful, is aesthetic, makes a product understandable, unobtrusive, honest, long lasting, through down to the last detail, environmentally friendly, and it is as little design as possible. He is asked what he means by honest. He replies: “Lying”. Apple’s entire product line follows his design approach, and the iPod design was a granchild of the Braun T3 pocket radio Rams designed in 1958.

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Cover page photo: Prototype of Hasselblad Moon Camera
Inside page photo: Moon shot of lunar surface using 250 mm f/5.6 telephoto lens.

Hasselblad Moon Camera (Part 2)

In our current issue, we'll talk less about the moon landing mission, and more about the task to create a reliable camera for space, and how it influenced Hasselblad company in more of a historical perspecive.

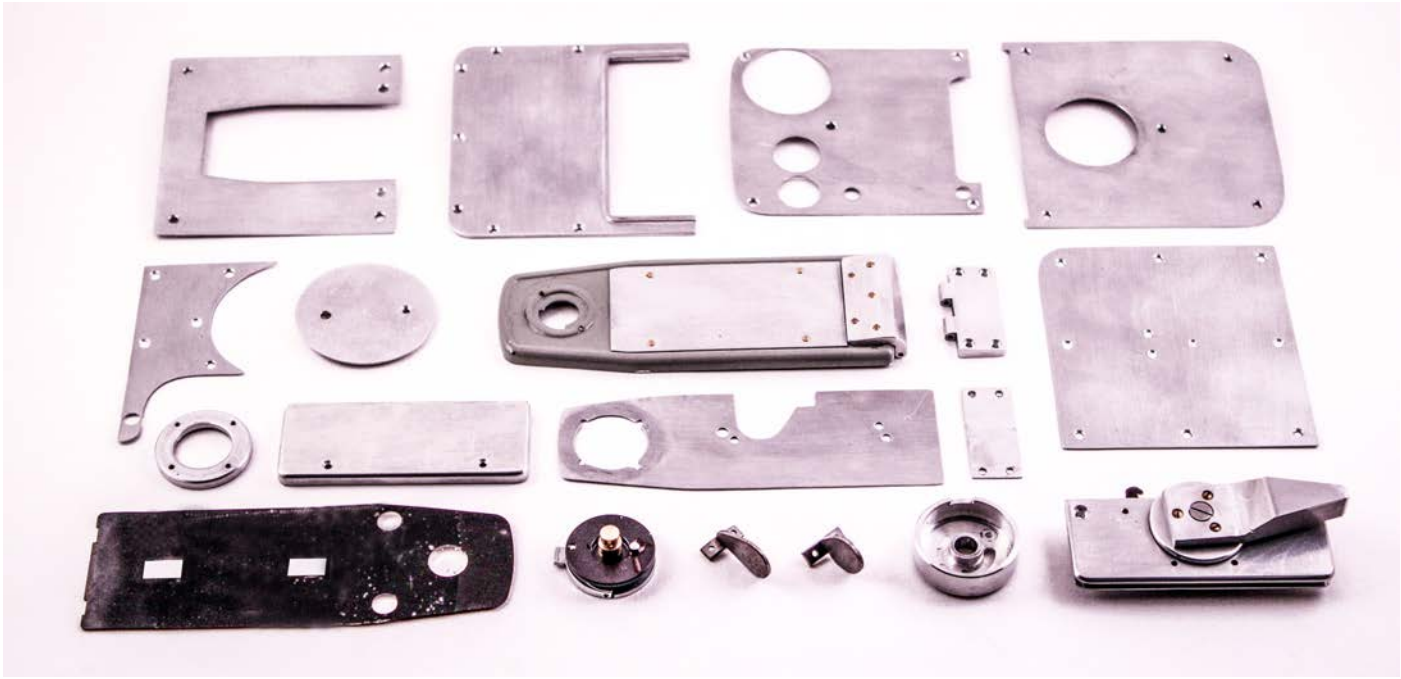
Hasselblad camera was the vision of Victor Hasselblad to offer a medium format camera with a wide range of accessories. Although a success, the company was still losing money every year because of its high cost of manufacturing in Sweden. Victor Hasselblad invested more and more into his company to help it survive. It wasn't until early 1960s when Hasselblad gained much greater publicity through its use in space, and it became world renown. Higher orders came pouring in to show higher profits for the company, and the company grew to 600 employees.

After Victor Hasselblad decided to retire in 1976 due to deteriorated health, he sold it to Swedish holding company Safvean AB. The company strived for almost two decades but the ratio between profits, and income was very low. The desire to profit from their investment, the company was gradually much more difficult to run, and in years 1996-2006, with the birth of digital revolution, and short sighted corporate ownership, Hasselblad almost went belly up. With some major restructuring, Hasselblad learned to survive, and today it is a world renown manufacture of medium format cameras.

Film cameras of 1960's modified for space use lacked concern for design esthetics.

Walter Schirra holding a Hasselblad 500C modified by NASA for taking out to space.

Walter Schirra looking through a viewfinder attached to modified Hasselblad 500C. Wearing two watches, it's apparent these men were so concerned about their missions in space, and how little time they had to deal with impediments of using a film based civilian camera. In just a few years, a modified version of motorized Hasselblad 500EL (introduced in 1965) was developed to work well with the physical limitations of astronauts in space. Skipping many details (see last issue), everything had to be made with metal to prevent electro-static shock to astronauts, and easy to use controls such as lens control knobs to be operated with gloves, and an easy to operate battery compartment. Lenses developed for this camera had different back focal distance to compensate through Reseau plate, and click stop knob for aperture control.



Replacement parts to convert Hasselblad Electric Camera (500EL) to the Lunar camera for moon landing in 1969.

Hasselblad Design and Manufacturing

Hasselblad cameras have always invoked my deepest curiosity for many years: How could a design be 70 years old, and still be so timeless? Both Leica, and Hasselblad seem to be carved in our minds as the look and shape for 35 mm, and medium format photography. Leica emerged out of the mind of a microscope manufacturer, and Hasselblad out of an aerial photography background. That explains the compact design of Leica lenses, while Hasselblad lenses were designed proportionally bigger.

Big and small shouldn't be taken for granted just because they are made that way. Cine cameras are un proportionally big, and I personally don't see much benefit in that other than being able to read the aperture, and distance scales in much larger fonts. To that end, the recently introduced Cine lenses by Leica are much smaller in diameter than others.

Hasselblad's body, and lenses were designed in the most compact way they could. The body proportions were entirely driven by the 6 x 6 cm square format of the camera. The body was designed by Sixten Sasson, a car designer who designed the Saab, carrying many of its design elements to the camera.

Like Steve Jobs, Hasselblad created the concept not by designing it himself. He rewarded a year's salary to his employees who developed the camera. While these visionaries had their own high expectations for the outcome, they had the guts to eliminate mediocrity in their design group to allow their best talents to flourish. Victor Hasselblad was so humble to note he had very little engineering knowledge..

Just like the shape of Leica M3 which Leica kept after its conception, Hasselblad's design of 1948 remained the same even after they switched from focal plane shutter to leaf shutter in 1958, and even after they went back to the focal plane shutter in 1977. Modern Hasselblads still utilize the same form, and design elements as the original classic design.

Victor Hasselblad showing the 500C at its premier in New York, 1957. Many of the big namers in photo journalism are present, including Jacob Deschin, editor of New York Times (with thick eyeglasses, sitting).

Sixten Sasoon was the original designer of V-series Hasselblads. He created the Saab car, and you could see its design elements in the camera.

Camera manufacturers realized the importance of estetics in camera design. The polaroid land camera was designed by architect Walter Teaque. Nikon F body was designed by architect Yasaku Kamekura, and Nikon F3 was designed by Italian designer Georgetto Guigiaro. Yashika/Contax RTS was designed by Fredrik Porsche group.

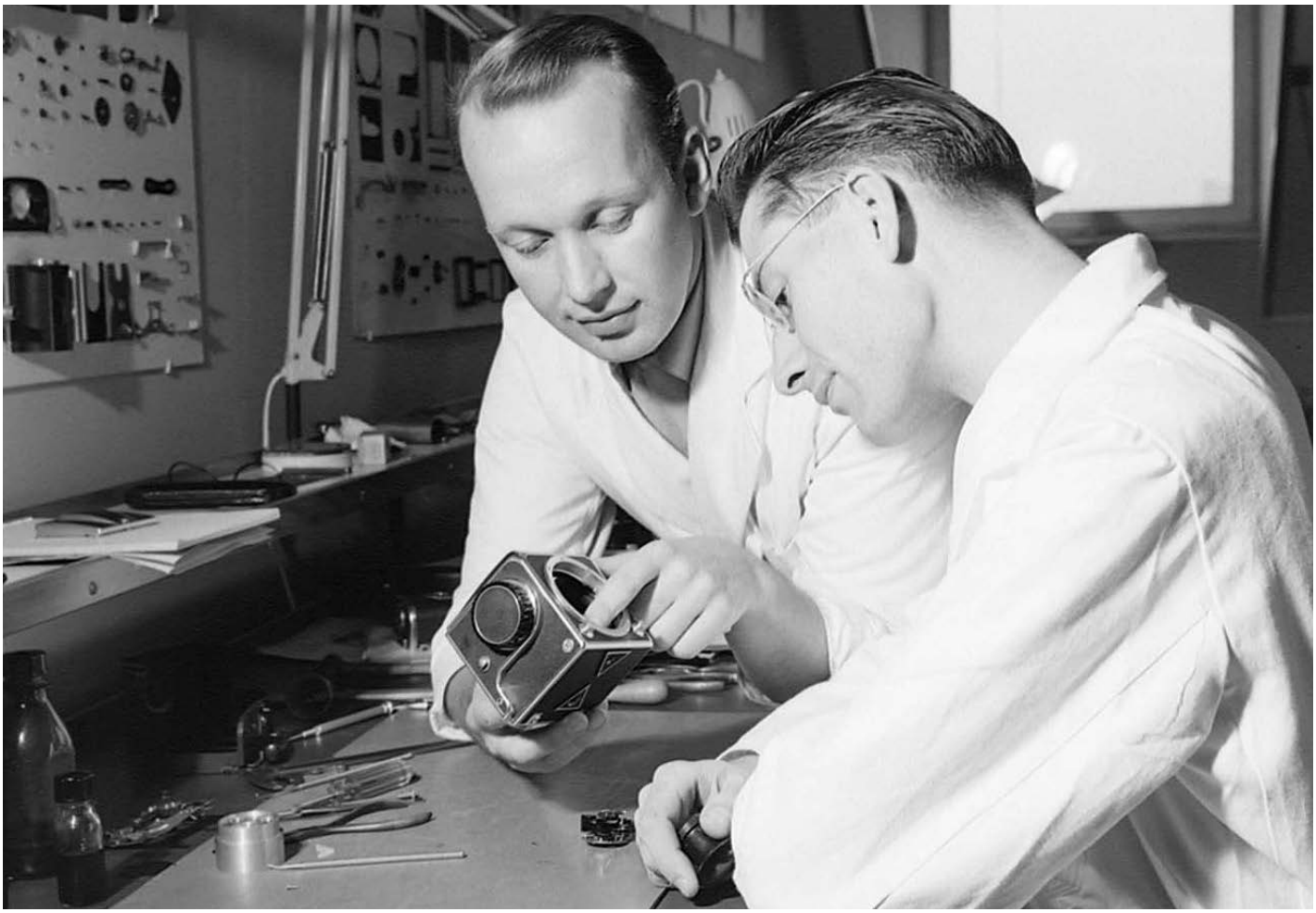
Victor Hasselblad showing his production facility to King Gustav. An employee demonstrates their engraving machine.

Factory employees in 1952. Long time collaborators Allan Grtvall (standing far right), and Extar Cronholm (far left).

Finishing touches on Hasselblad 1600F body shell castings at Sweden factory. The casting technology was impressive.

Assembling 1600F bodies, and fim magazines at Hasselblad factory in 1950's. Body shells were nickle plated (center).

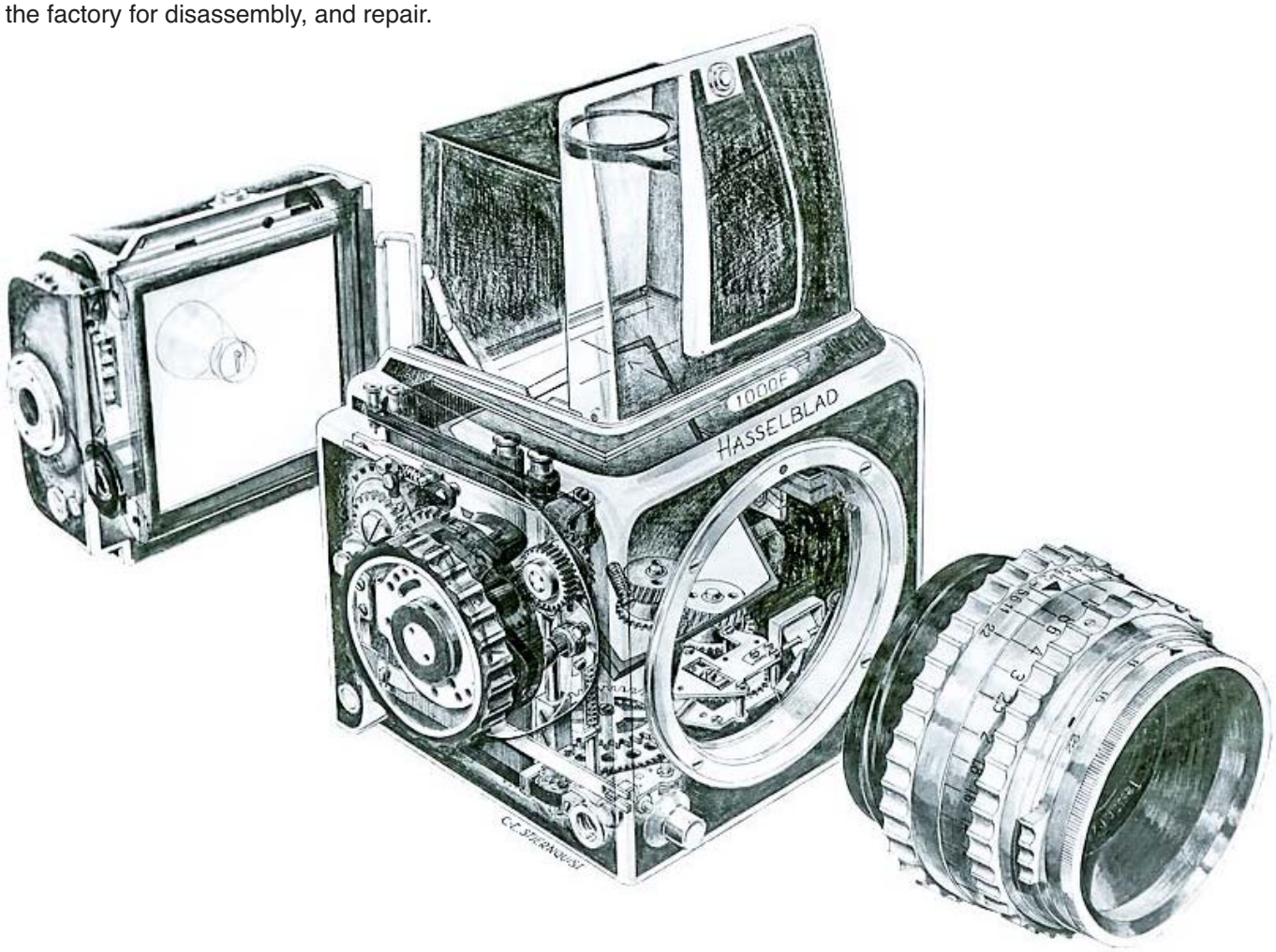
Hasselblad service center in 1950’s shows 1600F wooden tool chests with special repair tools for each technician.



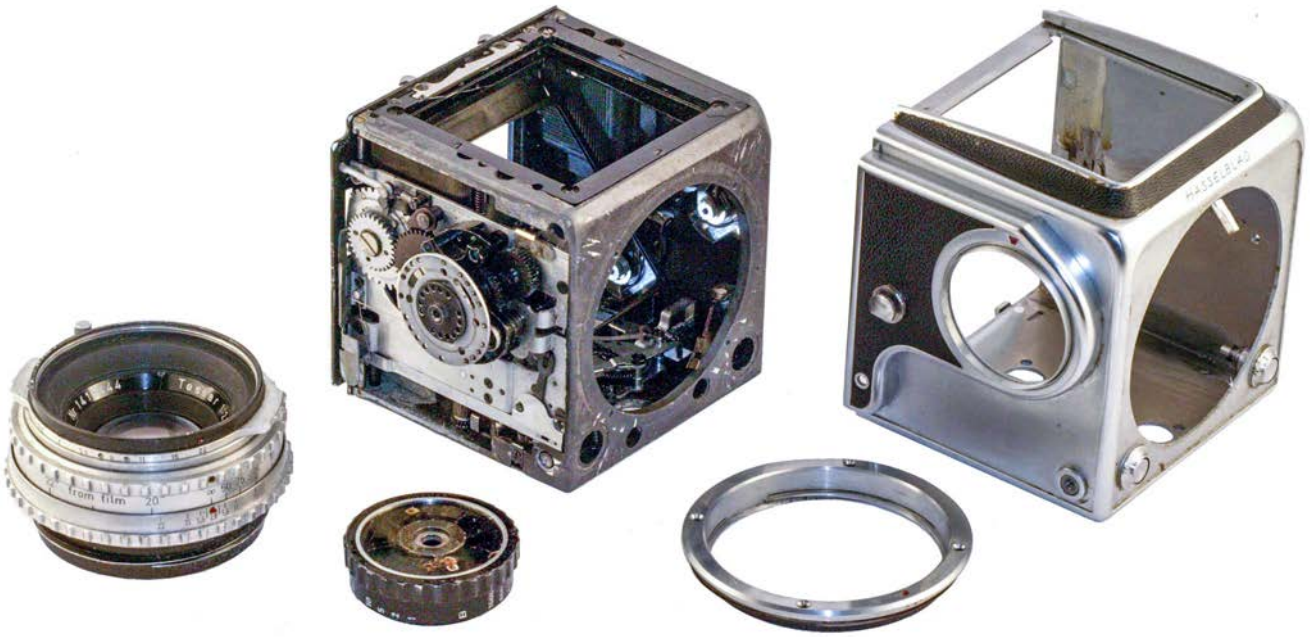
Servicing a 1600F by factory trained technicians. Diessected parts display on the wall shows body, and magazine parts.

Focal Plane Shutter Approach, Model 1600F, and 1000F

Hasselblad's initial look when introduced in 1948 (model 1600F, above), offered a focal plane shutter, interchangeable viewfinders, film backs, and Kodak lenses. In spite of its concept so well received, the focal plane shutter proved to be problematic. One major challenge was to protect its large shutter curtain during magazine exchange. The metal curtains could be jammed if they were accidentally pressed in by fingers holding the magazine, and the camera had to be returned to the factory for disassembly, and repair.



Internal design of Hasseblad 1000F (introduced in late 1953) reveals a complex horizontal running focal plane shutter. The shutter speed setting and film advance shared the same characteristic large knob on the right of the camera.



1600F camera disassembled to show inner mechanism. Its design was copied part by part by Russian made Kiev 80.

Frontal and back view of Hasselblad 1600F with a top speed of 1/1600 Sc.

Film magazine was relatively easy to load, and interchange. The flip door allowed setting the numerals on the good old, paper backed 120 size film to “1”. The camera automatically set the film advance for remaining exposures (1 to 12).

The Leaf Shutter, Model 500C

Hasselblad's difficultties with its large focal plane shautter forced its designers to switch to leaf shutter design. According to Victor Hasselblad, when they requested Compur (their shutter manufacturer) to offer them a leaf shutter for the LSR, they said it couldn't be done. Hasselblad team made a prototype of the shutter, and Compur was convinced to produce it for Hasselblad with the condition that they could also offer it to other camera manufacturers.

As it turned out, Synchro-Compur shutter became the favorite choice for many other cameras. The way this is accomplished is by a coupling key between the lens, and the camera body (below). The shutter release operation sequence began with leaf shutter inside the lens closing first, then mirror flipping up, an internal shutter openning, then the leaf shutter openning,a nd closing to make the exposure. This firing orchestration is so critical that there is a tool just to check the oreientation angle of the coupling cam between the lens, and camera (oposite page).

Hasselblad's relatively simple design, made the body operation much more reliable than the 1600F, and 1000F models which were packed with complex mechanics. The new body (500C) was later followed by 500C/M, also featuring interchangeable focusing screens. The camera offered flash shynchronization up to 1/500 Sec. shutter speed, allowing daylight flash photography. Hasselblad became the camera of choice for wedding phootography, and the result of this design change, was a camera so reliable that later found its way to the moon.

Image through Hasselblad's waist level viewfinder

Hasselblad's modular design allowed interchangeable backs, viewfinders, winding knobs, lenses, and focusing screens. The Hasselblad system was the most versatile camera concept in the world, followed by Bronica, Mamiya, and Rollei. All medium format cameras were actually miniaturized concept introduced by Graflex 6x9 cm format camera introduced in early 1900s.

Making of Hasselblad Moon Camera

By Ali Afshari

In the past issue I discussed the Hasselblad moon camera and its internal workings, and we'll examine its body design in more detail. I happen to own one of these cameras. Most of the existing Hasselblad lunar cameras have beat-up paint jobs, or barbeque black paint. My favorite version of the lunar camera is the one with grey paint. One of these cameras have been donated by Victor Hasselblad to Eastman Kodak New York museum (see page 5), and I really think it's the best of its kind ever made.

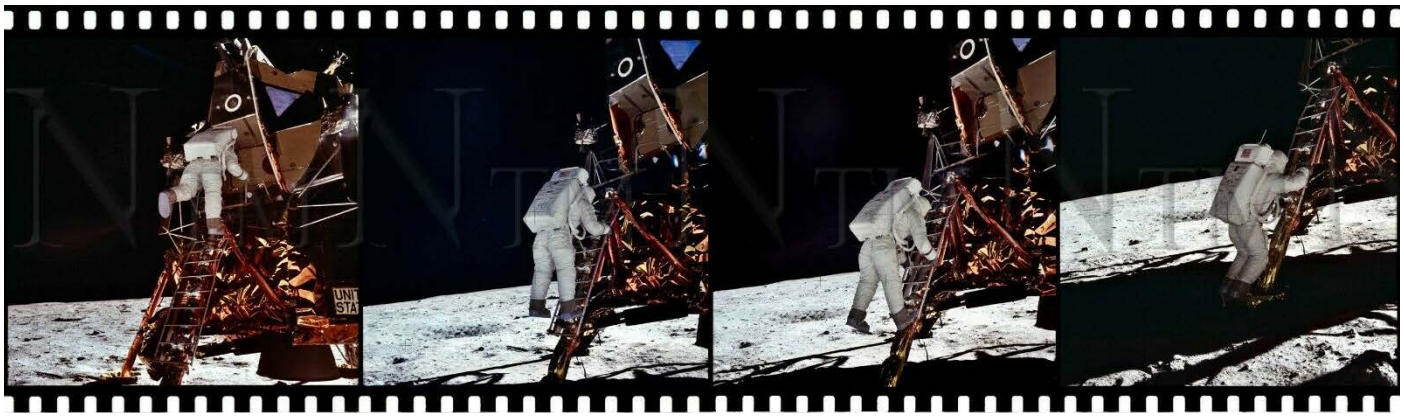
It has been said that in order to fully understand something, one has to build one, and I found that to be true. I built my own exact replica of Hasselblad Lunar camera, and I will use my camera making experience to describe its design. To make the necessary modifications, I had to use some of my watchmaking tools. Otherwise, tools found in ordinary machine shops are not sufficient to make camera parts.

Hasselblad utilizes M1.6, and M1.2 screws that are relatively easy to deal with by watchmakers. The Levin lathe was really useful in making the parts. So the images you are about to see is of my hand made camera. I specially like the battery compartment of the Lunar camera, and I wish all ELM cameras employed this design.

Victor Hasselblad and his wife examining negatives at his home in Sweden. Hasselblad foundation has a replica library of NASA images.

The magazine lock lever is characteristic feature of Lunar cameras, and to be honest, I prefer the civilian version, with the lock knob placed on top of film magazine itself, allowing it to be exchanged single handedly. In Lunar camera, the lever has to be turned by one hand while the other hand holds the magazine to prevent it from falling off. I don't know if you have seen any other space camera but they have been mostly designed, and built by machinists. So they are mostly dreadful modifications. The Lunar Hasselblad is not just an all metal user friendly camera for astronauts. This camera was assigned by NASA to Hasselblad design group, and it was done by their civilian design team. I remember the same elegance, and design style while working at NASA's Jet Propulsion Labs in Pasadena.

I found the body design of Hasselblad Lunar camera to be elegant, and esthetically so beautiful. Its design follows the simple is better approach, and its construction is economically wise, and cost optimized.



Images recorded on 70 mm film taken by the Hasselblad

Hasselblad Lunar camera in grey color hand built by Ali Afshari. Matched color powder coating for highest durability. Laser engraving on black anodized Aluminum. The original body, and lens of this camera were manufactured in 1971.


HASSELBLAD
ELECTRIC CAMERA
- 500 EL -
200
LUNAR SURFACE
HASSELBLAD
70-mm MAGAZINE


HASSELBLAD
ELECTRIC CAMERA
200
LUNAR SURFACE
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70-mm MAGAZINE


200
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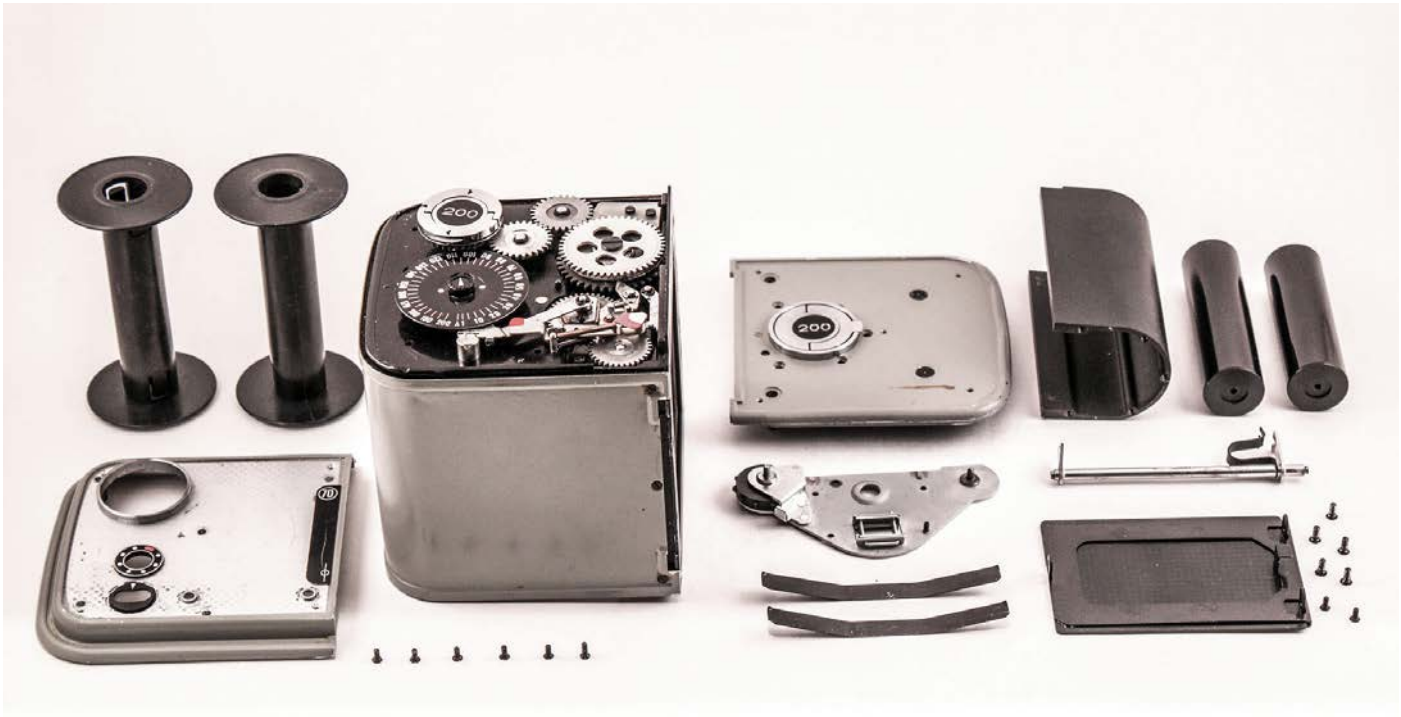
B 1 2 4 8 15 30 60 125
22 16 11 8 5.6 4 3.5
4 5 6 8 10 15 18 24 30 50 100 ∞
UP 400604
MADE IN SWEDEN

Fim magazine: For the moon landing mission, they used only 2 types of film: Ektachrome 160 ASA color slide film, and ISO 80 B&W Panchromatic film (ISO and ASA are the same).



Film magazine operation was discussed in some detail in previous issue. Hasselblad film magazines are designed similar to aerial cameras. The Lunar camera magazines are not compatible with civilian cameras (discused in the next section). The magazine to body interface is simiolar but different.

The battery compartment in Lunar Hasselblad utilized the same locking system implemented in its film magazines. The civilian motorized EL user had to use a coin to access the battery. Although two battery spaces, only the front one is connected. The other hollow space is usually kept empty.

Hasselblad implementation of Lunar model had huge historical importance. The body design modifications to the camera were not only user friendly in space, but also done with pronounced elegance, and simplicity.

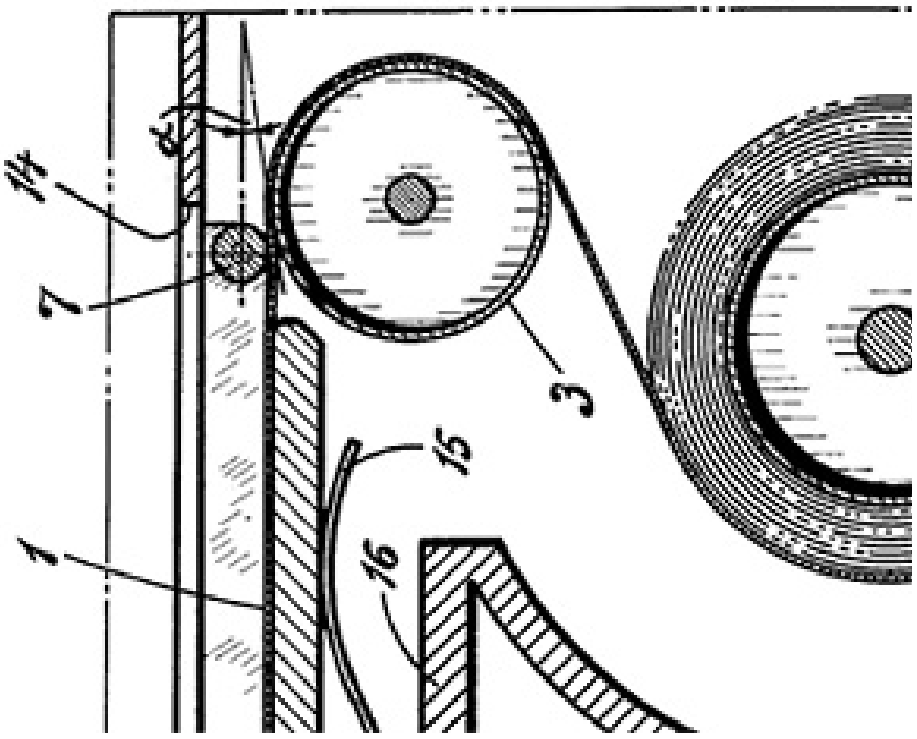
Space Shuttle Hasselblad

With 32 character recording on edge of film

The data recording module ran on four 1.5v batteries and was detachable from film magazine (opposite page). It was programable by a hand held device or IBM computer via special cable.

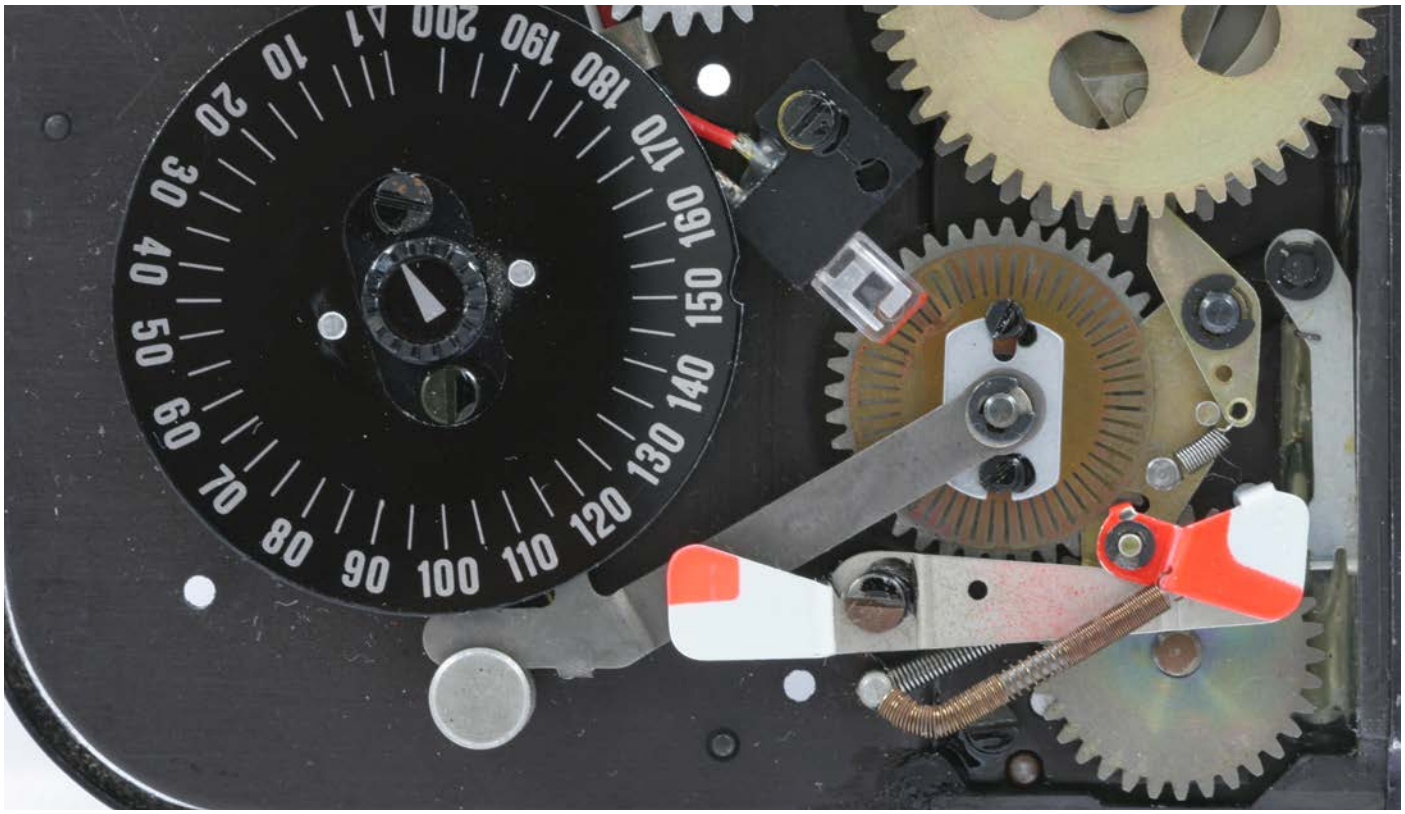
Hasselblad back DE-32 was widely used in Space Shuttle missions had data recording capability on the left edge of perforated 70 mm film. Detailed view of its mechanism is shown below, and on opposite page. HC-4 viewfinder provides viewing comfort while using the 200 exposure film magazine, and its optical clarity is the best in its kind.

Details of Hasselblad film transport mechanism, consisting of four film rollers (3, 7), and a carefully placed pressure plate (1) pressed against the film back by spring 15 assure film flatness during exposure. Aerial cameras utilize film suction during exposure but that wasn't an option for space cameras operating in vacuum.



Hasselblad patent for its film magazine

Hasselblad DE-32 film magazine shown here with magazine spools pulled out for film loading. A close-up view of film counter mechanism is shown below. The film transport encoder can be seen for recording exposure numbers on film.

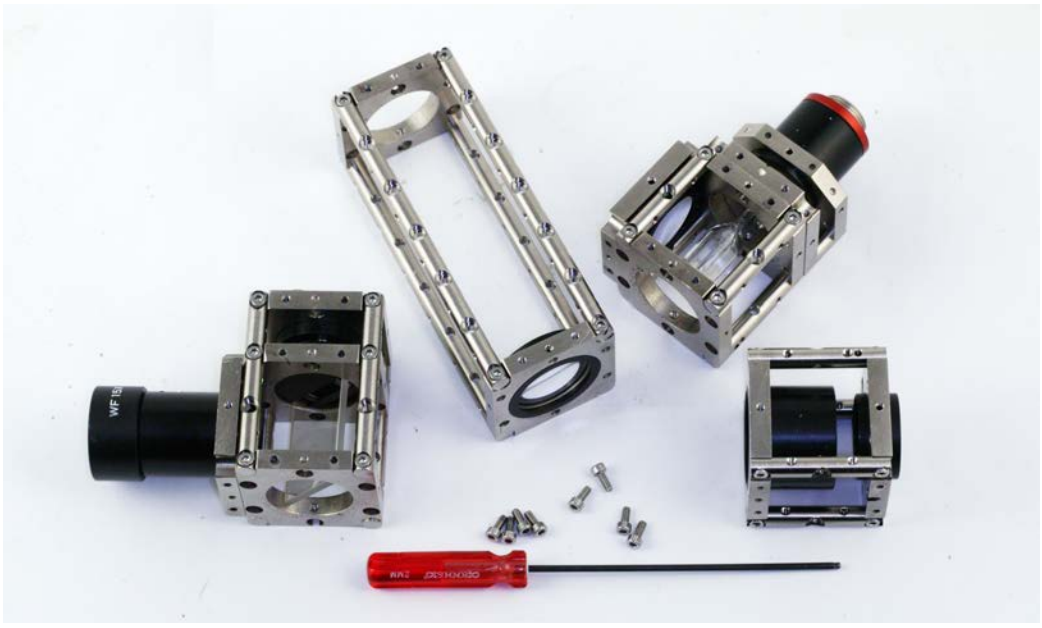


Digital Hasselblad

Surviving in modern age with a product is not an easy task. Hasselblad had its own dilemma transferring its image to modern age. There is no replacement to the classic shape of a product, so the new design has great resemblance to V-series Hasselblad originally designed by Sixten Sasson. The new body looks more like their model SWC, the super wide version without reflex viewing. The live view (opposite page) allows utilizing both new, as well as old Hasselblad lenses. The result is as beautiful as the original model introduced for the first time, 63 yeas ago at its premier in New York, 1957.


HASSELBLAD

Optoform's new Modularity Concept



Keep all your sub-assemblies, don't take them apart:

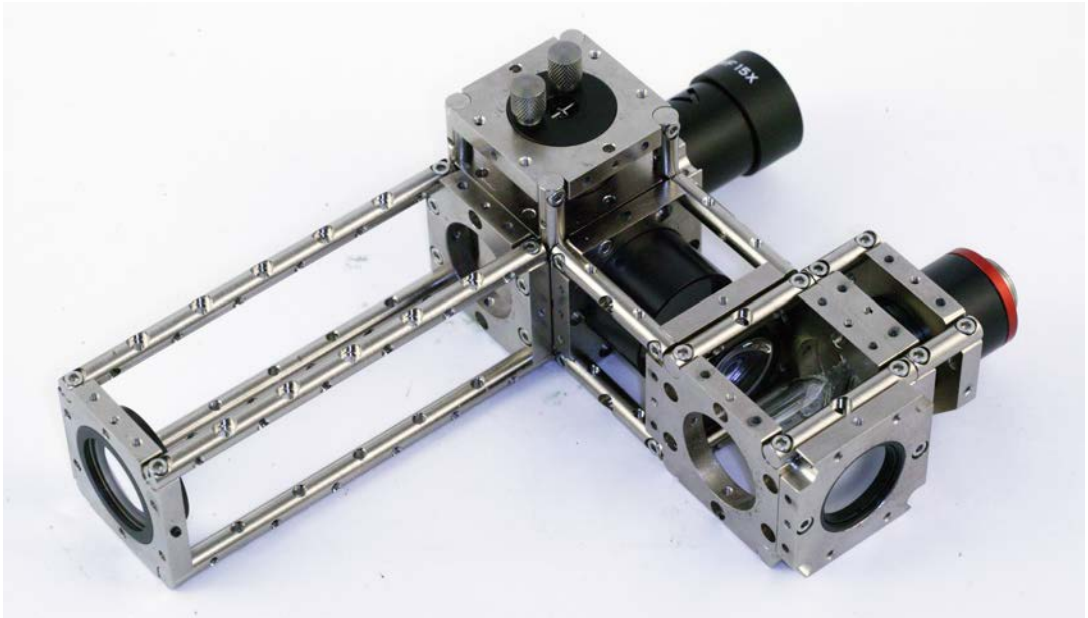
Lamp Housing

Collimator Optics

Beamsplitter Module

Objective lens tube

You can always use them to build your next assemblies

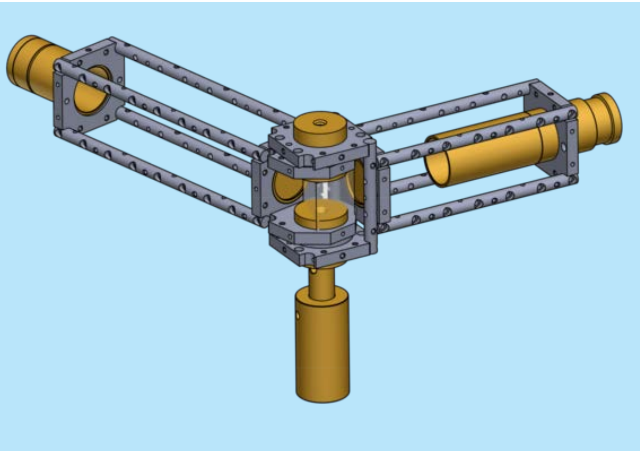


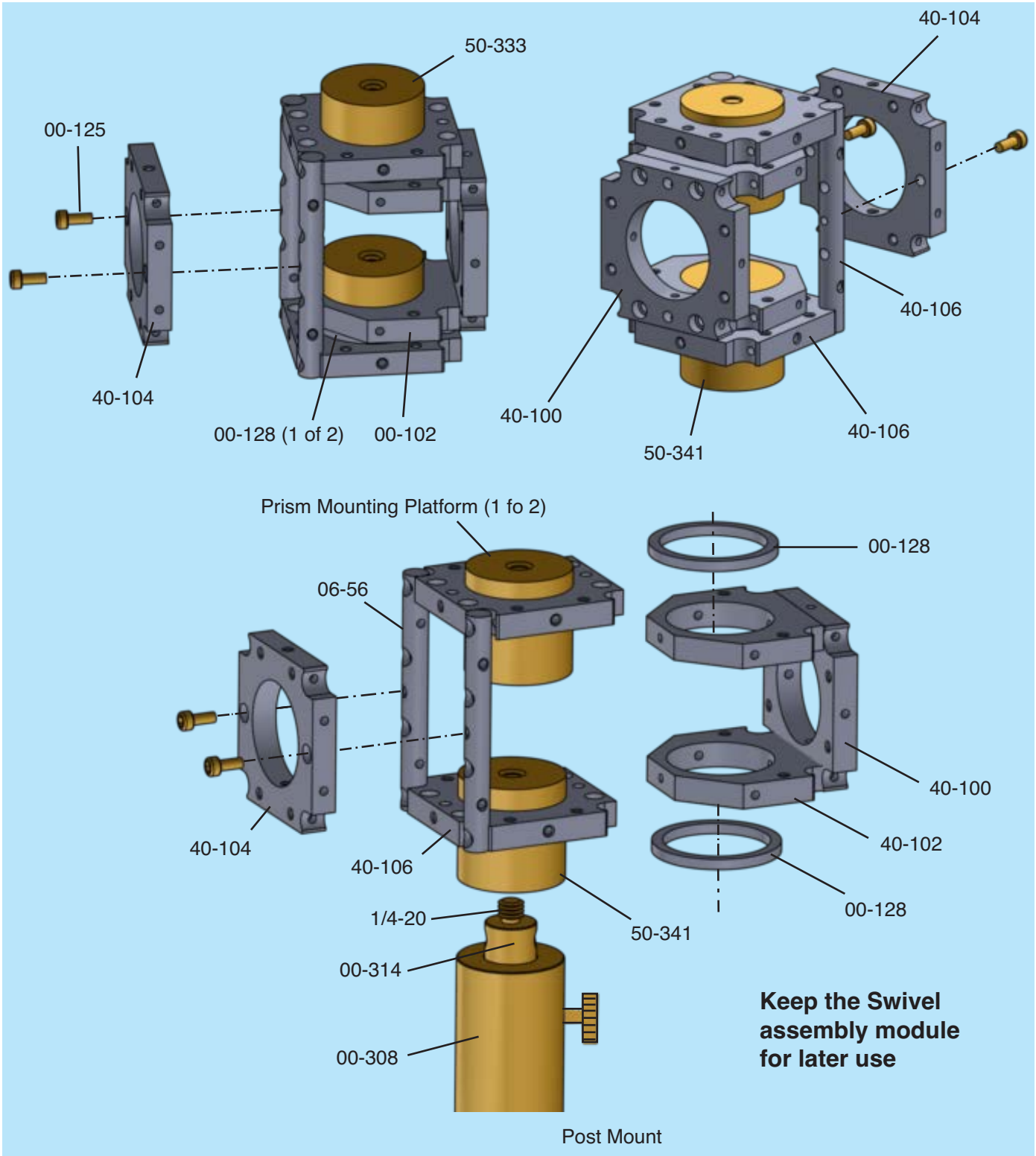
In Optoform, you deal with cubic forms that can be connected at any orienation in 3D space.

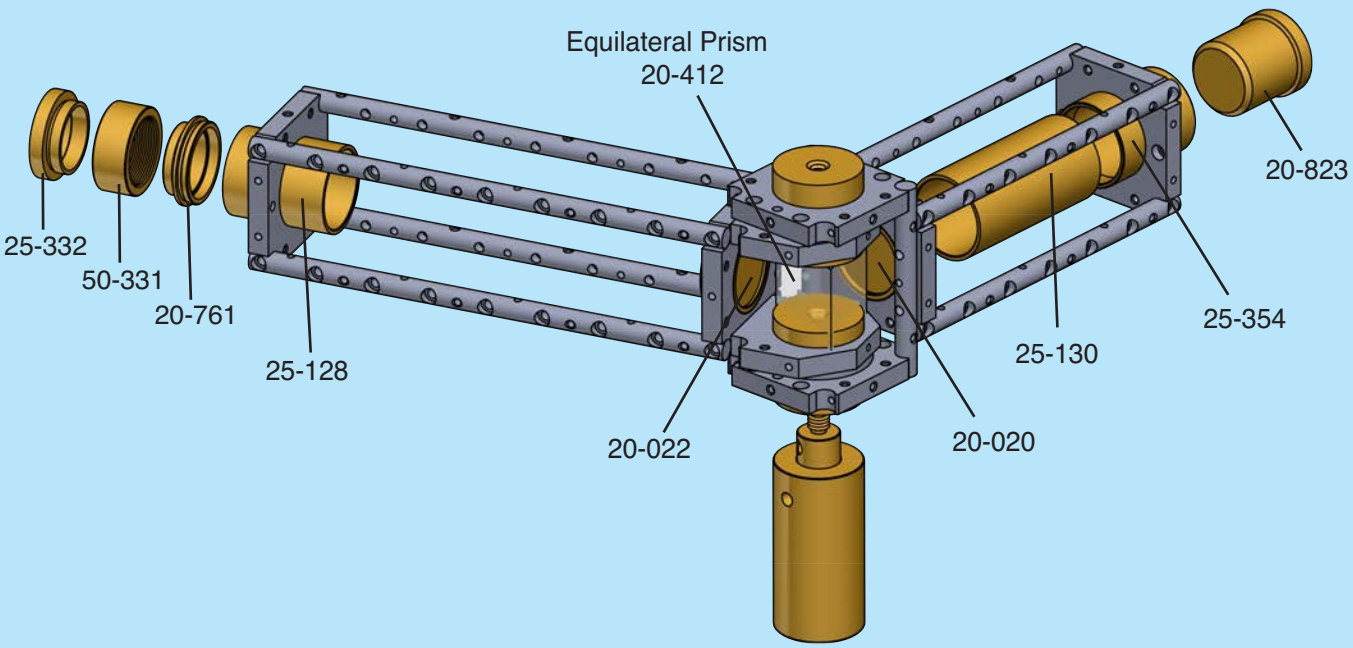
Optoform Application Notes

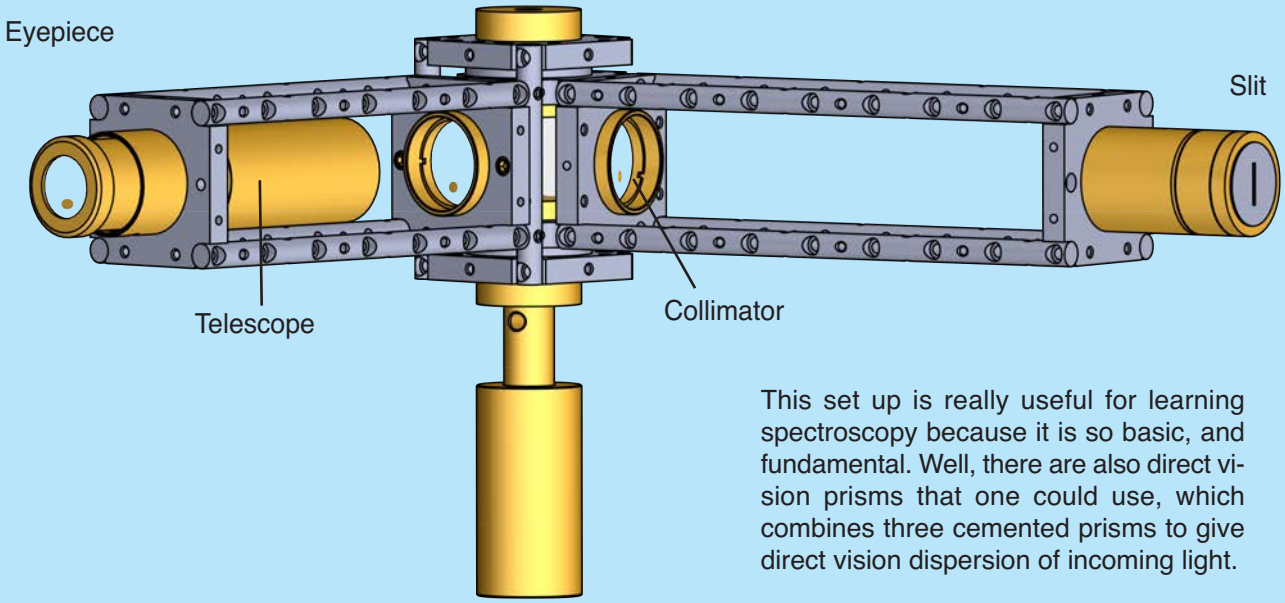
Building a Spectroscope

To build a spectroscope, we first need to construct a Swivel mount. The trick in here would be to utilize a pair of support rods 00-56, mounted to a pair of 40-106 mounts as shown below. Then a pair of 40-102 is mounted on both sides of mount 40-100. By inserting two cylinderical platforms 50-341 or 50-333, and two spacers 00-128, a swivel mount can be constructed as shown below. This assembly may be supported by inch or metric post mount.







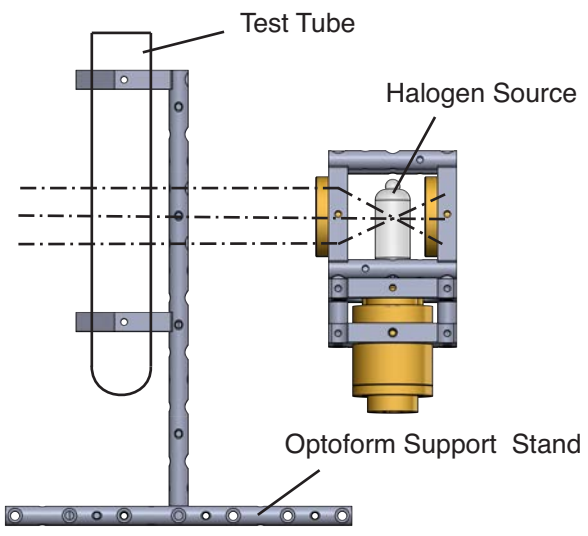


This set up is really useful for learning spectroscopy because it is so basic, and fundamental. Well, there are also direct vision prisms that one could use, which combines three cemented prisms to give direct vision dispersion of incoming light.

Bulding a Sample Holder

This is the most undermined task in most labs. Building a sample holder involves a test tube being held on a reliable platform, and illuminated from the back by a relatively constant light source with a reasonably flat spectrum output curve. We could utilize the Halogen lamp we built for previous experiments to get us going on this. Test tube holder can be constructed with two mounting plates 40-102, and two rods. I confess I borrow these mounts from outside of the kit for better appearance.

The most difficult task is to get the light source, and the test tube line up with spectroscope's input slit. In conclusion, this setup shows the possiblity of performing tilts and rotation with standard optoform mounts. It may be applied to many other applications such as a tiltable viewing head for microsocpy.

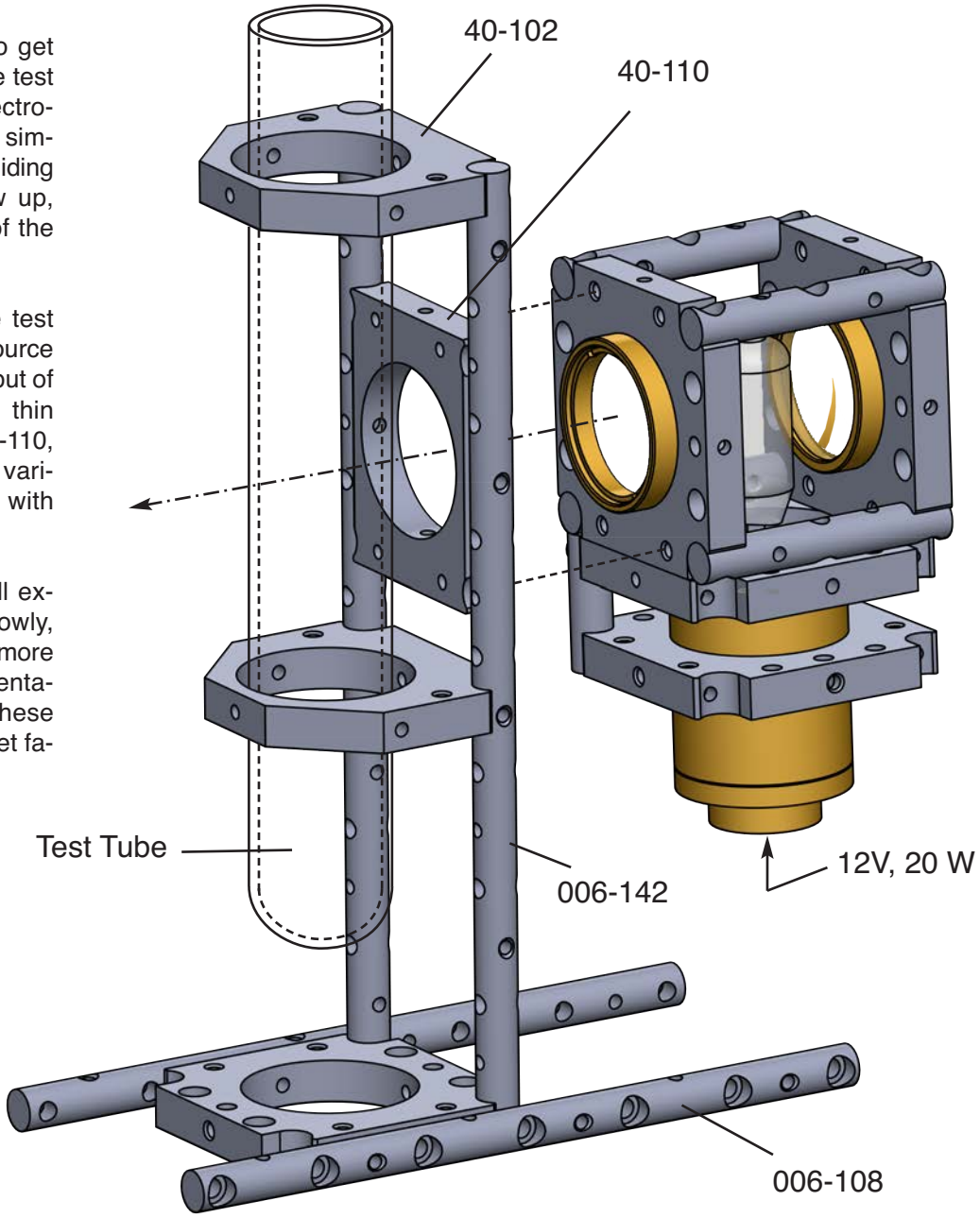


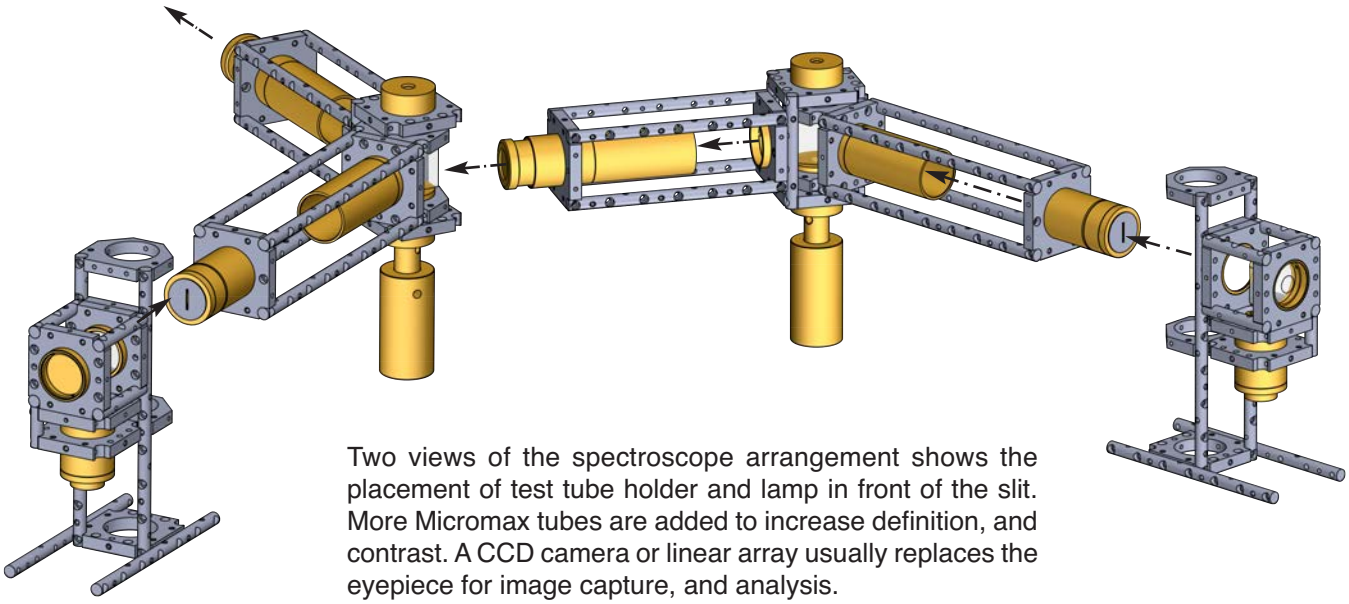
Final Assembly

The main objecive is to get the light source, and the test tube line up with spectroscope's input slit. The simplest way is to utilize a sliding mount 40-110, to allow up, and down adjustment of the test tube platform.

The result is a reliable test tube holder, and light source to line up with the slit input of the spectroscope. A thin plastic layer between 40-110, and the rods, provides variable height adjustment with adjustable friction.

On the next issue, we'll explore interferometry. Slowly, we are going to get into more sophisticated instrumentation with Optoform. These were child play just to get familiar with the basics.





Two views of the spectroscope arrangement shows the placement of test tube holder and lamp in front of the slit. More Micromax tubes are added to increase definition, and contrast. A CCD camera or linear array usually replaces the eyepiece for image capture, and analysis.

Trustee From the Toolroom

I remember when I was selling my first book at a trade show in southern California back in the 80's, an old man bought my book, and he was looking at all the hand-drawn illustrations I had made to describe how cameras worked. He looked at me as if he wanted to tell me his life experience. He asked me: "Have you read any of the poetic novels about engineering?" I said no, I haven't. He then recommended this book: "Trustee from the toolroom", by Nevil Shute. I went out to the library, and checked out that book, and I found it to be an uplifting story. Its title always resonated with me because it has such deep meaning.

Our life is entrusted with us to see what we'll do with it, and whenever mankind did something out of love, it reached excellence, otherwise it disappeared in the course of time. Rumi has a story of a young slave girl in a household that the wife was so jealous of, so she never let her be alone with her husband. This went on for a long time until one day she was at a public bath house, washing her hair, and

Leica 50 mm f/1 Noctilux for the M system

Roger Smith explaining George Daniel's Coaxial design

she remembered she had forgotten her favorite water pitcher to bathe herself. So she asked her slave to rush home to bring it. The slave girl ran to the house so swiftly to be in union with her master. They joined each other with so much longing, and passion. Back in the bath house, the lady of the house suddenly came to herself: "Oh what have I done!" So she washed her hair in a rush, and dressed up so quickly to run back to the house with still some soap in her eyes. In here, Rumi says: "There is a big difference my friend: One ran out of love, and passion while the other ran out of envy, bitterness, and jealousy."

In engineering, and craftsmanship, the same thing has been going on since birth of time. What was built in a hurry to compete felt so different from was made to thrive. Design out of love is so different from design out of envy. When you see how Leica cameras are built, you would realize these pieces were not built just for financial gain. Leitz factory has earned its reputation through a lifetime commitment to the trustee from the toolroom.

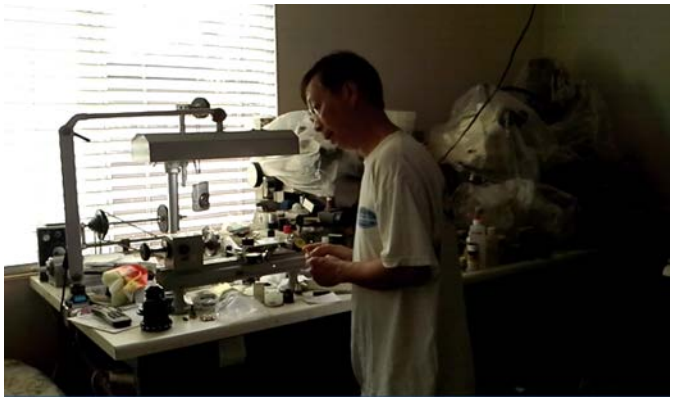
Designing out of love has in it, a commitment for perfection. You could see the same thing in Lang & Sohne, and Pateck Phillipe watches. It is a trustee that is carried from generation to generation of highly skilled opticians, and mechanical, and electronics engineers. George Daniel was a committed British watchmaker, and writer. He said to all his fans: "All you need to know about watchmaking you'll find in my book; Watchmaking".

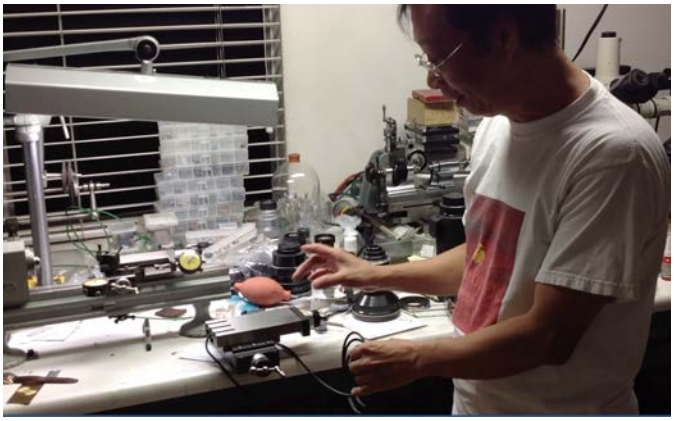
A young Roger Smith read his book to build his own watch. He showed the old man his watch, but the reaction wasn't pleasant at all. Instead of getting discouraged, he built it again, but this time not to impress no one but himself. While he showed George Daniel his watch, he recalls: "George stared at it for a 10 minutes, and asked: Who made the case, and the dial? I said I did; Who made the escapement wheel? I said I did." He then stood up, and with a smile on his face, said: "Congratulations, you are now a watchmaker". Roger Smith went on to work for him as an apprentice for the rest of his life to learn countless more skills. He now has a private shop that designs, and builds hand made watches starting at $30,000 each.

Trustee from the toolroom is not something to read from a book. It could only be learned by apprenticeship, and by doing. As a self taught machinist, and opto-mechanics designer, I have come across a few good teachers who have taught themselves by doing. In watchmaking, without a shadow of a doubt, Coung Dang is one of them. We met each other for the first time at a camera show, and he saw the SLR camera I had built by hand. From that point on, our friendship has lasted some 30 years, and any time I wish to see him, he tells me in his unique Vietnamese accent: “Ali, you come visit me, I’ll give you whole day”! Coung is one of such rare individuals I’ve met who has been carrying the torch.

Coung’s email: plato3000@aol.com

George Daniel’s hand made watches

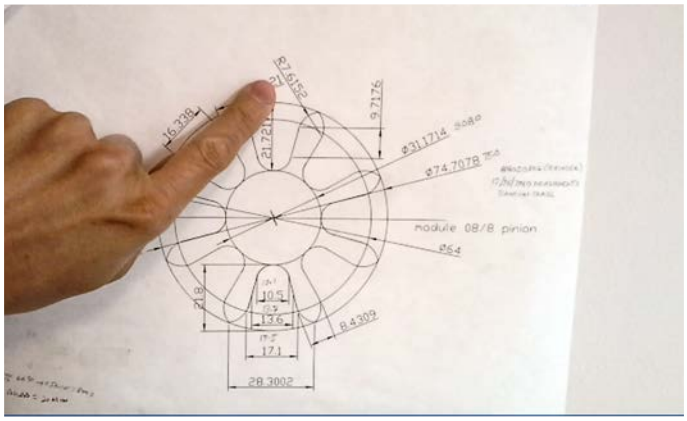




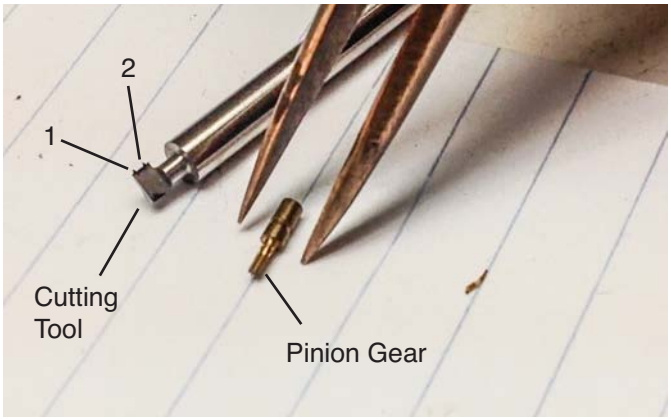
Coung Dang’s tool room where he makes his watches (left), working on a new cross slide for his Levin lathe (right).

Inspecting a tiny pinion gear (above), Coung designs, and builds his own micromechanics components.

Filing a piece (above) inside a custom made filing fixture, and running his high RPM air bearing CNC mill (right).

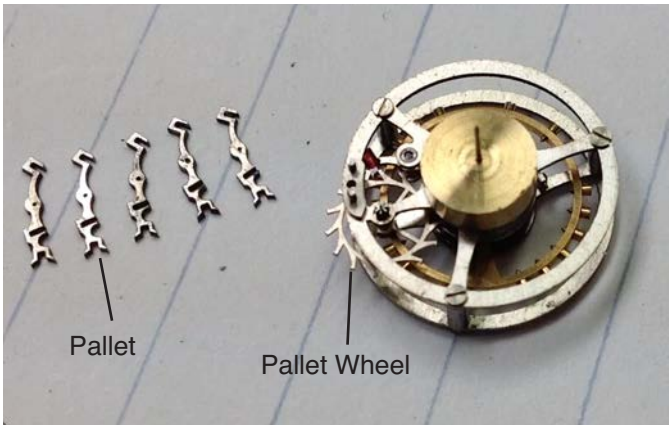


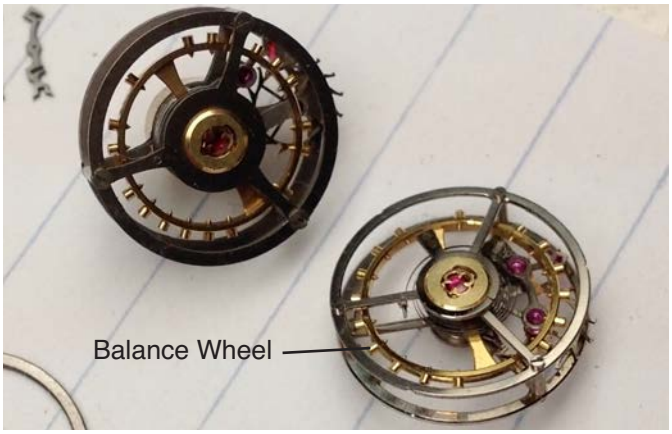
Coung explaining to me how gears work, and how he designs a gear section (above), then grinds the tooling to cut it.



Single point gear cutter is ground to shape to make pinion gears (leftt) using an elaborate gear cutting machine (right).

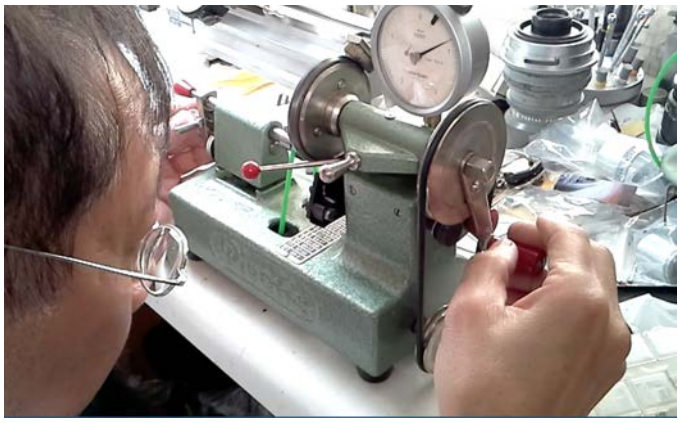
Working on his Tourbillon watch, he has three pre-ordered watches by those who have seen his work at watch shows.





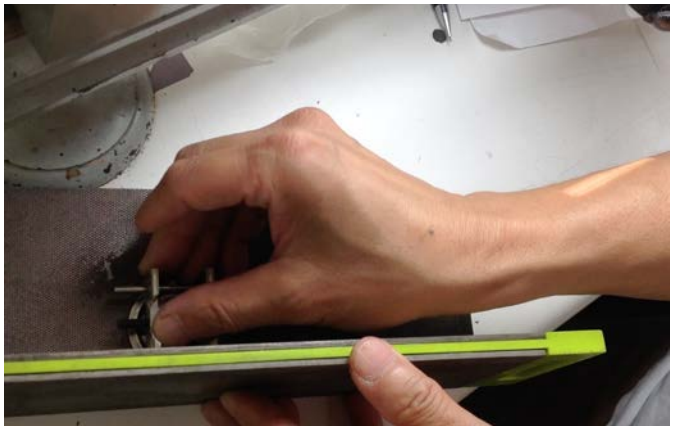
Tourbillon parts are first machined in a CNC machine (left), then polished to assemble the final movement (right).

Showing me how to use the pivot polisher tool. I later bought this tool, and was able to save a broken balance wheel.

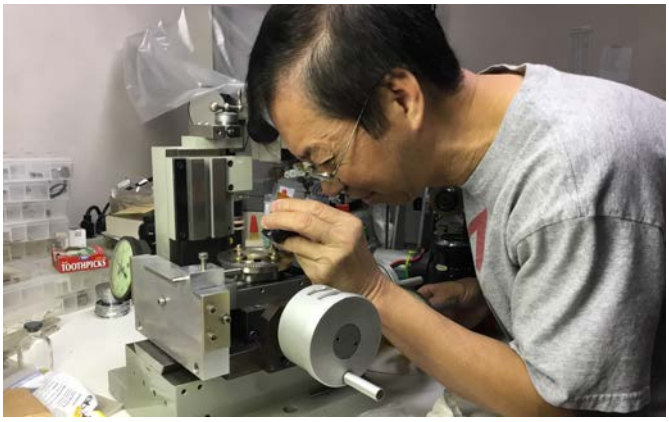


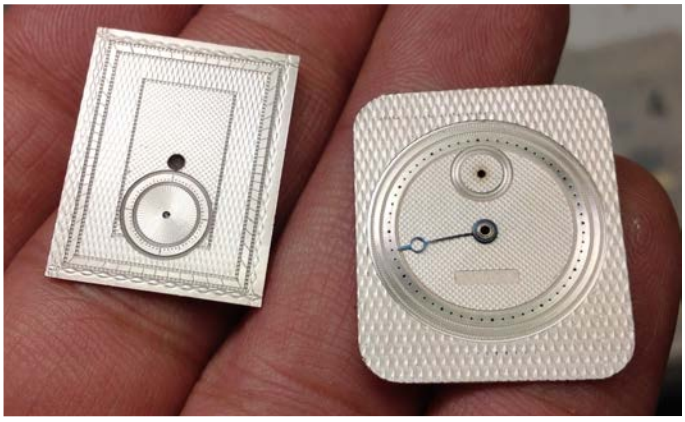
The pivot of a balance wheel is held at two points. A Carbide wheel presses, and polishes the pivot at the same time.

Teaching me how to clean tiny jewel holes in a Rolex watch, he sharpens orange wood sticks to a fine point (above).

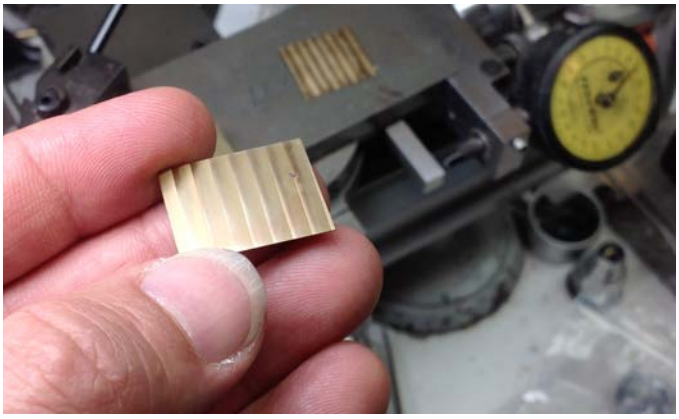


Polishing the back cover plate of the Rolex watch on a stone block: The fixture prevents the cover from rotating (left).

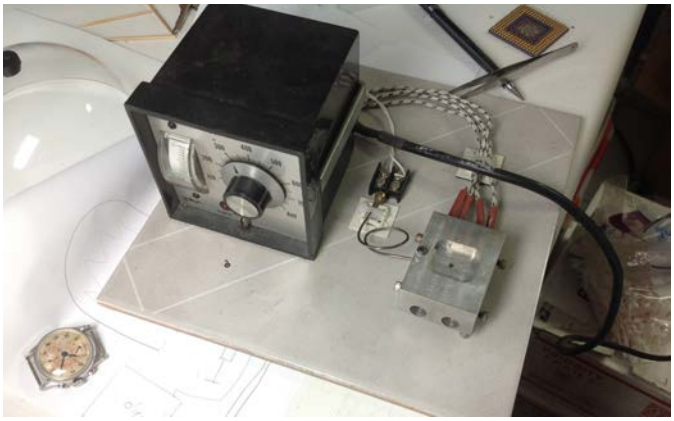




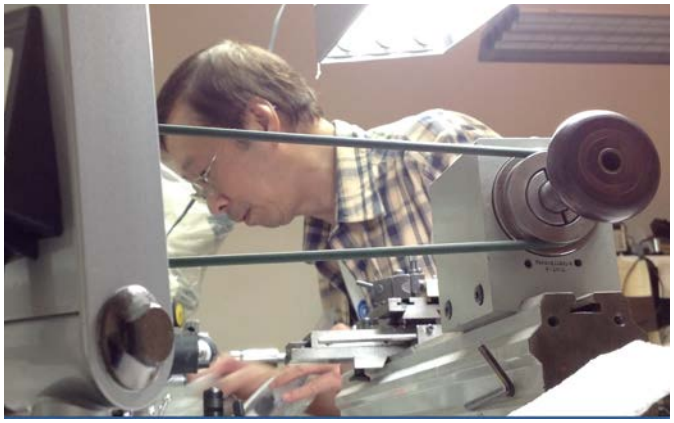
Dial face engraving machine made by Coung can engrave dial faces with precicion diamond, and other creative patterns.



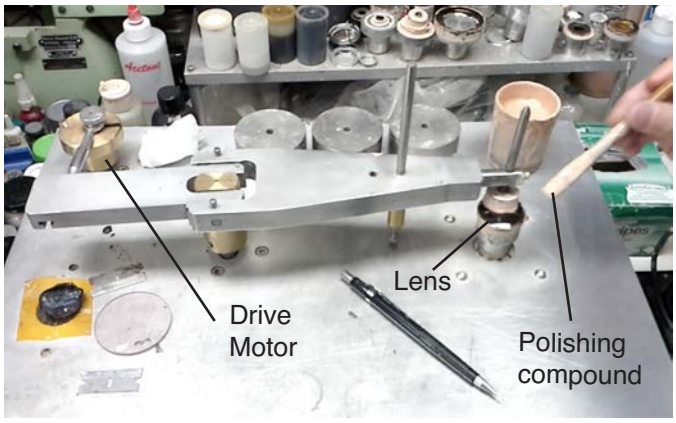
Polishing machines are utilized to make Geneva patterns on mechanism plates inside the watch, or on gear faces.



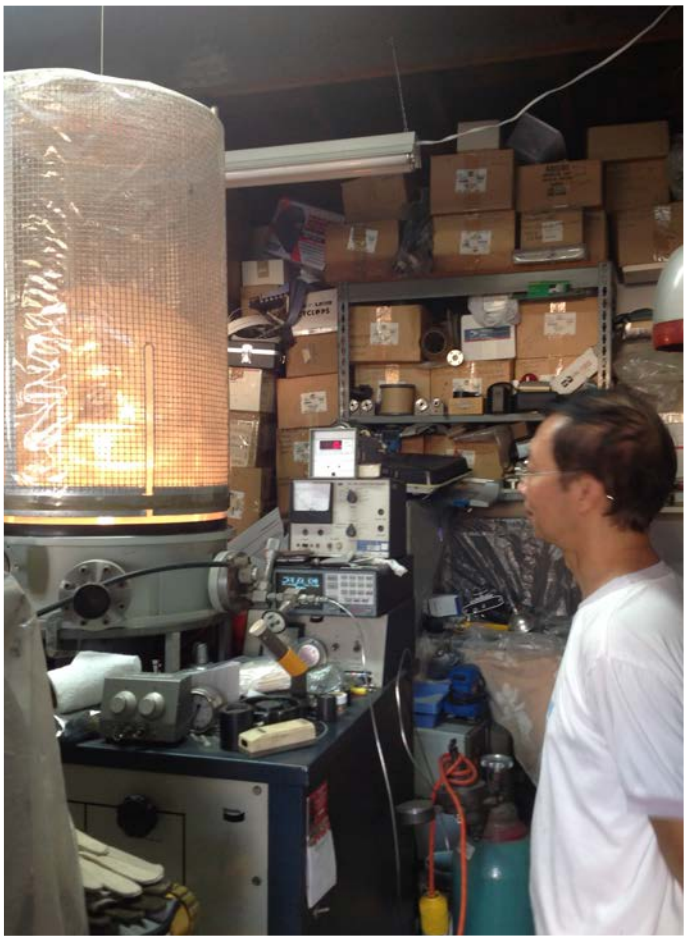
Micro watch screws as small as 0.3 mm are possible with the right tools. Bluing oven made by Coung Dang (right).



Coung makes his own micromechanics components, and hardens them in vacuum to prevent oxidation.



Polishing a scratched lens element in his optical shop.



Final inspection of polished lens (left), and MgF2 coating of lenses inside one of his three vacuum chambers (right).

Coung has equal passion for photography. Here, he shows off his very fast lens by installing it on a Canon EOS camera.

He shows me how a portrait stands out with a wide open lens. My picture on the right shows its optical quality.

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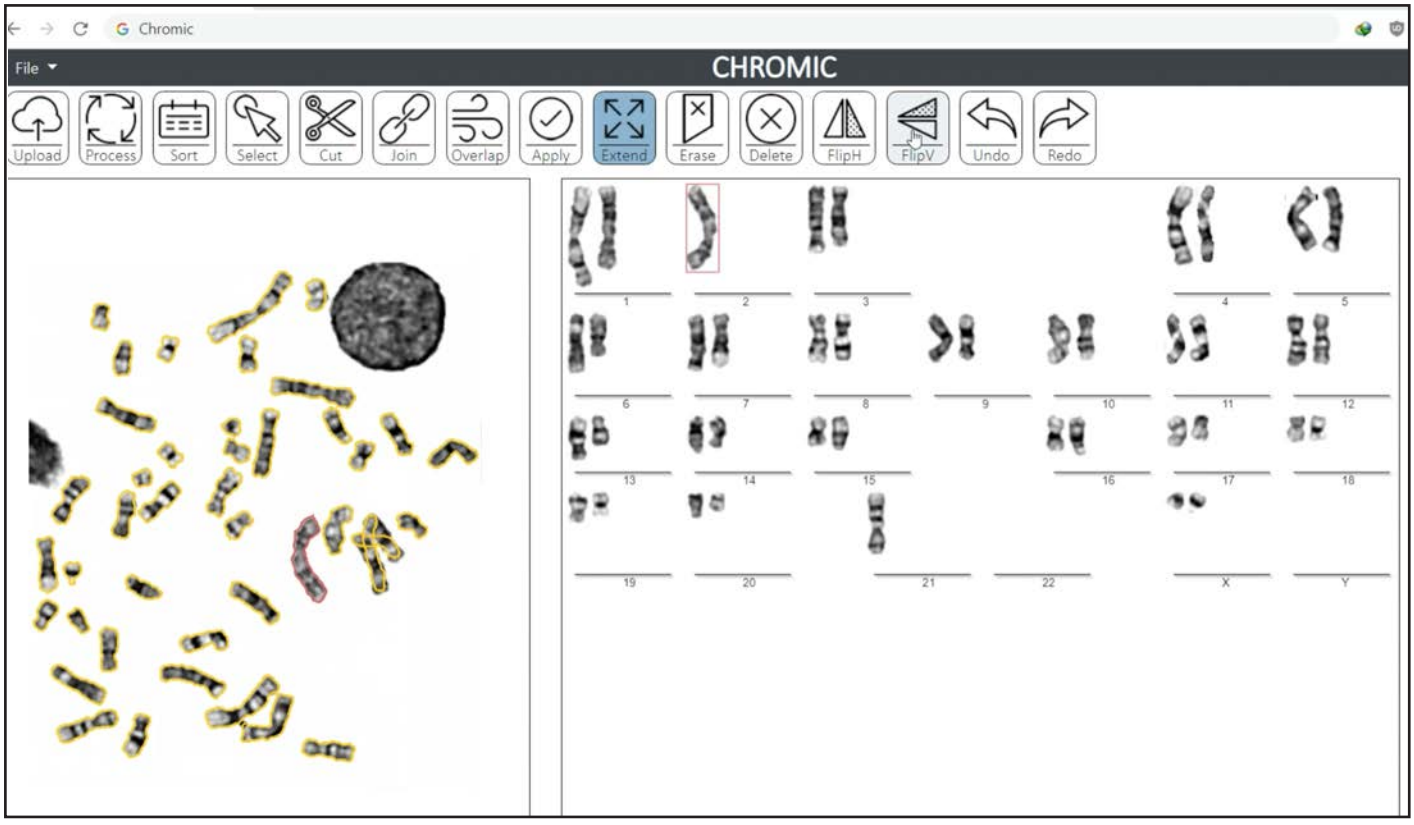
- Personalization options for labs and users
- High quality and lower cost
- Technical support



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