

Optomechanix

Car designs: Mercedes Benz
BMW, Volkswagen, Porsche
Ferrari, Maserati, Lamborghini
Aston Martin, DeLorean
Optomechanix Design
Zeiss Ultraphot II
Emco's Super 11
Emco Concept Mill 55

European Design: Influence of Auto designers on Optomechanics

Oct-Dec 2026



Technical journal of OMiD, Opto-Mechanical Institute of Design



Two generations of Porsche: Model 356 (1956), and the 911 (1965).

References for the photos: "Ferrari Milestones" by Roland Lowisch, Two great books by Blake Z. Rong: "The German's beautiful machines" and "The Americans", The Lamborghini book" by Michael Kockritz, "The Story of Classic Cars" by Peter Tomalin, Stuart Codling, and Luke Smith, "Sidhatha" by Hermann Hesse. Some drawings and photos, Courtesy, Carl Zeiss, Emco Maier, elferspot.com. Articles reference: Wikipedia and many more online resources.

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Hermann Hesse 1877-1962

This issue Dedicated to:

Hermann Hesse (1877–1962) was a German-Swiss poet and novelist who won the Nobel Prize in Literature in 1946. His interest in Eastern religion and philosophy, together with his experience of Jungian analysis, shaped much of his writing. His best-known novels are *Demian*, *Steppenwolf*, *Siddhartha*, *Narcissus and Goldmund* and *The Glass Bead Game*. Each one explores an individual's search for authenticity, self-knowledge and spirituality.

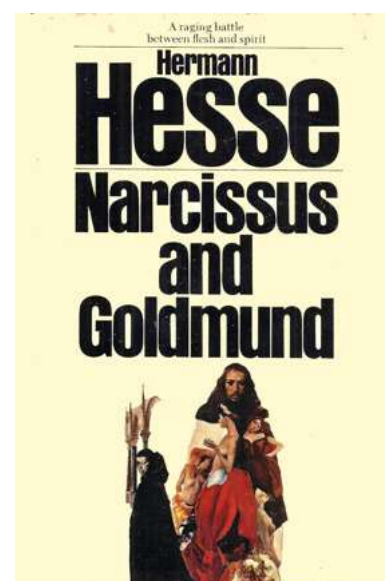
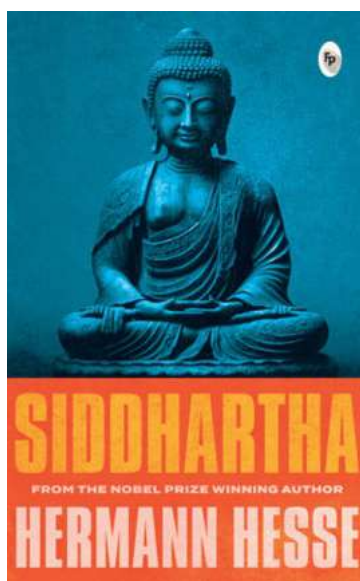
During his lifetime Hesse was widely read in German-speaking countries. His lasting international fame came only a few years after his death: in the mid-1960s, his books became enormously popular with a new generation of readers in the United States, Europe and beyond.

Hesse was born in Calw, in the Black Forest region of southern Germany. His grandparents had served at a mission in India for the Basel Mission, a Protestant missionary society, and his mother was born there. He grew up

in a Swabian Pietist household. Pietism tended to gather believers into small, deeply introspective circles. His father was a Baltic German from Estonia, and Hesse called this heritage "an important and potent fact" in forming his identity. His father's stories of Estonia gave young Hermann a different view of religion from the one he met at home.

His maternal grandfather, Hermann Gundert, was a scholar with a doctorate in philosophy who spoke many languages. He encouraged the boy to read widely and gave him free use of his library, which was full of world literature. All of this made Hesse feel like a citizen of the world. His family background, he later wrote, became "the basis of an isolation and a resistance to any sort of nationalism that so defined my life."

Source: Wikipedia



Hesse's most popular books: *Siddhartha*, *Narcissus and Goldmund* and *Steppenwolf* are Hesse's major explorations of the divided self.

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Cover page photo: Porsche 356

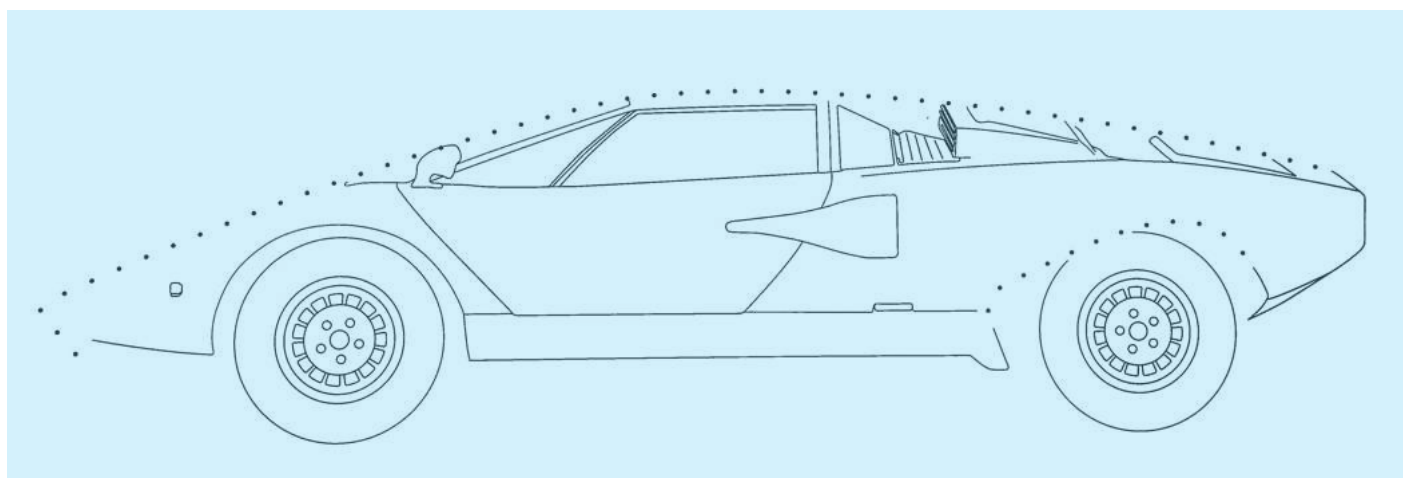
Inside back cover: Porsche 356, and Porsche 911

In This Issue ...

In this issue, I would like to discuss form, and design a little bit. Form gives a product its identity, and without it, a company has no lasting culture. We are going to discuss three forms in product design: The round, square, and triangular, and for that, we'll take the example of Porsche, and Lamborghini, etc. In optics, it's obvious classic microscope design followed the round form, while modern design is in most part rectangular and triangular. We'll examine some of these three forms in car design, and look at the philosophical views of their designers. In precision mechanics, it is also the design of machines that make the parts. I am going to continue my discussion on Emco Maier's Super 11 machine design, and their educational CNC machines that are most suitable for prototyping.

In general, design cannot really be put into words, so, we are going to have a very illustrative issue! But remember design has a soul. Relying on just the look of things is not enough to understand design. It would be like looking at glamorous images in a magazine, and expecting to understand femininity. What lets you see design is your own sense of nostalgia: a feeling for what is missing in the world, which design can then reveal.

Ali Afshari
Editor in chief
Optomechanix



Connecting the dots in the Lamborghini design reveals its DNA to be from their 1971 Countach (above). This is what they achieved then, and kept most of its features ever since. That's why Leica camera has also kept the basic contours of its Model M3 (1954) to date. That's how design gives identity to a company, and if they are wise, they won't let go of it.

Curved vs Rectangular Design, Carl and Bertha Benz

By Ali Afshari

Optomechanix is not about cars, but it is about industrial design, and cars play a great role at a global scale. We live with cars, and grow up with them with admiration. I grew up with Mercedes Benz cars in my family: First my dad had a black Mercedes, and later Both my brothers-in-law drove them, and as a kid sitting on the back seat, we kept staring at a Mercedes 200 speedometer as it moved upward in the freeway. The speedometer scale went up to 200 km, and we thought that's because we were riding a 200 model, and we figured it should go that fast. We also knew of Mercedes 500, and thought: Wow, that could go as fast as 500 Km/h! Later in life, we realized it referred to their combustion volume in Liters. Later, my nephew told me he pushed their Mercedes 200 and it could only go as fast as 160.

Below, right, Carl and Bertha Benz in a Benz Victoria of 1893, after the Motorwagen patent in 1886. Benz continued the manufacturing as a popular transportation car after the passing of Carl Benz who died in 1929.



Carl, and Benz in Victoria 1893



Classic Benz 220SE was considered a luxury car of its time



Benz W116 S (1972–80) was the modern look of that era



Interior of Benz 280 SL (1968 - 1971)



Benz 190SL (1955 - 1958) Note the accent above the wheels



I drove E320 for over 10 years. Its headlight design, and turn signal hidden below it were my favorite features of that car.

What are the elements in Mercedes design? One could see the square grid air intake for its radiator, below its raised Mercedes Benz logo. In their sports cars, Mercedes has shifted to eliminate their raised logo at front of its hood, and has displayed a large logo in front of their car. They started with round headlights, then elliptical, and switched to rectangular headlights, then switched back to round on their sports cars, then rectangular again on their super sports cars.

BMW

Then there is the BMW look. What are the design elements in BMW? What could you remember? For one thing, it emphasized on round headlights, and rectangular tail lights. The middle air intake for the radiator is unique to BMW. It's right under the company's logo that always laid flat. It's even kept in their modern sports cars (below, right). Overall, BMWs have round corners in their body design. As we'll see, most sports cars shifted to square lamps, and sharp edges, then in most modern designs, they switched back to round, and extremely round bio designs as Colani influenced on most of his designs that we'll look at later.



The design of BMWs through the ages



BMW 3.0 CSL has the classic DNA of the brand



Rear view of BMW 3.0 CSL



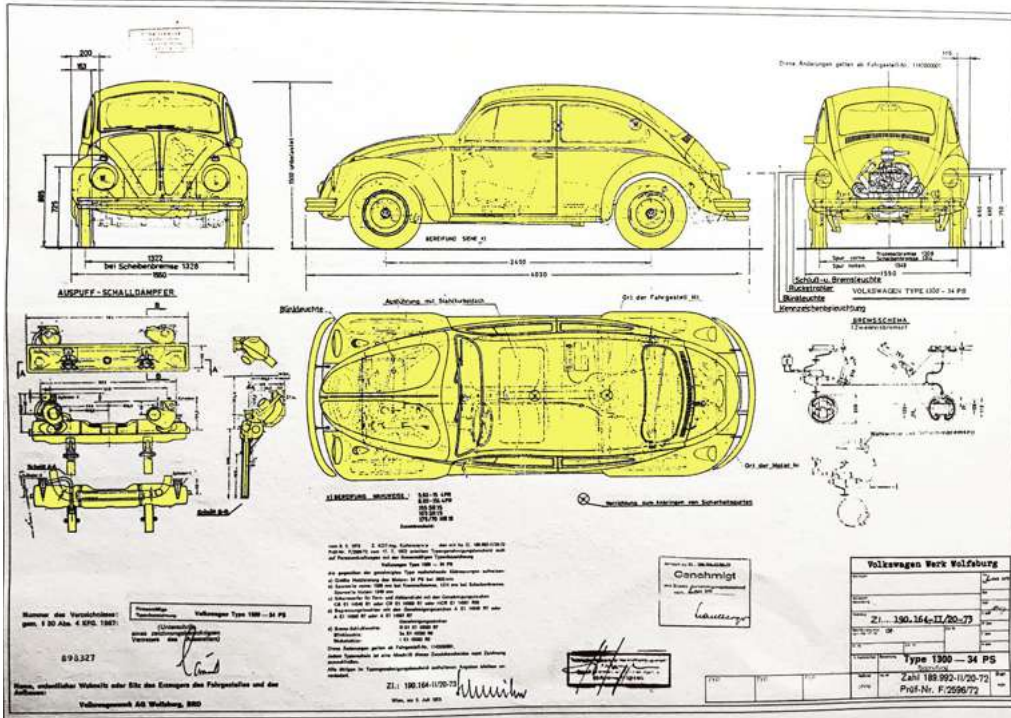
Interior dashboard design of BMW



BMW M1 has the characteristic fin in front of the radiator.

Volkswagen

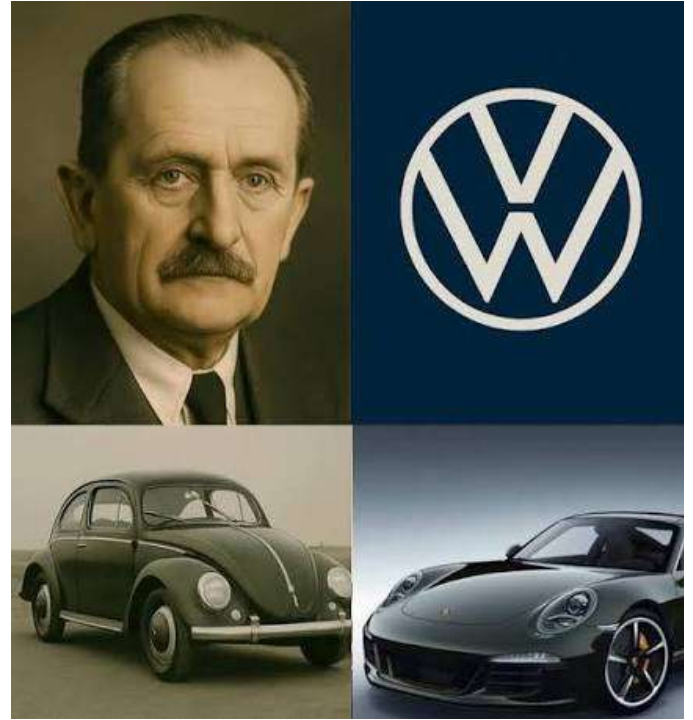
Ferdinand Porsche who was an independent designer was assigned by German government to create an inexpensive, durable air-cooled car for Germany's fast cross country highway network. He took the work of Hungarian designer Bela Barenzy who had laid out the curved shape, and Hans Ledwinka, a pioneer in air-cooled engines to design Volkswagen



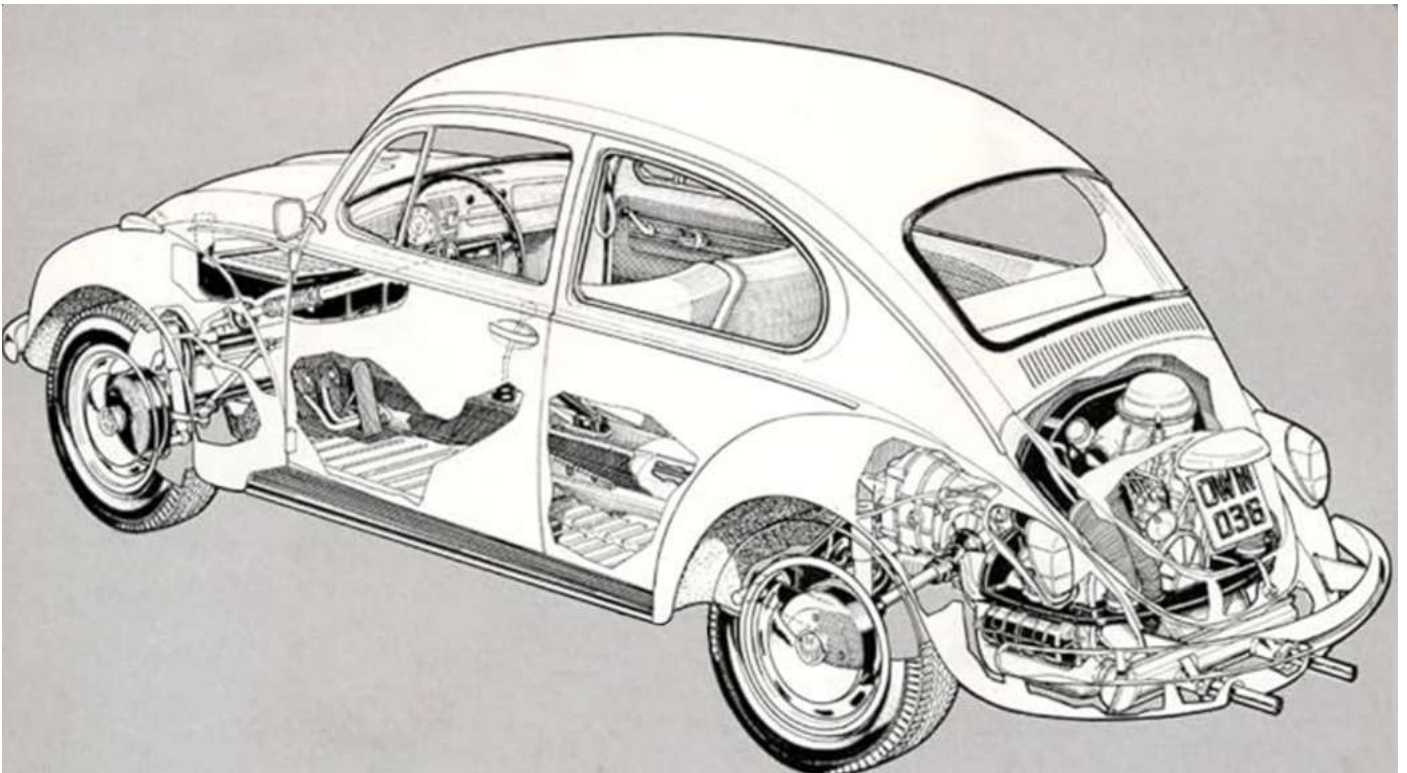
Beetle around 1934 (right). Its prototype was finished in 1936 and production started in 1938. After World War II, its production facility in Wolfsburg fell in the hands of British, and after its army's order of 20,000 cars, it became a sensation in the consumer market. The beetle became the highest produced car in the world with 22 million built in its 65-year production until 2003.

Below, Production at the Wolfsburg plant in 1956. Volkswagen became one of the world's largest automobile factories in the world with 30,000 employees.





The classical design of Volkswagen was brought back to life with its modern design. In their modern body upgrade, VW not only did not lose its identity, it even bolded it, and brought out its core concept from the past.





Ferdinand Porsche looking through the steering wheel of Porsche 356.



Ferry Porsche standing in front of his father's 356 product.



Ferdinand Porsche posing in front of his creation Porsche 356, an upgrade from his earlier VW body design.



Porsche 356 looks so much like Saab, except in Porsche, the engine is put on the back so the hood could slope down.

Porsche

Originally designed by Ferdinand Porsche, and Erwin Komenda. Ferdinand initially incorporated VW engines in his first creation, model 356 (cover page). The first generation of cars were built with handmade Aluminum body. Car enthusiasts are used to see cars being introduced every year, but few people realize how difficult it is to make them.

Sports cars were and still are a sensation. Today, you might ride an electric car, and think it's the same thing, but it's not. One might think electric cars could race a Porsche but these cars still dominate the road.

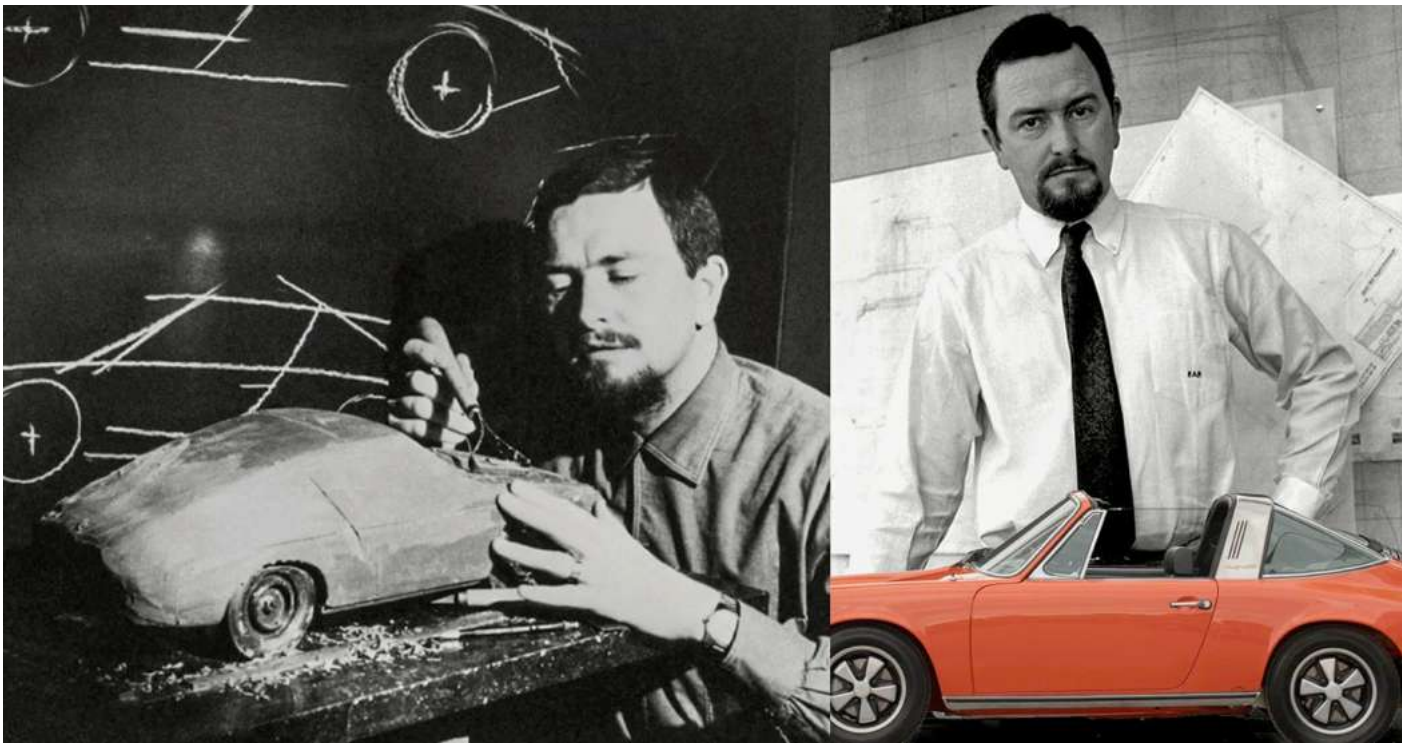
Porsche has the look of Volkswagen with its front and back stretched. Using Photoshop, take the side view of Volkswagen, and stretch it. The iconic design is formed by stretching the headlights, but having the hood sloping down. This develops into its final form in the 911 design.



The Porsche 356 became an icon because its minimalist, aerodynamic shape and clean lines avoided baroque ornamentation.



Three generations of Porsche: Ferdinand Porsche, his son Ferry, and Ferdinand Alexander. Above, posing in front of 911. The 911 design has the characteristic sloped hood, and raised lamps. It is the refined form of 356 design.



911 was designed by Ferdinand Alexander Porsche, and Erwin Komenda. Above, Ferdinand Alexander Sculpting the 911 body



Porsche 550 of 1955 (known as James Dean car)



Porsche 911 of 1965



Photos credit: elferspot.com

In the following pages, we'll look at Porsche 1969 design. As you'll see, the way to understand a design is to look at each part on its own. The design then registers in your mind with all its details. Your own design process works the same way: it means studying every detail and being pleased with each one. The details matter as much as the design as a whole.



Fat nose, sloping rear, and bulging headlights ...

... rectangular front air inlets, front fuel tank cap.



Rear bumpers follow the contour of rear slope ...

... small internal trigger door handle.



Cloverleaf wheels



911 Targa's roll hoop stayed in place for safety ...

... the roof/rear window could be folded down.



Rectangular door lock lever, left hand ignition ...

... while the right hand shifted the gear

Ferrari

Enzo Ferrari was a racing car driver since his youth, and he built custom cars for racing. He developed powerful engines to achieve faster cars. Founded in 1939 by Enzo Ferrari, the company built its first car in 1940, adopted its current name in 1945, and began to produce its current line of road cars in 1947. To reach its top speed of 260, most Models like Testorassa had a V12 engine. Many early Ferraris, dating back to the 1950s and 1960s, were counted amongst the most expensive cars ever sold at auction.

Ferrari is one of the world's strongest brands, and it maintains a brand image built around racing heritage, luxury, and exclusivity. Ferrari is also one of the largest car manufacturers by market capitalization, with a value of approximately US\$85.5 billion. As of the end of 2019, the total of Ferrari built and sold cars in its whole company history is 219,062. Ferrari Cabriolet was featured in 1992 movie "Scent of a Woman". In that movie, you could hear the sound of gear shifting in this amazing Italian car.

One of Ferrari's life tragedies was his son Dino who had Muscular Dystrophy and died young. There are those who claim Enzo ceased to travel and attend motor races after the death of his son in 1956. Ferrari preferred life in his new workshops in Maranello until his death at the age 90. "I have in fact no interest in life outside racing cars" Enzo Ferrari.



Enzo Ferrari (1898–1988)



Ferrari Mondial T Cabriolet was the work of Pininfarina Design



Interior design of Ferrari 250 GT



Ferrari and his son Dino in 1947



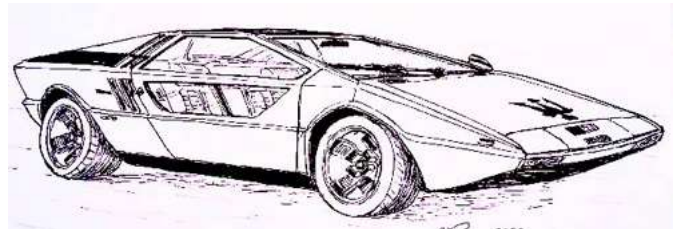
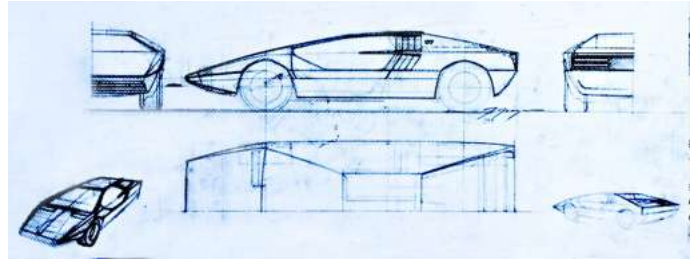
Ferrari 275 GTB (1964) with iconic round tail lights



Giorgetto Giugiaro: Maserati

Giorgetto Giugiaro has enormously influenced sports car design, and other industrial products. This versatile Italian designer has greatly influenced the look of numerous Nikon cameras since his most famous creation: Maserati Boomerang. Right, conceptual drawing of Boomerang, and below is the finished car design.

One might think electric cars could race a Maserati, but these cars still dominate the road. On my first Maserati ride, the driver went so fast that I felt my heart drop to the bottom of my stomach. Before electric cars, you could drive this crazy inside a small city like Garden Grove, southern California: At a green light he pulled out from behind the waiting cars, passed in front of the oncoming traffic, and was gone before anyone behind us had moved. This memory reminds me of Muhammad Ali's boast that he could switch off the light and be in bed before the room went dark.



You can't design a body so slick for a regular car without having such top performance.



Maserati Boomerang by Giorgetto Giugiaro



Maserati Boomerang's radically different interior design



Giorgetto Giugiaro the Italian Designer who designed many iconic European sports cars, and the DeLorean, later was hired to design the Nikon F3 body, and later models.



Lamborghini

Ferruccio Lamborghini (1916–1993), an Italian manufacturing magnate, founded “Automobili Ferruccio Lamborghini” in 1963 to compete with Ferrari.

Lamborghini thought Ferrari's cars were good, but too noisy and rough to be proper road cars. He categorized them as repurposed track cars with poorly built interiors. Lamborghini brought his misgivings to Enzo Ferrari's attention, but was dismissed by Ferrari. After successfully modifying one of his personally owned Ferrari 250 GTs to



Airbrush drawing of Lamborghini Countach

outperform stock models, Lamborghini gained the impetus to pursue an automobile manufacturing venture of his own, aiming to create the perfect touring car that he felt no one could build for him.

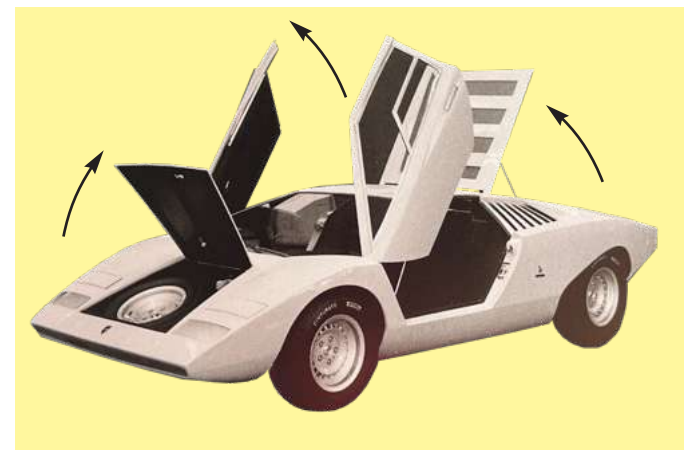
The firm's ownership changed three times after 1973, including a bankruptcy in 1978. American Chrysler Corporation took control of Lamborghini in 1987, then owned by Audi since 1998.



Lamborghini Countach, designed by Marcello Gandini at Bertone, is one of the most iconic sports cars in automobile history.



This is how 12 cylinders look like. Rolls Royce also used V12 engines but their 100EX concept car had a 16 cylinder tank engine! For Rolls Royce it's power, but for Lamborghini it's for speed.



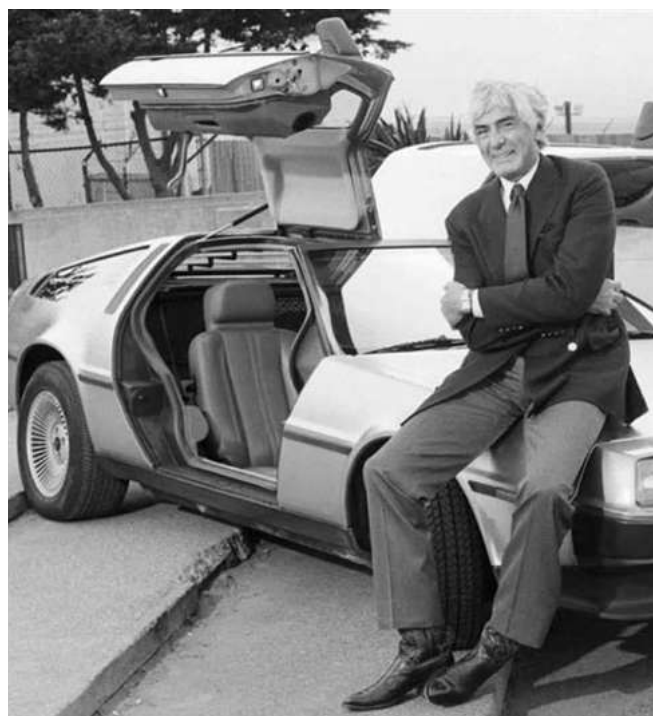
looking at all these unusual hinges, and having so little line of contact with the car, how could they work reliably, and smoothly during the life of the car which is at least 50-70 years? These classic cars must last forever. They are not designed to work for a few years, and end up in junkyards.

Now that you have seen the Porsche design, your eyes are more observant of the beauty of the Lamborghini.

DeLorean

As for American designers contributing to Optomechanics we could only count a few. However, we did discuss Giorgetto Giugiaro's designs, and DeLorean's outer body (built with polished stainless steel) was actually his design. Many people are familiar with DeLorean because of the 1985 movie "Back to the future". The time machine was originally intended to be a refrigerator, but in the movie, it is introduced by Doc, this way: "If you're going to build a time machine into a car, why not do it with some style?"

DeLorean had an amazing life, first he became one of the executives at General Motors, then he left his job to build his dream car. The story of DeLorean reminds us that inventiveness, and creativity, and even wealth does not guarantee success. Porsche and DeLorean both worked for another company before



DeLorean posing with his DMC-12. Only 9000 were made before its bankruptcy, and going to oblivion. The movie "Back to the Future" brought it back to life to its maker's delight.

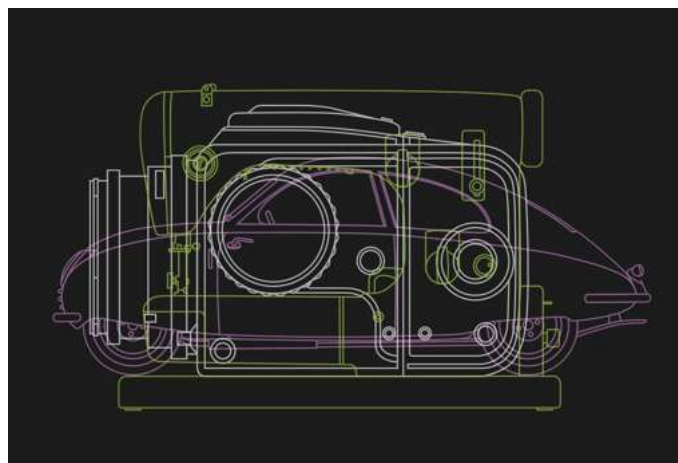
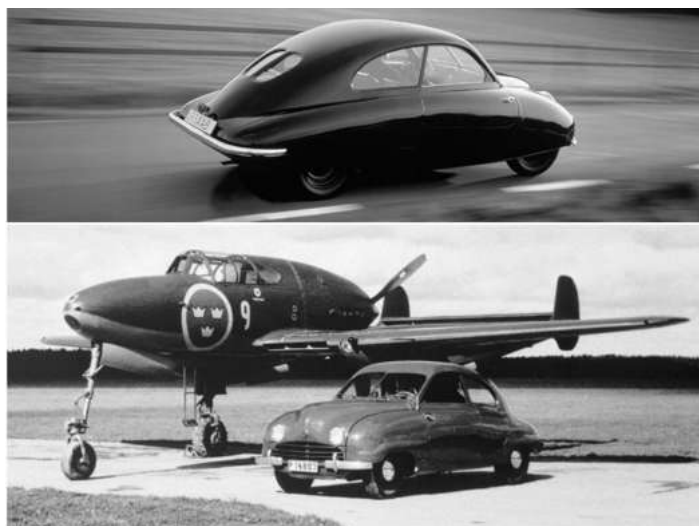


taking off to produce their own cars. Just like Ferdinand Porsche with his big role developing Volkswagen Beetle, John Z. DeLorean was a hot shot at General Motors, who had played a key role in developing 1967 Pontiac Firebird. After World War II, and downfall of the Nazis, Porsche even spent some years in jail. But Porsche later became an enormous success while DeLorean was left behind in void. If it wasn't for the movie "Back to the future", it would have been written completely off the minds.

Sixten Sason

Sports cars are like airplanes with half their body hidden beneath the road. Sixten Sason was born in 1912, the son of a Swedish sculptor. He trained in Paris as an artist and later as an industrial designer. He had a stint in the Swedish Air Force until an injury disqualified him for flight. In the 1930s he became noted for his "x-ray" renderings of industrial products. His style was designing cars like airplanes with round nose, and pointy tails.

Many times, you'd see original designs are changed for marketing reasons. The rear end of Saab 96 of 1961 was changed to offer more room for rear passenger seat. This same reason influenced Porsche 911 to have a raised roof to give headroom for those sitting in the back. The original Porsche 356 didn't have that constraint.



Overlapped Saab, Hasselblad, and Sixten's sewing machine

Sixten Sason who turned a drop into Saab design (left). Porsche's engine was placed on its rear. It allowed it to have sloped down front hood. If Ferdinand Porsche hadn't designed the rear engine Volkswagen, we might have never had the 911 design years later.

Aston-Martin

Aston Martin was founded in London in 1913 by Lionel Martin and Robert Bamford. In its early decades the company built fine sports cars but was always short of money. That changed in 1947, when the industrialist David Brown bought it, and under Brown, Aston Martin won the 24 Hours of Le Mans in 1959. The DB5 of 1963 became the world's most famous car when James Bond drove it in Goldfinger. Ford owned the company from the late 1980s until 2007. Today Aston Martin builds its cars in Gaydon, England, and has returned to Formula One.

In March 2016, Aston Martin and Red Bull Racing announced the "ultimate hypercar" (right).



DB 2403 was sold for 1 million dollars to set the standard for hand work carefully restored legend.



Ercole Spada (right) Italian car designer created the style for Aston Martin, as well as many other car "clothings".



What would you expect to get for \$3 Million price tag? A lot of discomfort while getting in, but an unequaled attention as if you arrived on a space ship from outer space. This looks like a motorcycle design, or a Batman car.

Influence of Car Designers on optomechanics

Camera design has been immensely influenced by car designers, and architects. This is when camera manufacturers began hiring outsiders to design the look of their cameras. This was after realization that consumers' conception of a camera is based on their body design concept.

Walter Teague was one of the first industrial designers in America. He designed the UPS truck, and the Air Force One. He also designed many cameras in 1930's for Eastman Kodak, and Polaroid. Dieter Rams the German industrial designer designed many Nizo Super 8 cameras, and Braun Super 8 projector.

Leica M by Jony Ive / Marc Newson was developed for an Aids fundraising. It raised \$1.8M for the cause. To achieve a minimalist design, they raised the recessed portion of classical Leica M3 body to



Leica M9 designed by Walter de Silva of VW



Walter de Silva of Volkswagen designing Leica M9



Giorgetto Giugiaro with Nikon F3. He added the iconic red line on camera's grip, and designed its motor drive. With its motor drive, the F3 is a well handled camera. Many cameras with their motor drive tip over when adding any lens longer than its normal lens. Not the F3.



Jony Ive, and Marc Newson, co designers of Leica M



Leica M (2013) by Jony Ive / Marc Newson was developed for an Aids fundraising, sold for \$1.8 M.

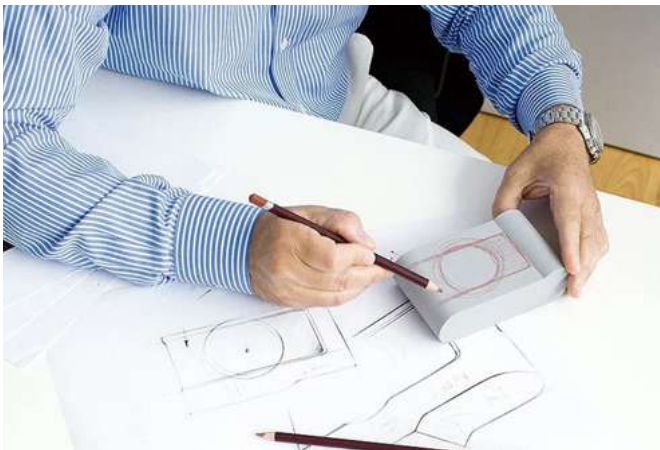
get sort of flat-top Focaflex design. Earlier camera designs were limited to internal mechanics of the camera. But today, it can be arranged in any shape, and from. In this design, instead of traditional leatherette wrap, a laser-machined anodized aluminum body is incorporated featuring over 21,000 microscopic perforated hemispheres for a unique textured mesh. Critiques criticize it as an uncomfortable, slippery departure from classic Leica ergonomics. There is a consensus on Reddit that the flush, recessed controls sacrifice practical shooting functionality for pure aesthetics.



Canon T90 was a bio design with curved corners



Luigi Colani, naturalistic visionary, designer of Canon T90



Walter DeSilva designing Leica M9: He kept the original identity of Leica while giving it a modern-age bright-line viewfinder. He also centered the Leica logo on the camera body. Like every old school designer, Silva designs with pencil and paper.



From 1927 Walter Teague made camera designs for Kodak, later also for Polaroid. Thus he influenced camera design of the most popular American camera makers. For many of these cameras he also designed the sales package.



Nikon F3 had originally a black body. The exterior of the integrated camera body and motor drive MD-4 was designed by Giorgetto Giugiaro. The novel design aiming at a simple form with a concave section on the front of the body for gripping and the impressive red vertical line exerted a large influence on subsequent camera designs.

When you study the designs of other opto-mechanical products like microscopes, and telescopes, you'll see this strong influence too. The Celestron design (covered in Optomex 31), and many microscopes in the market today, you'd see their inner optics hasn't changed much, but their body shell has changed drastically. American Optical (AO) microscopes, spectrosopes, etc. were so beautifully engineered back then. Today, manufactures have learned to emphasize their core design elements to establish their branding.



Nikon F3 was an all black body until Giorgetto Giugiaro added a vertical line next to its grip!



Ever wondered why some designs just feel right? Meet Dieter Rams, the industrial designer behind the philosophy 'less, but better'. See an entire article on him in Optomex 8. His 10 rules of design are covered in Optomex



Sixten Sasson was given the task of Hasselblad 1600F body design, see the Hasselblad design in Optomex 10, and 11

I couldn't say much about the Nikon microscope design till recently they introduced an interesting look to their line of inverted microscopes. Olympus designer Yoshihisa Maitani, whom Japan's auto industry offered him a job, he turned it down. Instead, he contributed enormously to camera, and Microscope designs. Leica and Zeiss both had traditional curved contours but they switched to cubical form in 1970's. Leica has now gone back to the curved concept while Zeiss added triangular shapes to their Axio line since mid 80's. The wide availability of 3D printer has given the opportunity to designers from all walks of life to contribute to the art. As the creator of Optoform line, and founder of OMiD museum, as well as this design magazine, I hope to have given the youth the tools to participate in this journey.



Olympus BH-2 has Y-shaped design



Nikon angled Semi Cubic Design



Nikon Full Cubic Design



Leica DMR followed the cubic/angled contour design officially released in 2005.



Leica DM750's (2008) rear view shows its curved body design concept.



Leica tiltable Finder is a close collaboration of inner optics, and outer body design.



Zeiss utilized the curved design in this 1955 model, covered in issue 17 of Optomex



Zeiss adopted the triangular design since their Axio line (1986), covered in Optomex 30



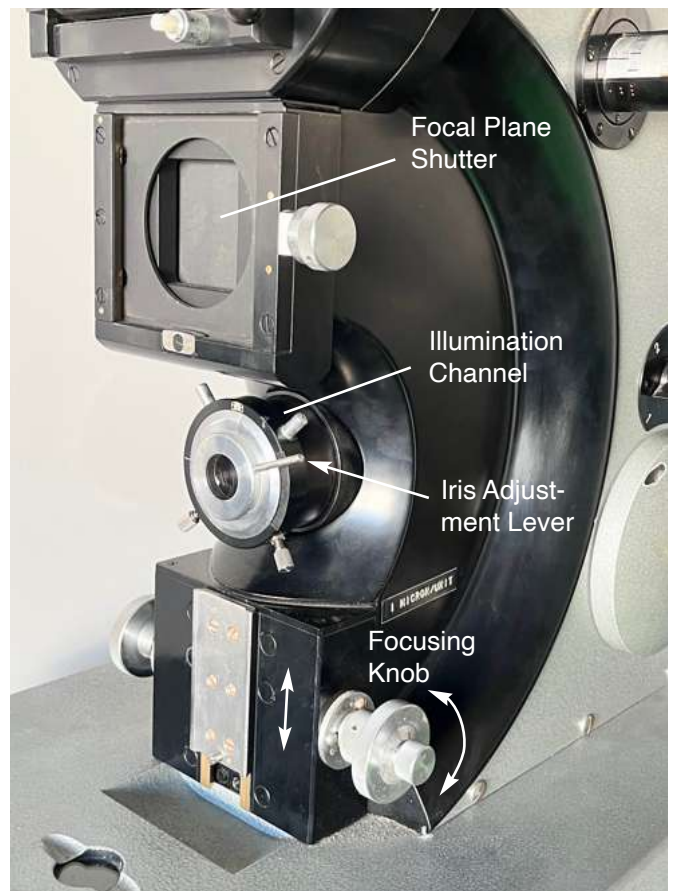
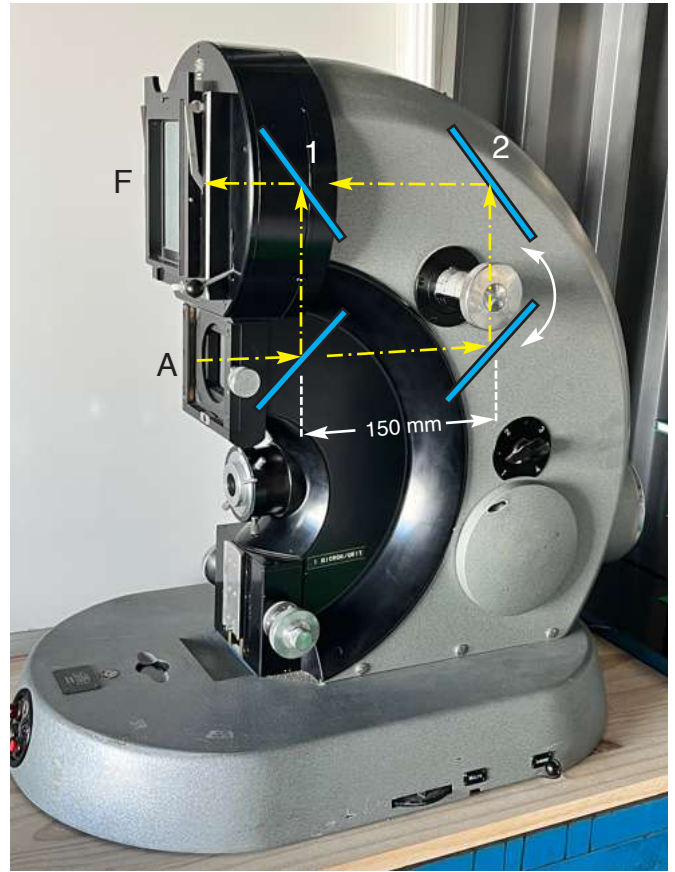
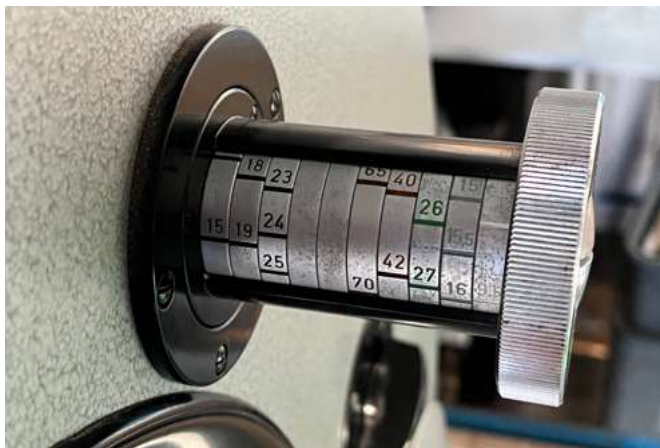
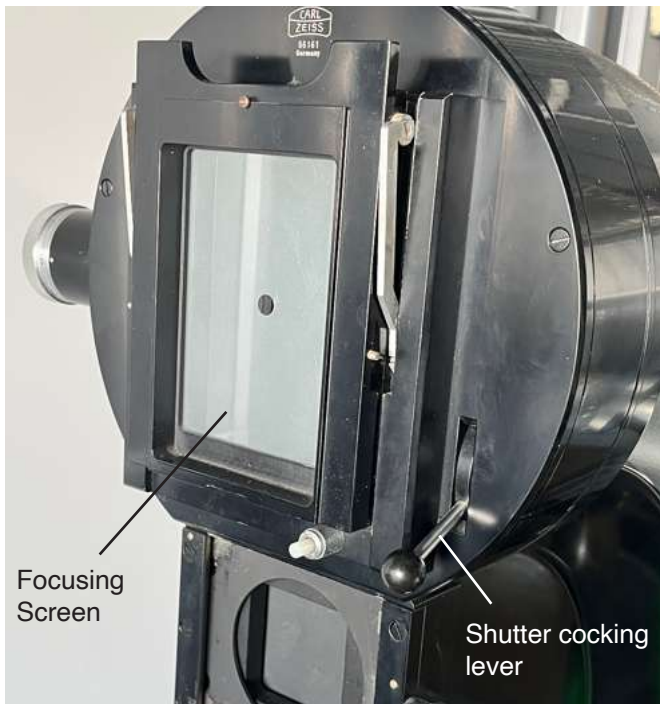
Zeiss Ultraphot II (1956) is covered in this issue of Optomex (next).

Carl Zeiss Ultraphot II

By Ali Afshari

If you have ever seen this huge looking Volkswagen Bug microscope design, and wondered what it is, it's a fantastic micro-photographic instrument made by Zeiss in 1950's. Back in those days, the most high-resolution images were captured on 4x5" negatives or Polaroid, and this was a zoom-like instrument to cover that format.

The way it works is through internal folded optics: A magnification change knob on top of the microscope (right) translates two large mirrors via a rack and pinion design. The optical path-length between the focal plane shutter A to Focal plane F varies drastically as the mirror pair moves from position 1 to 2 (right). This produces a nearly 1.7:1 zoom at the film plane without image degradation associated with zoom optics. The housing is entirely made of Aluminum weighing 100 lbs. when fully equipped.

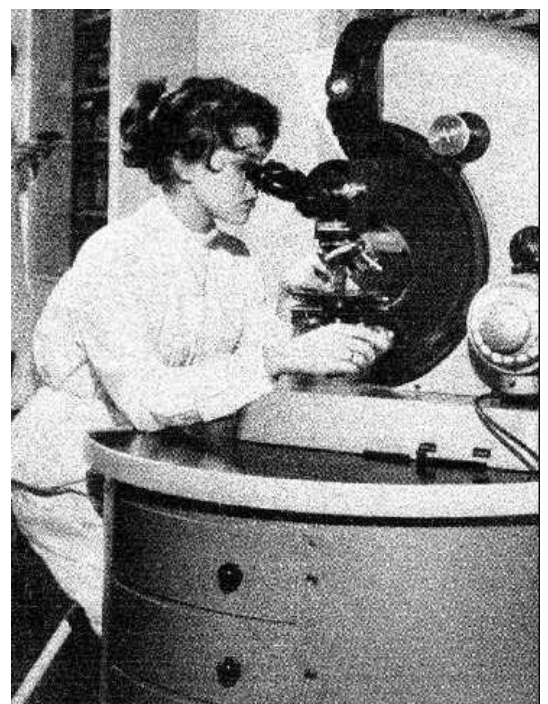
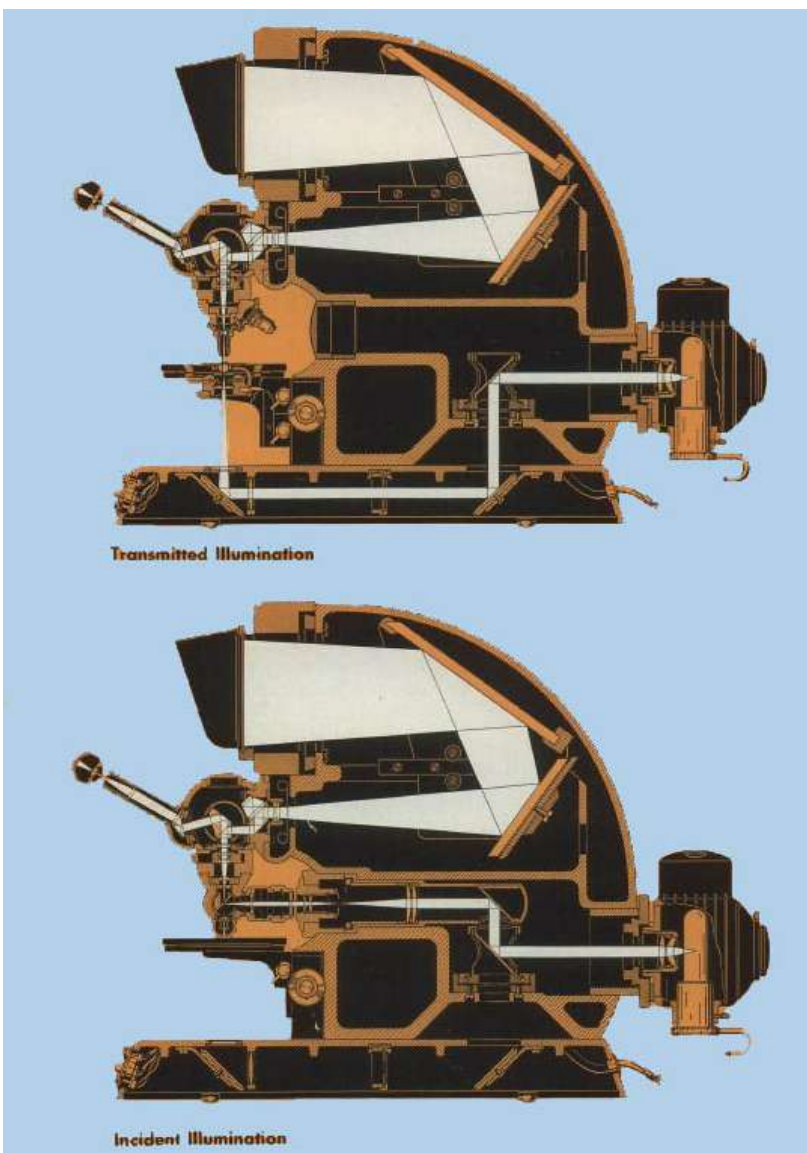


The magnification knob (left) has a 50 mm pinion gear that puts in motion a rack gear to translate the folded mirror pair back and forth. The magnification scale corresponds to various microscope objectives.



Just some of the attachments for the Zeiss Ultraphot II are shown above. Missing are various focusing stages/ sample platforms, 35 mm film attachment, and various accessories that this microscope shares with other microscopes of its era.

Left, transmission versus incident illumination path is shown in an illustration in Zeiss catalog. Below, laboratory table made specific for Ultraphot II provided ergonomic use of the microscope which would be otherwise a very uncomfortable giant machine to use.





Two views of Ultraphot II with 35 mm film cartridge attached in place of the 4x5 film holder. This one-eyed instrument reminds me of the monster living in a cave in the movie: "Odyssey". The dedicated stand that Zeiss developed for this microscope, and it's cleverly designed drawers looks like a machinist's work bench. Right, the magnification change as the result of mirror shift is nearly 1.7X.

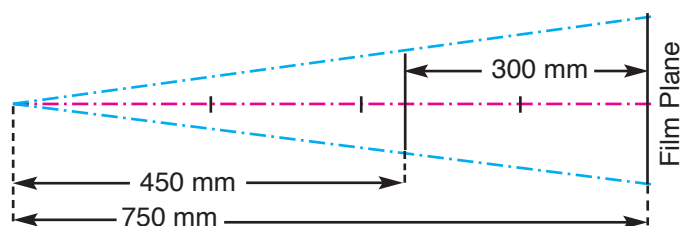
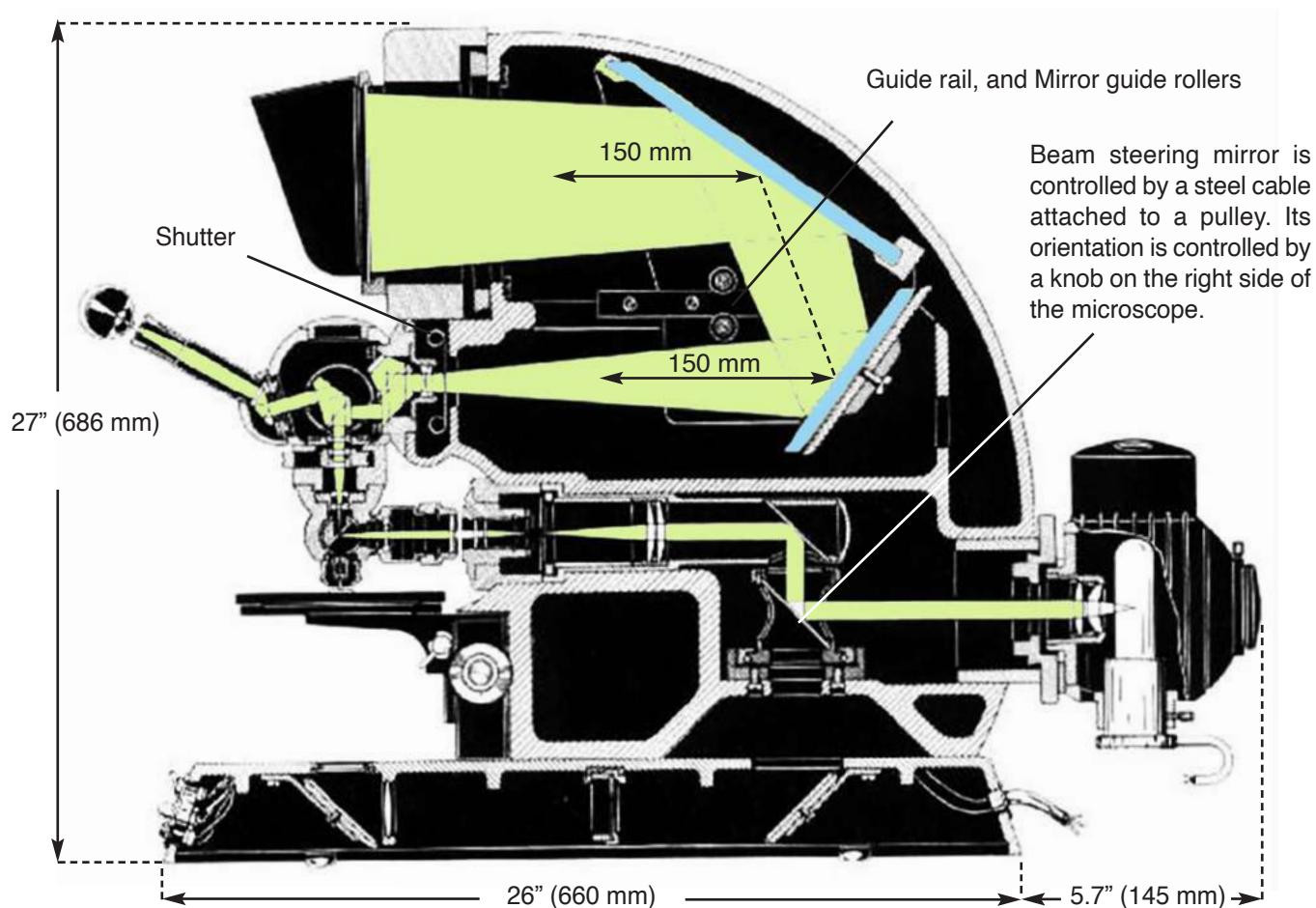
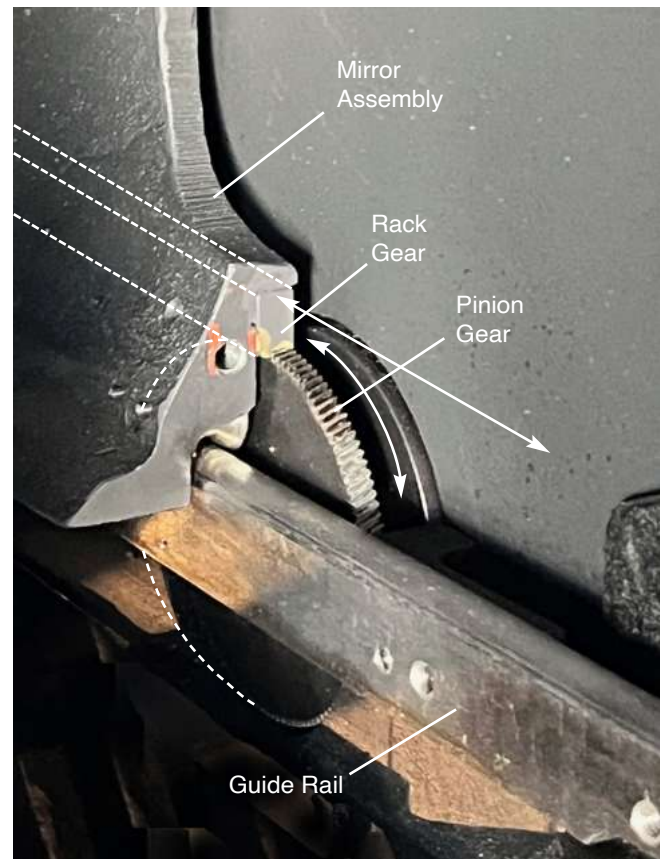
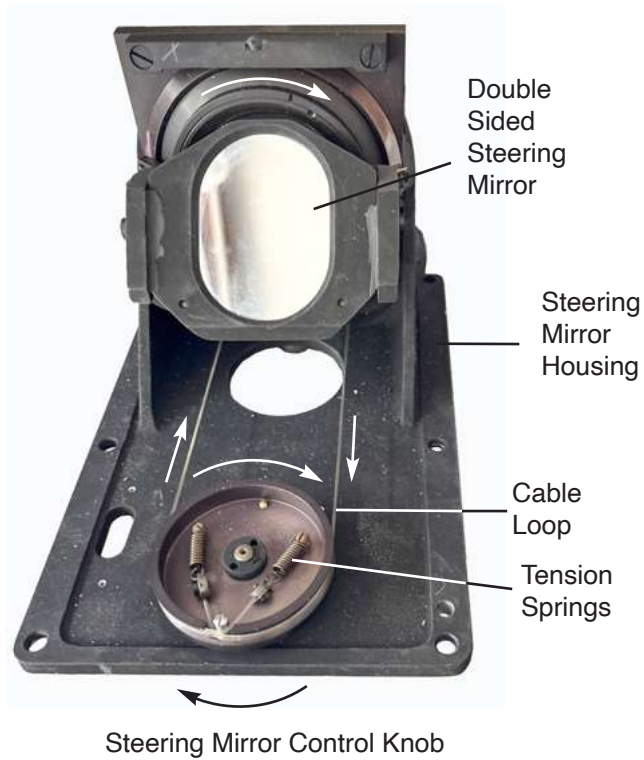


Image enlargement via 150 mm change in optical Path length between the projection lens, and film plane.

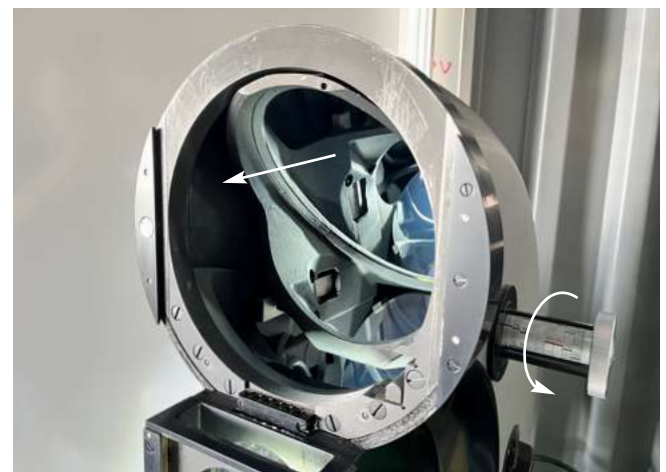


The footprint of Zeiss Ultraphot II is 17" x 26" or 432 x 660 mm, or 17" x 32" including its lamp (above). This makes it a very uncomfortable microscope to be put on top of a standard laboratory table. Zeiss offered a special cabinet for it (above).

Beam Steering and Shutter Mechanism

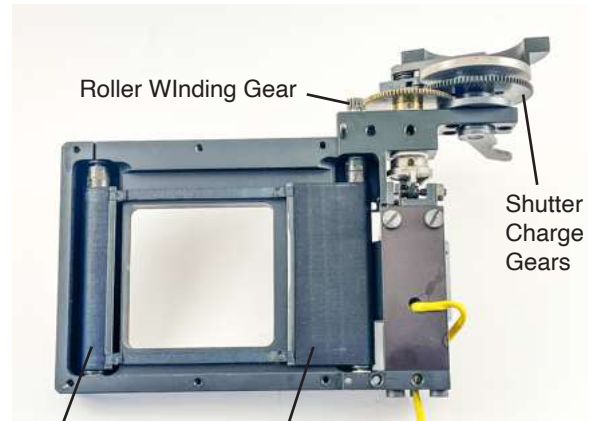
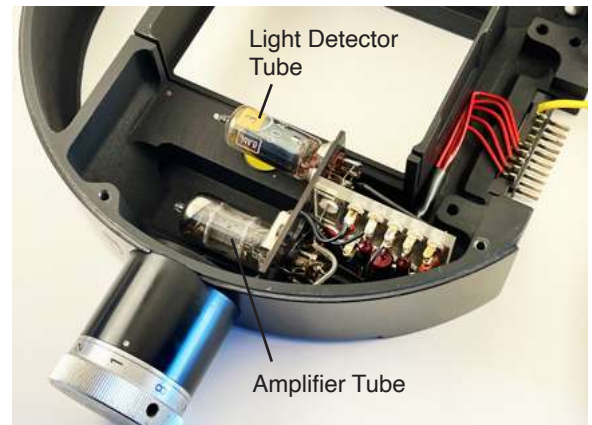
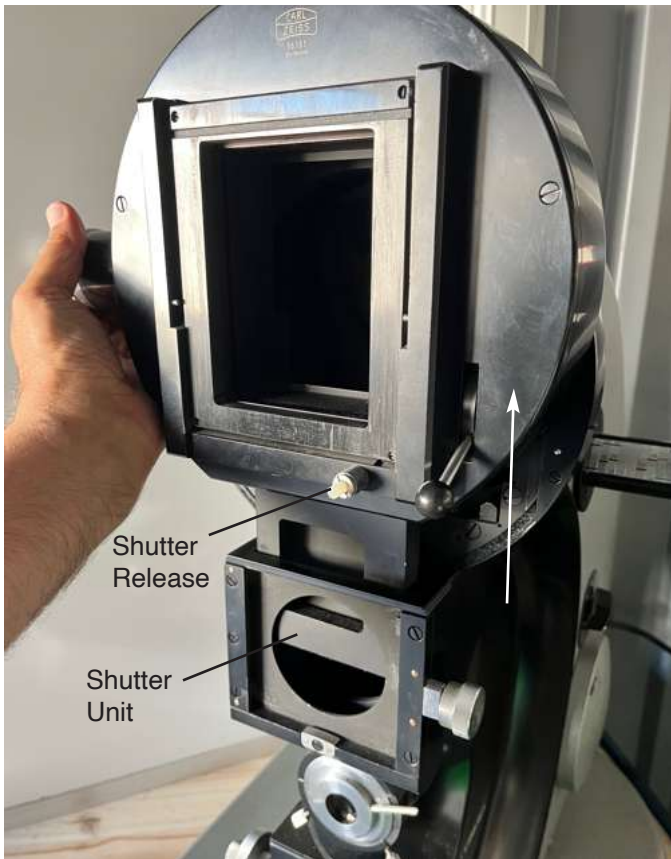


Above, the steering mirror mechanism is shown. Right, the rack and pinion mechanism for shifting the mirror assembly.

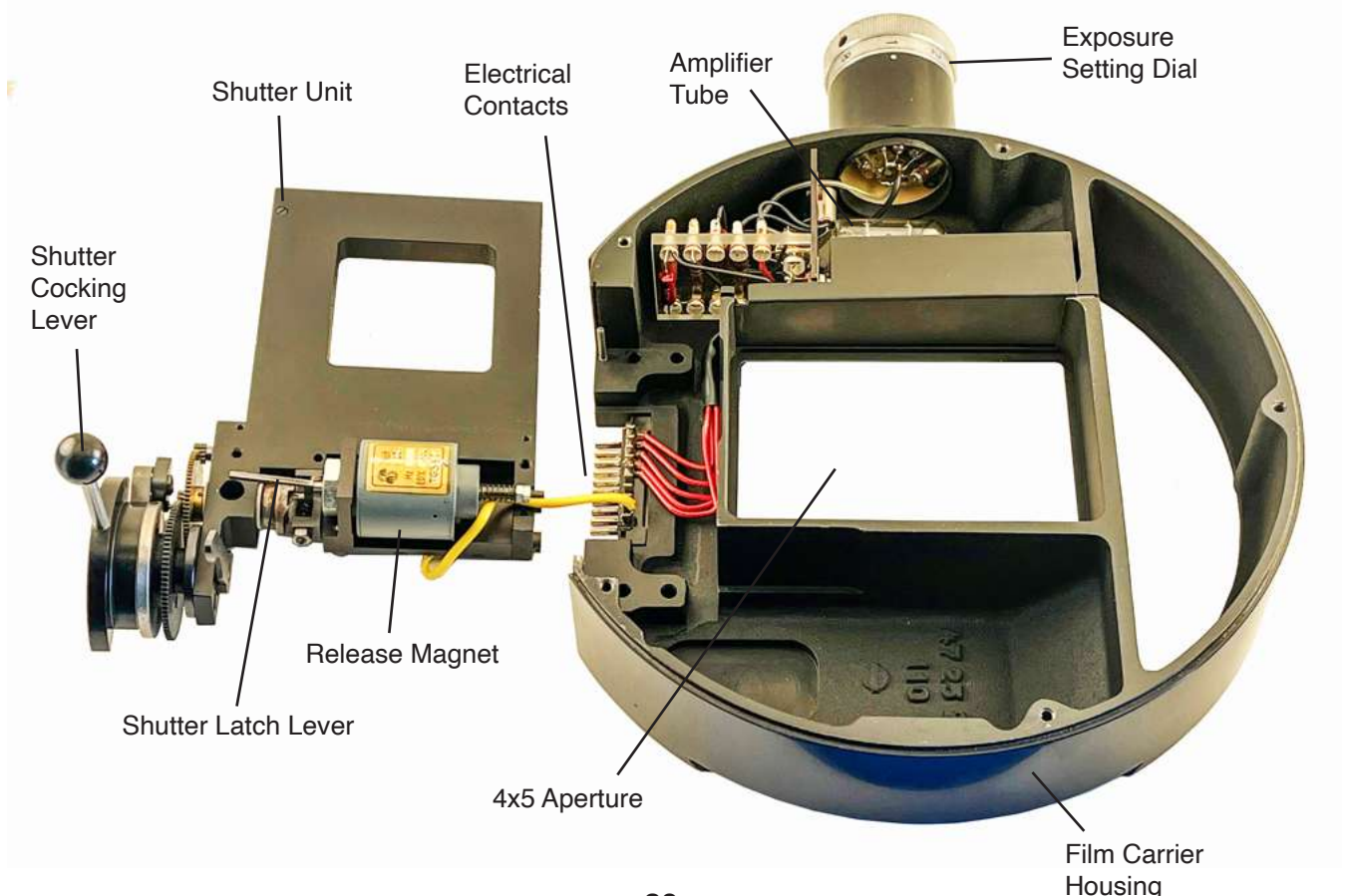


Mirror control knob rotates the steering mirror (shown above) via a closed loop steel belt.

Mirror travel inside the housing is 150 mm via rack and pinion mechanism above, or 300 mm change in OPL.



Above, the entire shutter, and focal plane slides out, and is fully interchangeable. The shutter mechanism (right), and the exposure control circuit (right, above) are shown in detail. The shutter is manually cocked by a large lever, and released via an electromagnet (below).



Designing for Large Scale

Now that you have all the details, we could talk about its broad scheme design. When you are given such a large volume to fill with optomechanics, how would you do it? This is almost the size of a three-drawer cabinet. How Zeiss did it was with presence at every corner of this large-scale instrument.

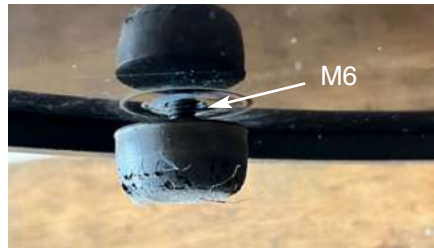
Realistically one could say this has very little empty space. I don't know if you have seen the inside of microfiche machines. There is a small projection optics at the bottom, and the rest is empty space. When you study this instrument, you'll see its well-balanced use of space. If you were the designer, how would you have adjusted an iris diaphragm (right) from 215 mm away?

I was curious to see how they had done it. While we look at these large instruments, we'd tend to ignore the small dials or levers beneath a very large instrument. From the cross-section views (P 26) this instrument has an illumination path from below, and to a field lens, and the iris diaphragm, the designers had to devise long levers to reach them (right).

The diaphragm adjustment knob, for example, is linked to the iris diaphragm via a linking rod (right, below). The controls have their own large-scale detent to prevent damage to the delicate component they are tweaking. The base plate is held by a single screw at its center, and four M6 screws also acting as instrument's rubber legs. I was impressed with the quality of rubber material they used that have lasted 70 years, and still functional. These four rubber feet support the weight of this large-scale microscope.



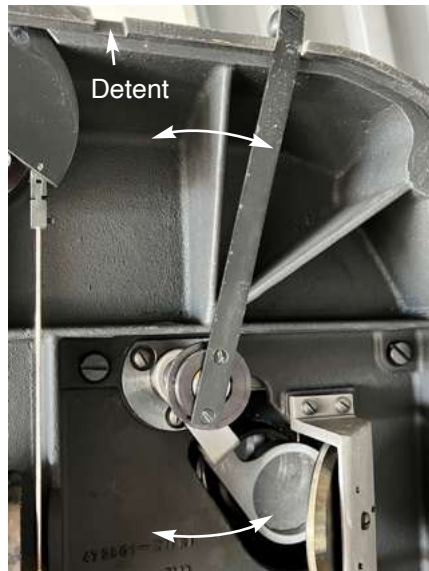
Power supply for shutter, exposure meter and front control panel (below).



What material Zeiss has chosen for its rubberized legs to last so many years.



This dial controls the iris diaphragm via a linking rod (below).

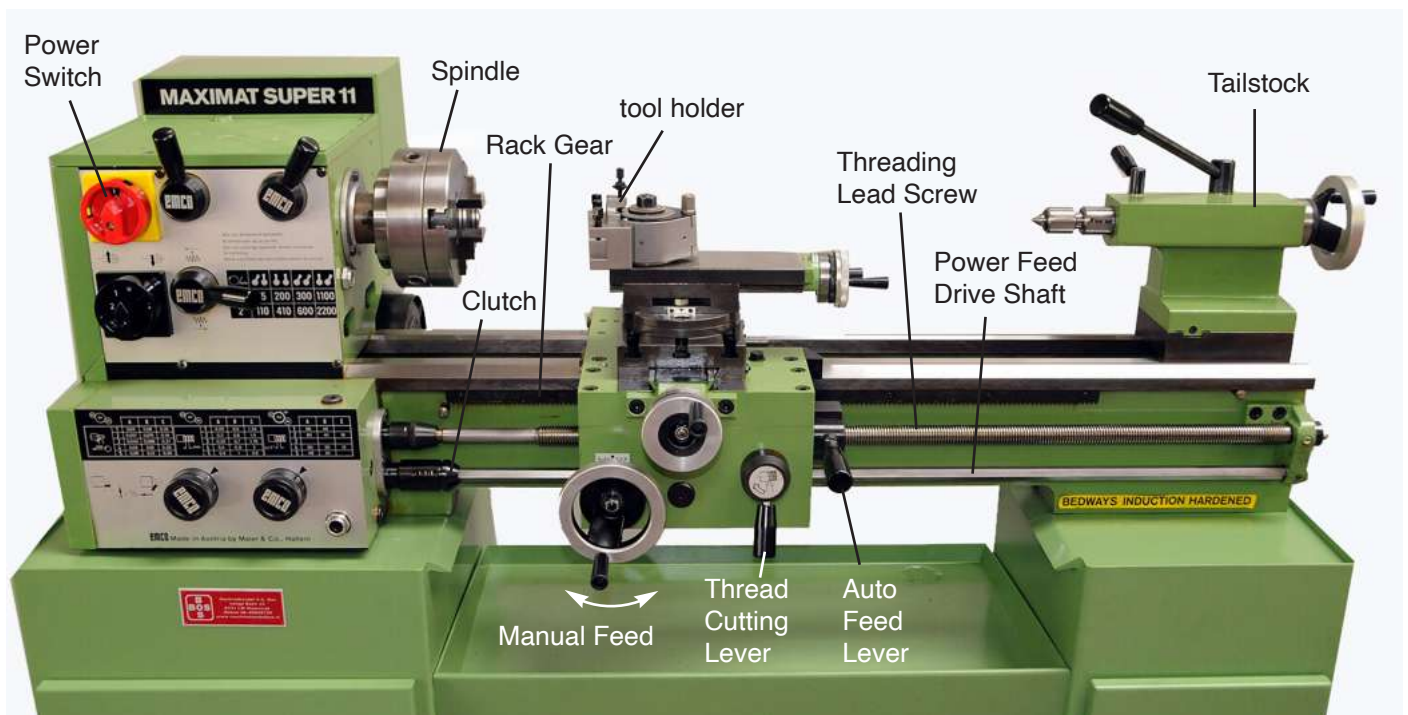
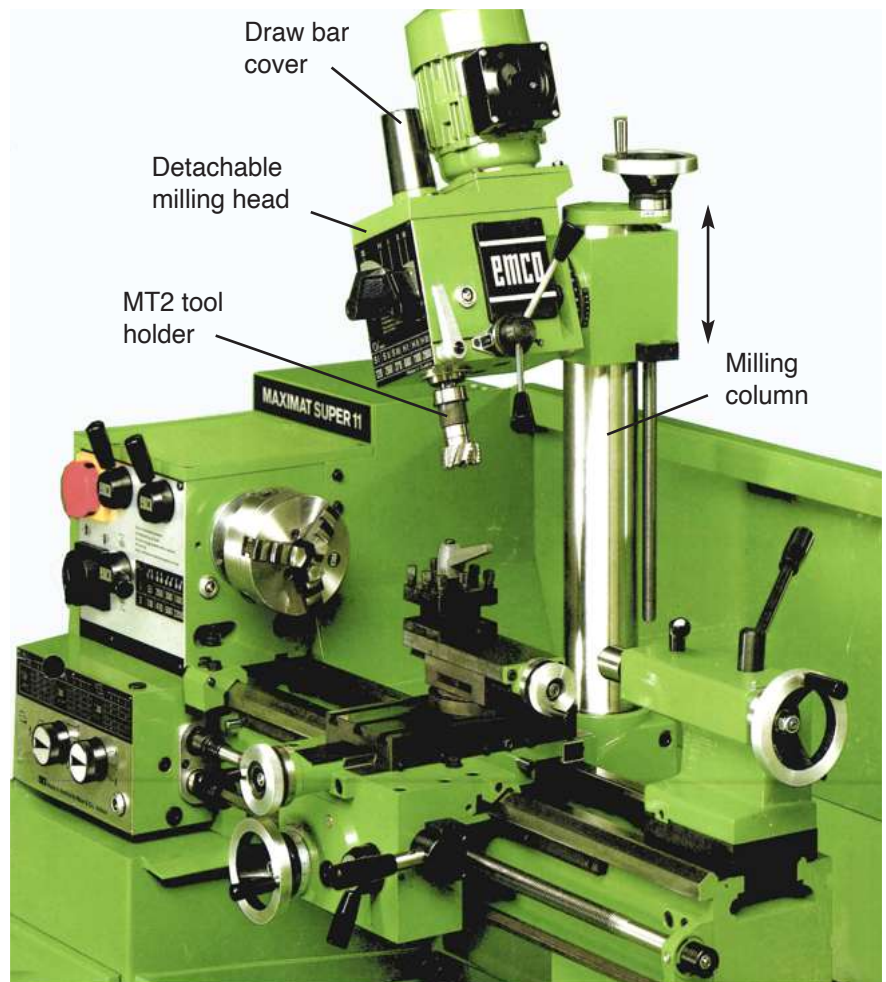


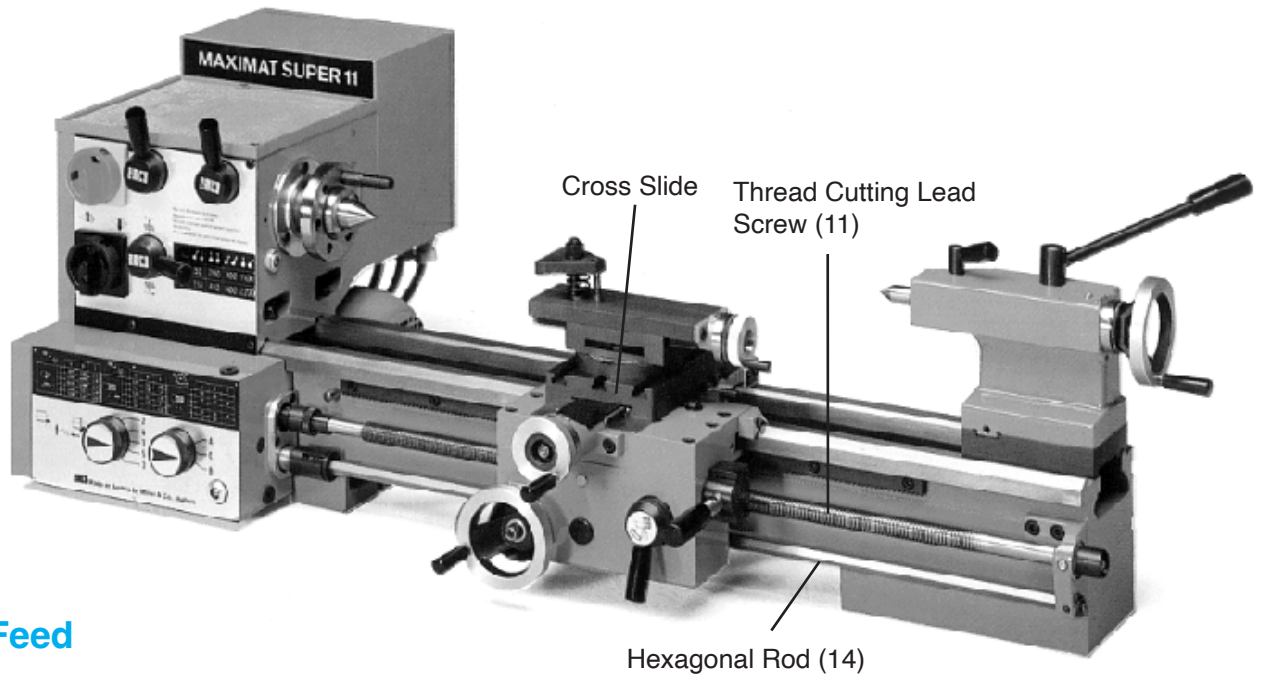
Emco design: The Super 11

The design of Super 11 follows the attractive minimalist European design. It is a cubic design that gives contrast to the cylindrical parts that are being machined. You can't lose a part inside this machine because a round part is so easy to find in a cubic design. You rely on all its top surfaces to lay down your wrenches. You could also visualize all the control knobs and levers because they are round.

The machinist's two hands handle the controls separately. The left hand is responsible to turn on the spindle, and change the spindle speed, and to hold the chuck while something is being held by it. The right hand tightens the chuck using a wrench, and it also spins the tailstock lead screw for e.g. drilling, and controls the position of the cross slide. Most important of all, the right hand is primarily used for parts handling.

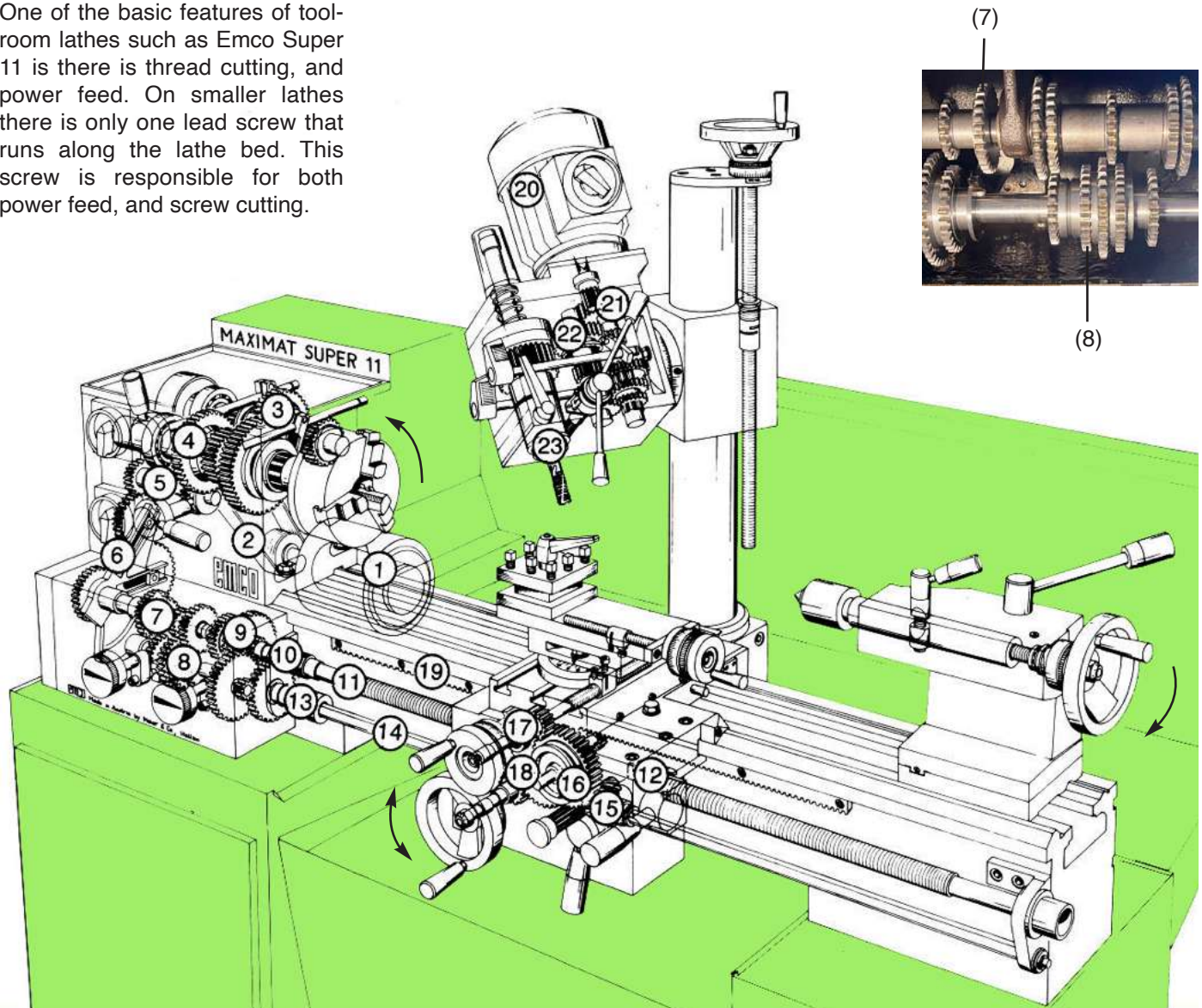
The bed design consists of two V-Guides: One is to guide the cross-slide carrier, and the other guides the tailstock. The lathe bed is induction hardened, and is the most important part of the lathe to be protected. Full sized lathes like Super 11 have two rotating drive shafts: A threaded leadscrew for thread cutting, and a hexagonal shaft for automatic feed (below). The auto feed drive shaft is driven by a clutch, so it could come to a stop while the main spindle still runs. The manual feed crank moves the cross-slide carrier left or right via a rack & pinion scheme (below). These are the basics of toolroom lathe controls. The idea of attaching a milling head behind the lathe bed to turn it into a milling machine is not unique to Emco but they have made extensive use of it in all their machines from the smallest (Unimat 3) to their largest (the Super 11). I am not sure if Maximat V13, which is even bigger than the Super 11 takes the milling head, but why shouldn't it? It's just adding 4 threaded bores on back of lathe bed. Emco has since upgraded these models to 14D, 17D, and 20 D but they have very similar mechanics.



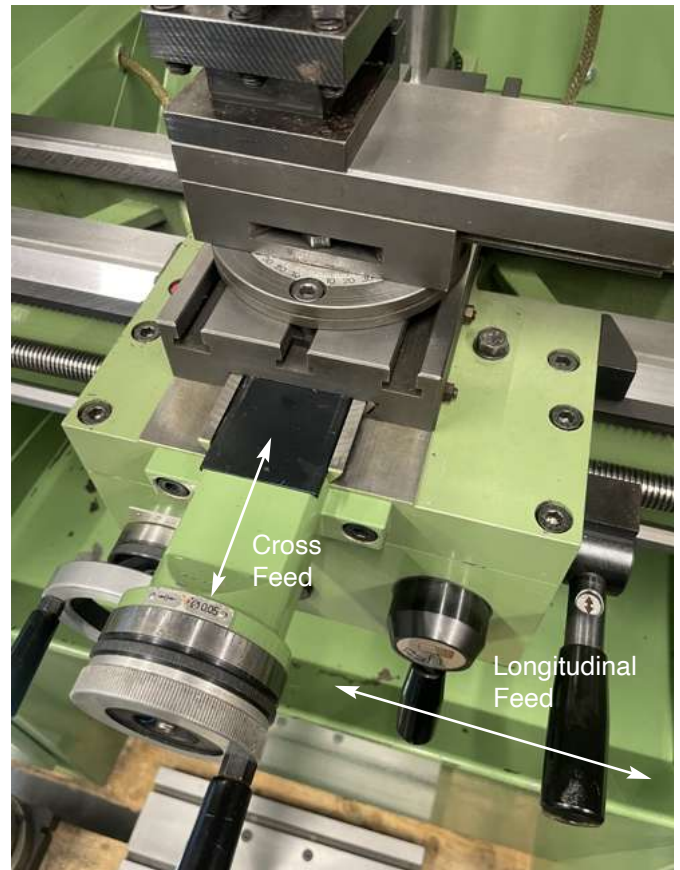


Power Feed

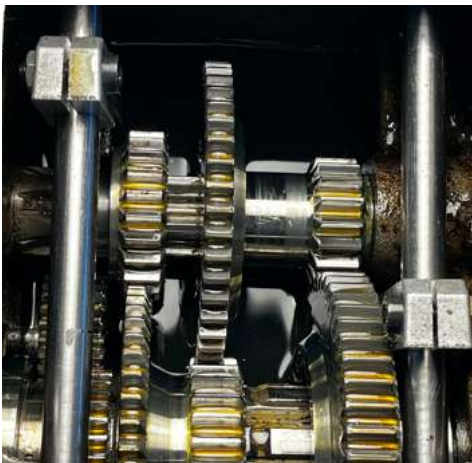
One of the basic features of tool-room lathes such as Emco Super 11 is there is thread cutting, and power feed. On smaller lathes there is only one lead screw that runs along the lathe bed. This screw is responsible for both power feed, and screw cutting.



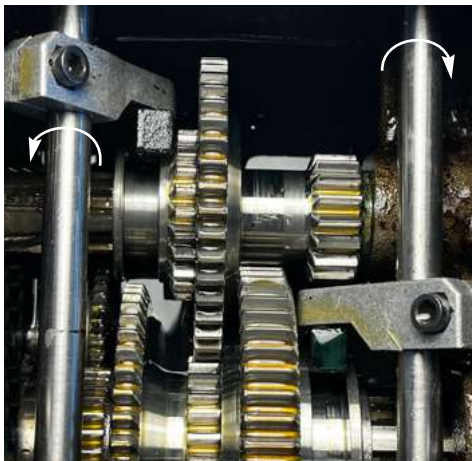
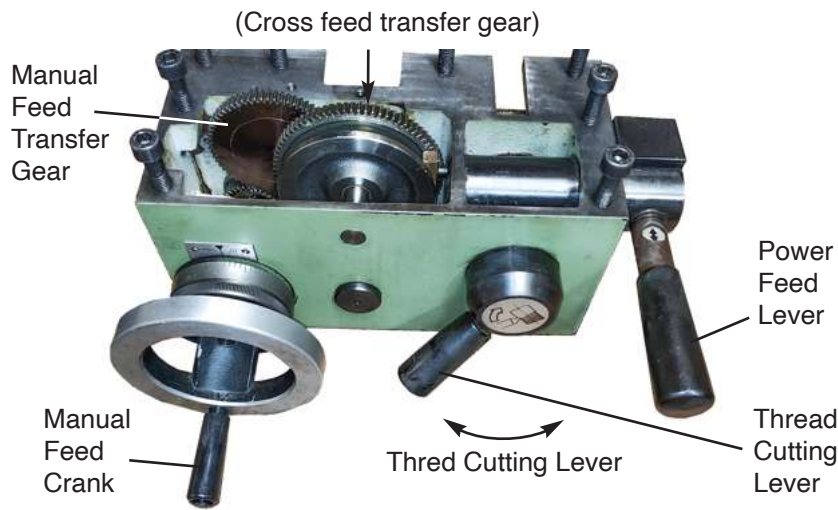
As the cross section drawing of Super 11 illustrates: The power feed is run by a hexagonal rod (14). The hexagonal rod is driven by a separate gear box (8) than the threading feed screw (11). The hexagonal rod can be utilized to perform both longitudinal as well as cross feed via gears (17, 18) on the cross slide, and via control handle (12).



Cutting an Aluminum block with a 5" circular saw with cross feed. Right, two automatic feed controls in Emco Super 11



High gear (above) / low gear (below)



Gear shifting in the main gear box to switch between speeds



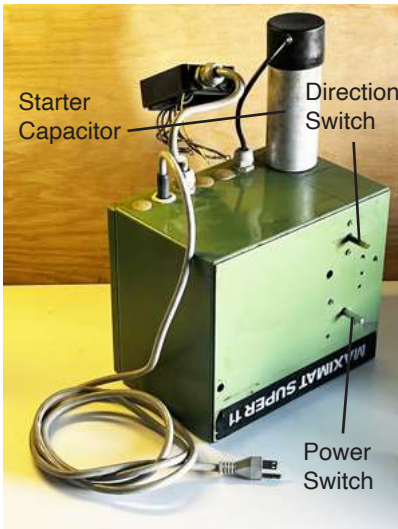
Cross slide split nut to engage/disengage to the lead screw activated by thread cutting lever

Control Console

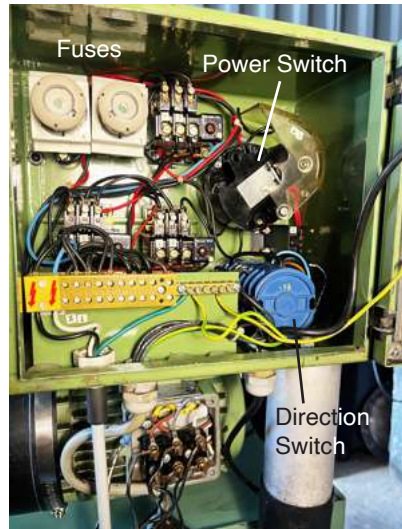
The electrical system in lathes is electromagnetically controlled. In other words, the power switch goes through relays to handle the ampere of the main motor, and to turn it off during a short circuit. There is a spaghetti of wires, and complex switches inside Emco's control box. There are also two large capacitors, one is to start the motor, and the other is to help it run better. The starter capacitor basically delays one of the drive coils in the motor so it would run in a specified direction. Connect that capacitor to the other coil's leads, and the motor would go in the opposite direction. The full schematic of the lathe is shown below, as well as the power switch (right), direction switch (blue), and wiring connection to the motor (far right).



Emco 14D current generation curved design



Control console with starter capacitor



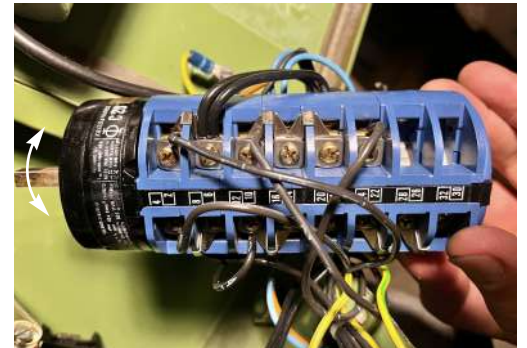
Inside the control console



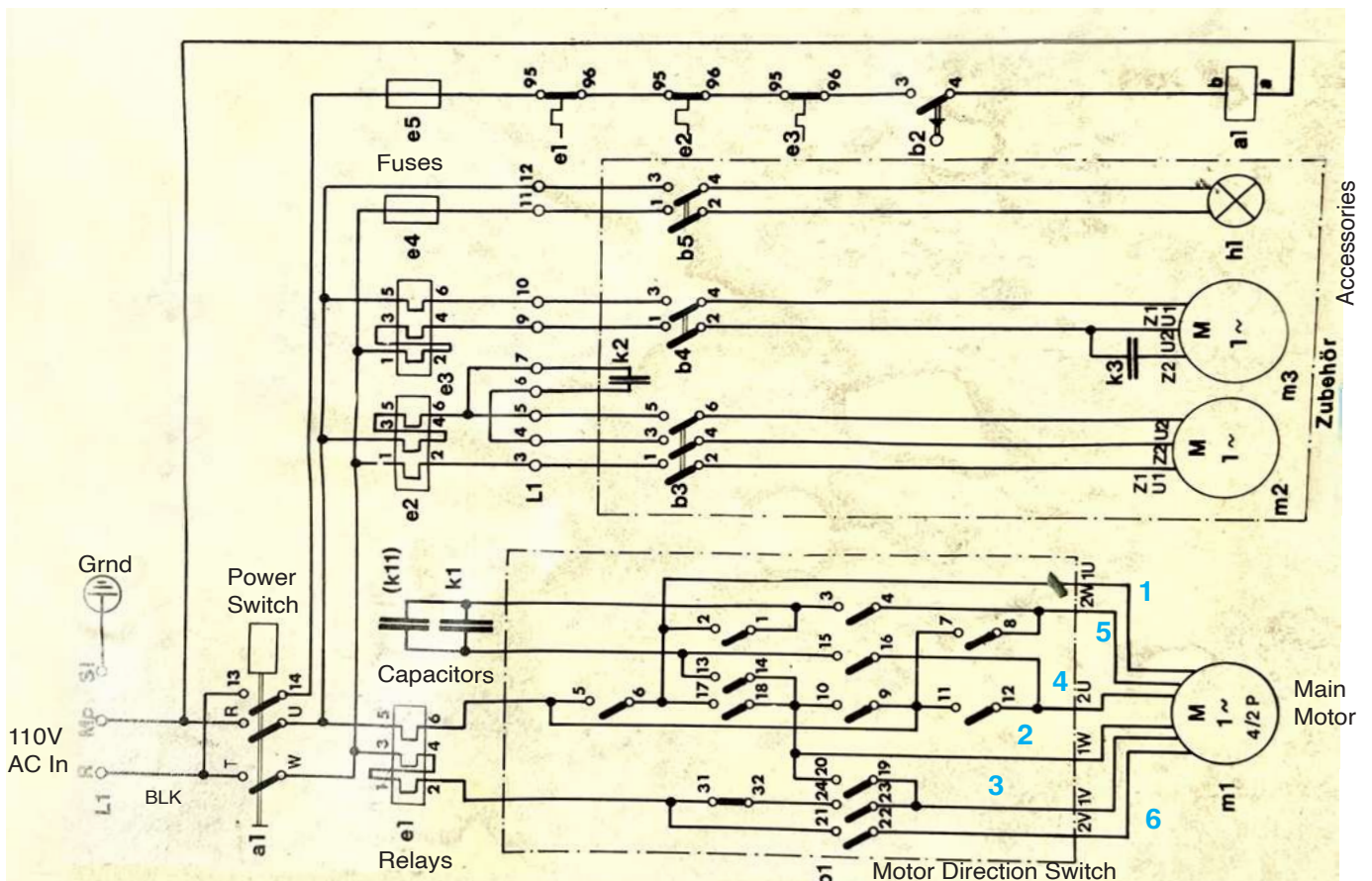
Emco Super 11 main single phase motor



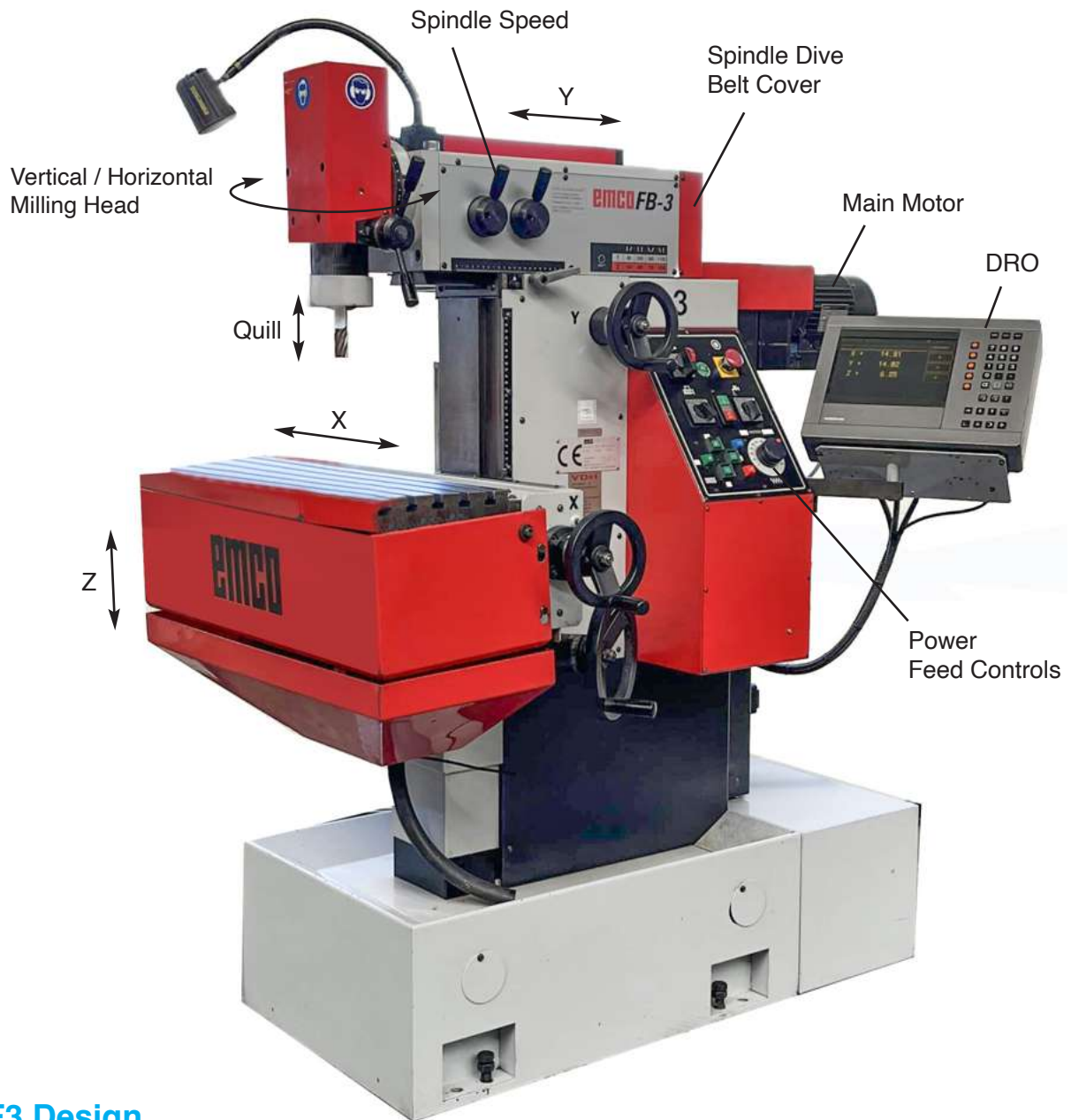
Inside Power Switch



Direction Switch (do not take this apart!)



Electrical Diagram of Emco Super 11

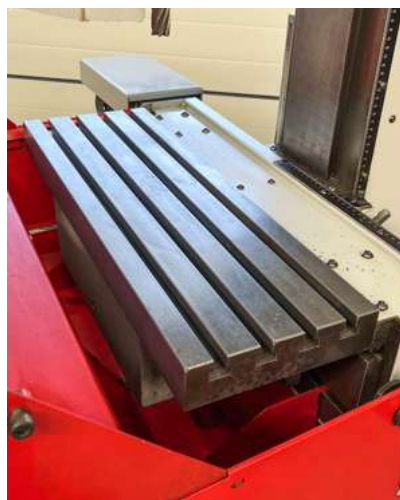


The F3 Design

Emco F3 is one of the most elegant milling machines built in the world. Although it has limited 600x300x350 mm travel, it's one of the most sought-after milling machines for prototyping, and R&D work. This is again a European minimalist cubic design that machines cubic and rectangular parts that are parallel with its contours during machining.



Chip guard



Milling bed

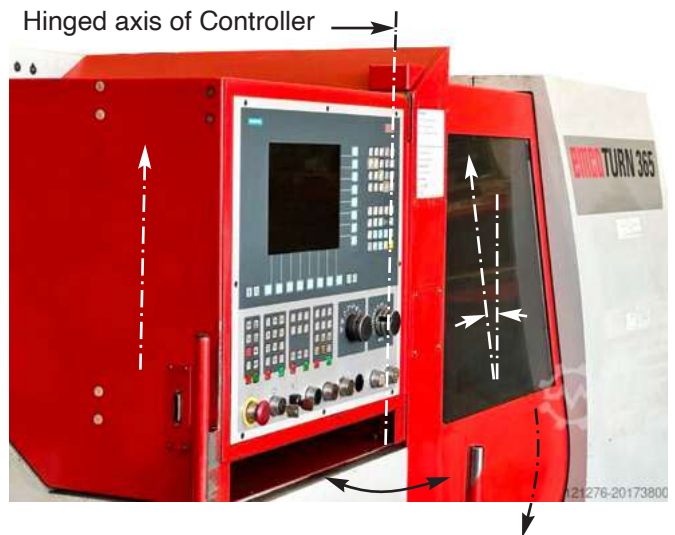


Power feed controls/DRO

Emco's Industrial Design

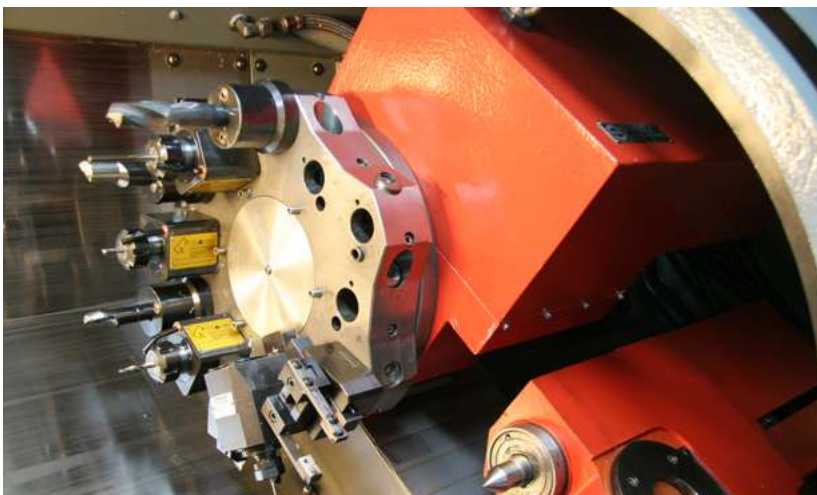
Now we come to the core of European design in this line of CNC machines that are designed by the Austrian tool maker Emco Maier. Like many Emco enthusiasts, I began my journey with a Unimat 3 lathe that I covered in our last issue. This issue is dedicated to their design. Emco isn't big in advertising, but so many educational institutions in US are using Emco machine to train the next generation of CNC programmers. The Emco educational line is not anything less than their full-sized machines. I have been using them both in our manufacturing facility, as well as producing R&D parts in their small machines, and they really look, and feel the same. It's the same quality parts, the same style in their body design. What does really distinguish between Emco and other machines?

Like so many box-like CNC machines, Emco follows the cubic design, but it has curved doors bulging out of the machine. This makes the footprint somewhat less, like the stomach of a fat man leaning against the wall! Considering the spindle to be the center action of the machine, it is positioned much closer to the front door. So, when you'd open the door, you'd seem to be closer to the part than other lathes.



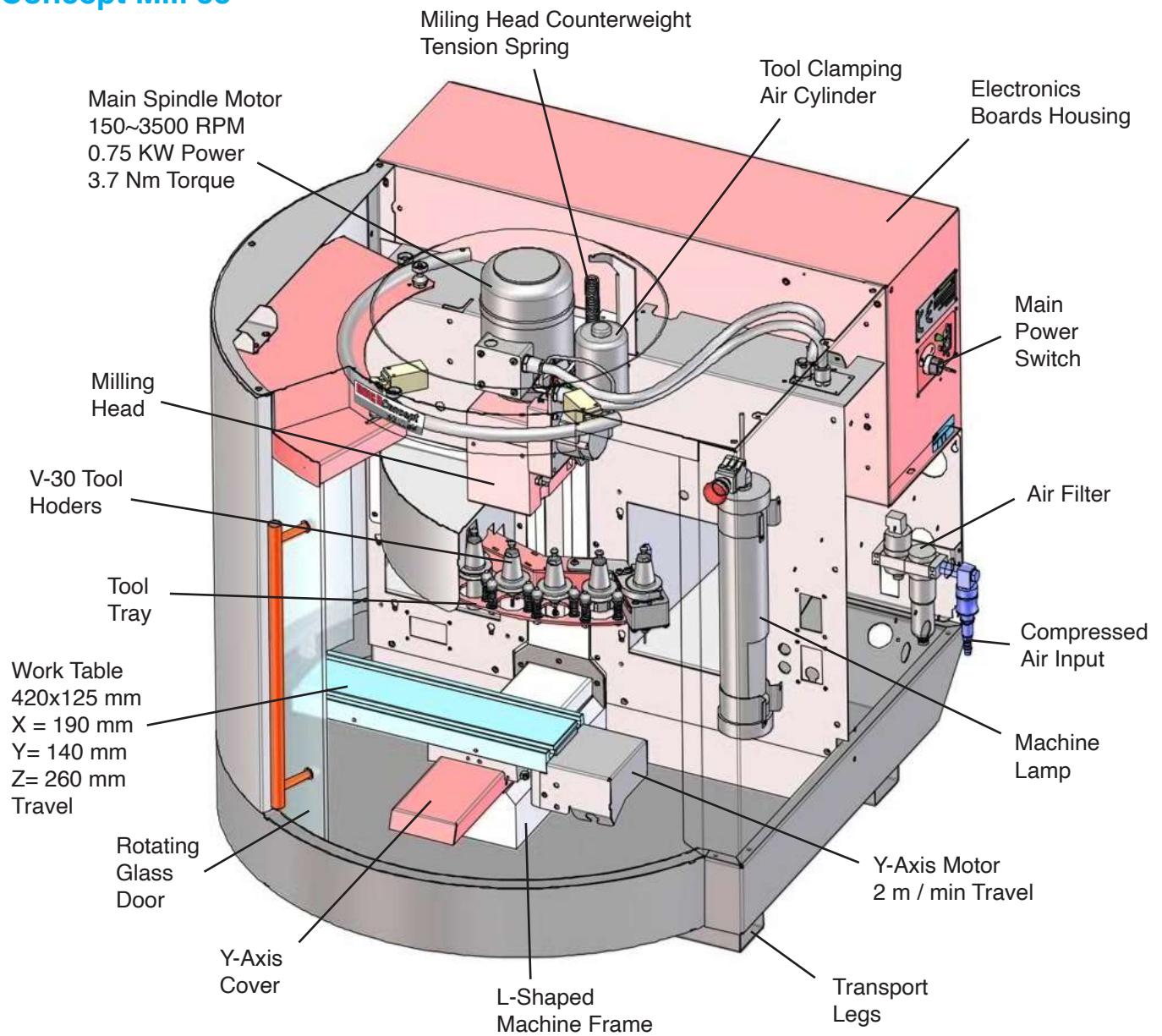
The first Porsche cars were made in Austria. No wonder the world's best looking machines are also made in Austria. The design of these machines is the best in the industry. So much thought has been put in designing the aesthetics of Emco machines.

The mechanics of live tooling machines, such as the older generation Emcoturn 365 (below) we produced Optoform with, and their newer generation E45 (left) is the typical European made precision. I have disassembled, and reassembled these machines to their smallest screw. The quality of their construction is flawless.

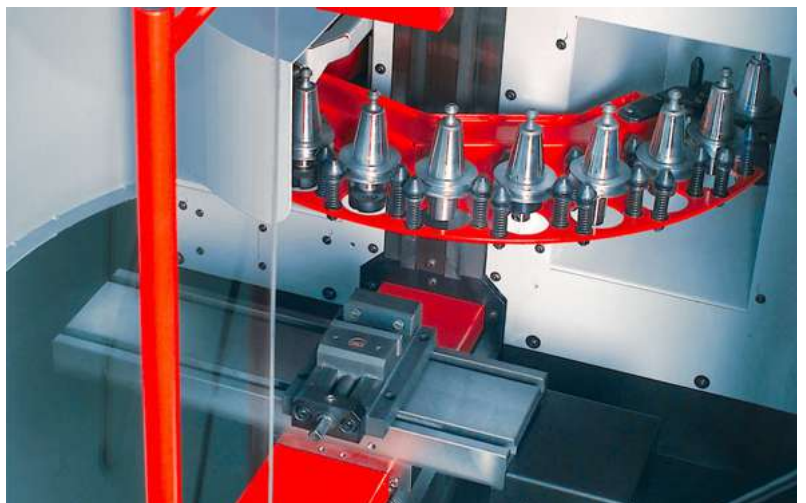
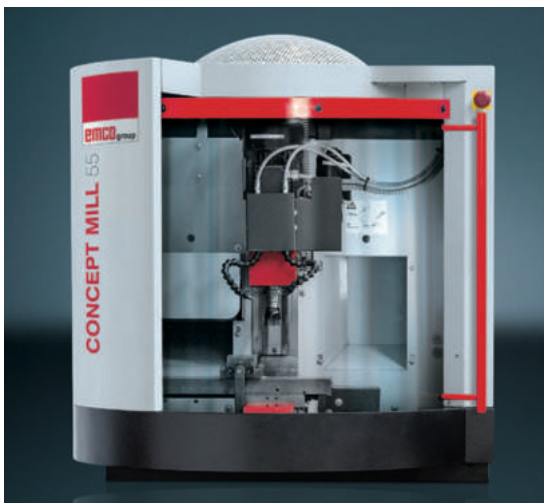


Close up of some of the live tooling we used in manufacturing Optoform. To start with, this machine drilled a 1" bore right into the 2" Aluminum bar with no problems. Then each live tooling had to be repeatable better than 10 microns to machine the rest of the precision bores (right).

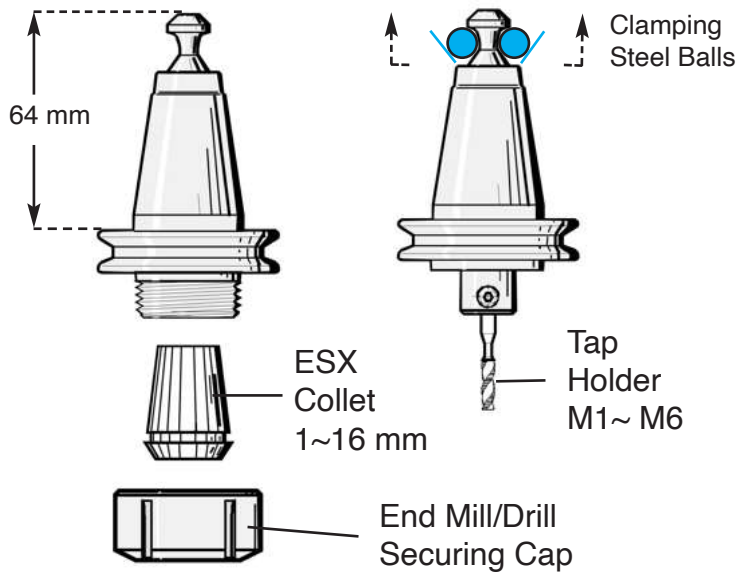
Concept Mill 55



In Concept Mill 55 there is a clever integration of a semi-circular tool tray (above) with the machine's cylindrical body design that all fit inside a compact package. The electronics boards are housed behind the machine without a noisy fan.



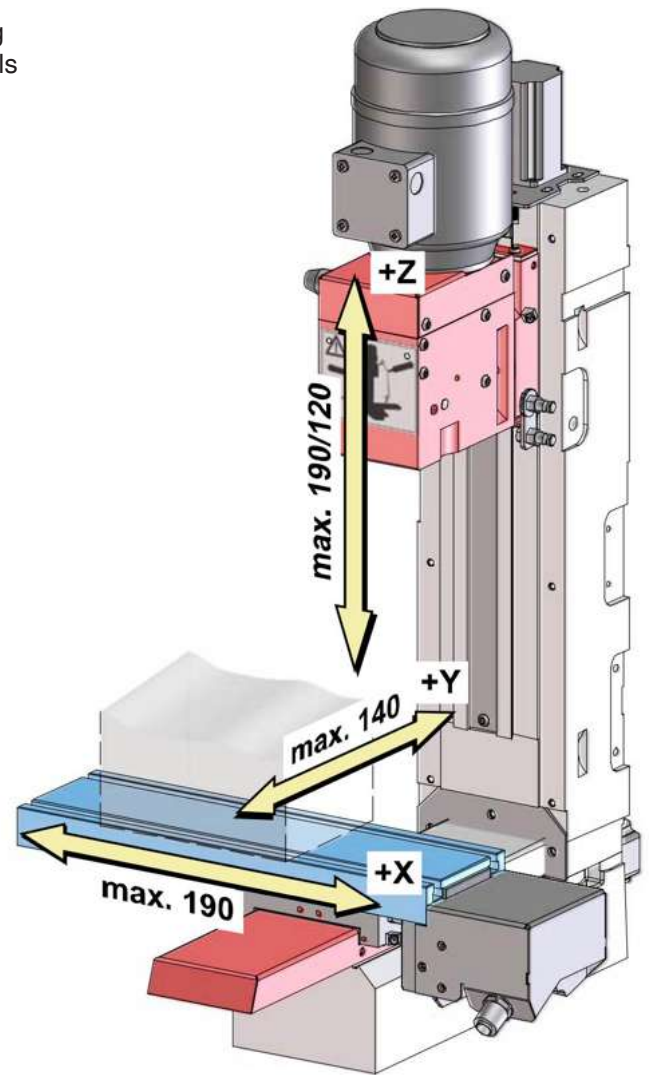
Frontal View of Concept Mill 55 and the 8-station tool changer: It offers full machining cycles to build a complete part.



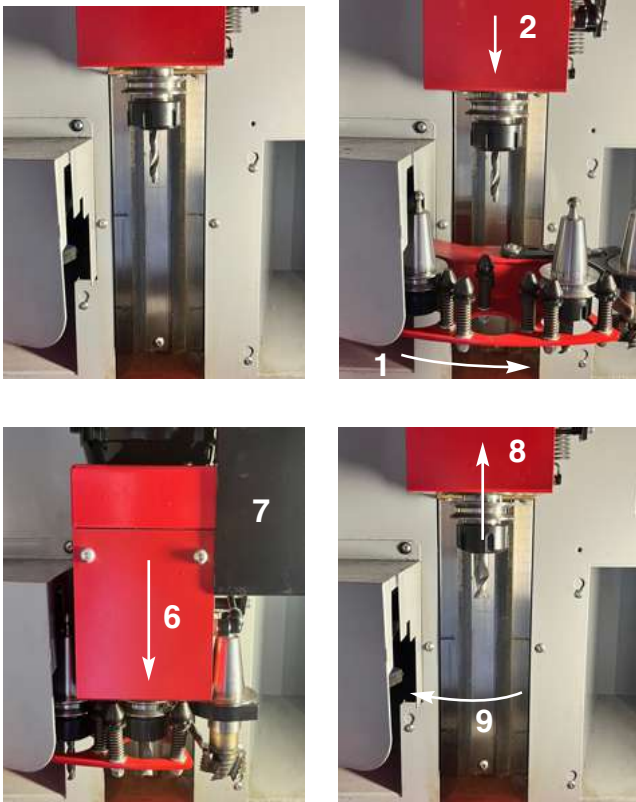
Automatic Tool Changer

The tool change scheme in Concept Mill 55 relies on specially made (short length) V30 tool holders. It was hard for me to imagine this would work reliably until I saw it with my own eyes. There is plenty of travel in the Z axis, because some of it is used up for automatic tool change.

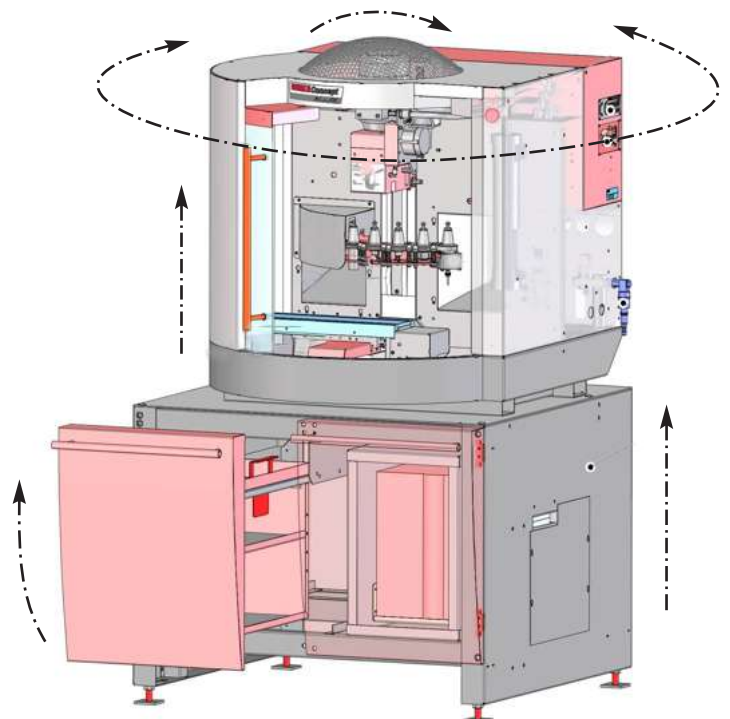
Anyone familiar with CNC design would say bravo to this scheme. There are some limitations of course: Tool length cannot exceed 45 mm (below). After tool exchange, V30 tool holder is clamped in position by three steel balls (above) that fall into the back end of each holder, and pull it up against the V30 conical interface.



L-Shaped diecast of 3-axis stage in Concept Mill 55 is also supported by the sheet metal housing against bending. The upper portion of Z column is only utilized for tool change.



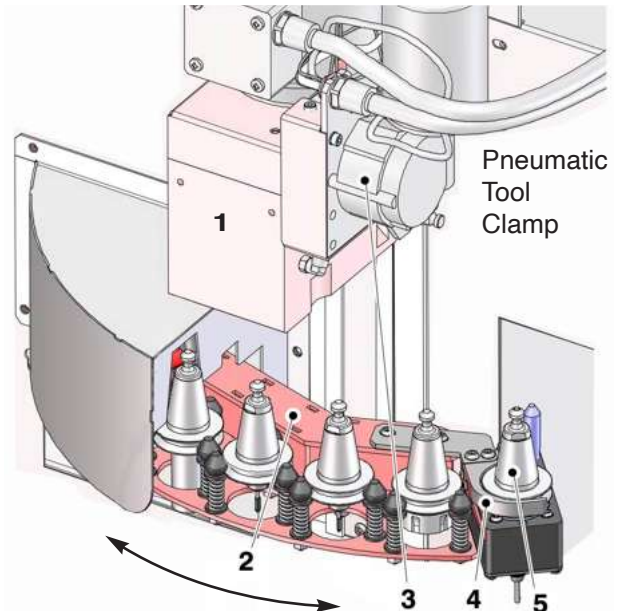
Tool change between T3 (drill) to T2 (end mill). It takes nine operations to complete this tool change



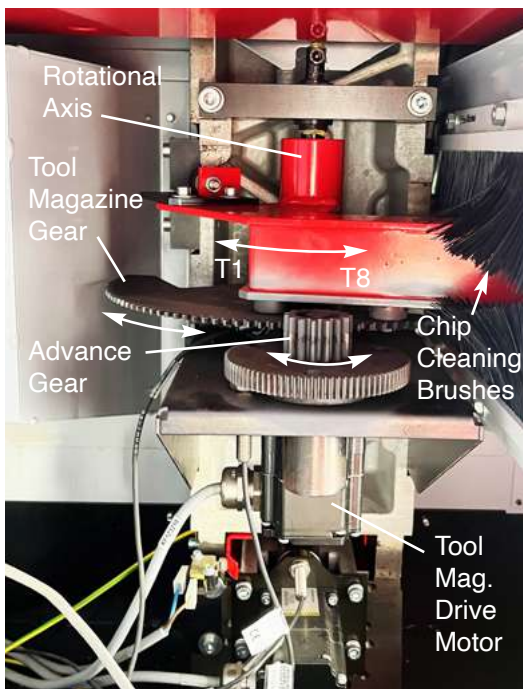
Emco's cabinet obeys their same design philosophy



Front, and rear view of the tools magazine

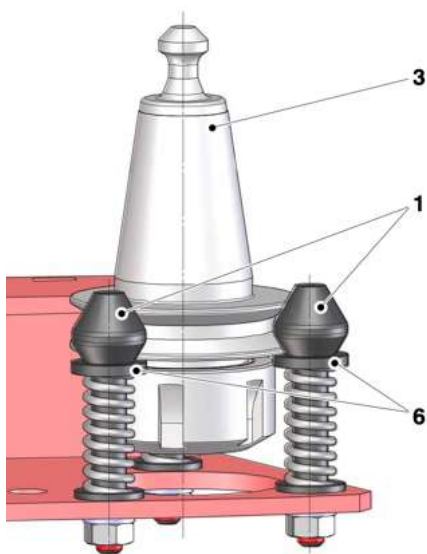


Components of Automatic Tool Changer: 1) Main Spindle, 2) Tools Magazine, 3) Automatic Clamping Device, 4) 40,000 RPM engraving Attachment, 5) Mounting Interface.

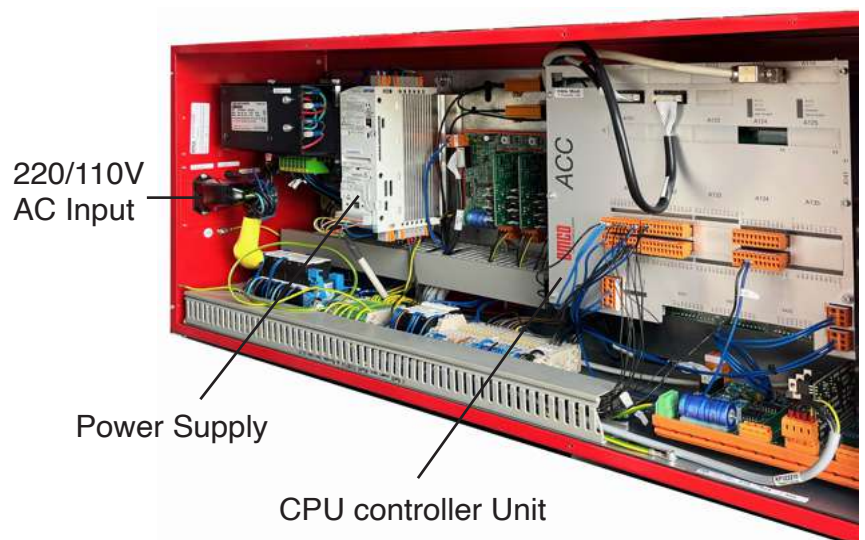


The automatic tool changer in Concept Mill 55 is driven by a stepper motor with several feedback sensors to advance the tools between 1 through 8. When the machine is initialized, the tool magazine rotates by its drive motor (left) for initialization. As the tool magazine rotates, there is a tool sensor that senses which toll slots are full, and which ones are empty. This is necessary so when a tool is to be released, it will not crash on top of another tool.

This simple and practical tool change scheme works flawlessly. It requires a sequential timing between the air operated pneumatic tool clamp 3 (above), tool magazine control motor (left), and the Z axis motor. If there is no air pressure, the tool will be dropped. There is also a special tool slot (5 above) that is reserved for an optional 40K RPM tool that is intended for engraving. It is a belt driven tool.



Close up of tool holding fixture via three conical grabbers (1). V30 tool holders (3) rest on washers (6).



Power Supply

CPU controller Unit

(Rear Electronics Bay)

Teacher then no teacher at all By Ali Afshari

In the last issue I discussed the book: "Trustee from the tool-room", and in this issue, I'd like to talk about "Siddhartha". In Hermann Hesse's Siddhartha, the young Siddhartha tells the Buddha that no one can find salvation through teachings or words. That is why he has to leave the Buddha, and every other teacher, and find his own way. His life's journey teaches him to be his own teacher.

Today I see many people take a snapshot of themselves with someone important and post it on Facebook or Instagram. But that picture adds nothing to their worth as a person. I think we do this because we don't know our own worth. Who are we, really? We are worth more than that, much, much more. But why?

Wayne Dyer once put it this way: if you asked a piece of pie who it was, it would say, "I don't know, but I must be like the pie I was cut from." That pie, Dyer says, is God. So, based on the scriptures, you could claim you come from God. But who is God? God cannot be put into words.

Stella Adler, Marlon Brando's acting teacher, believed that theater and acting are not just entertainment but vital vehicles for expanding the human spirit. In her view, our soul is far bigger than an ordinary life allows us to live. That is how enormous we are. By stepping into extraordinary circumstances, complex characters and vast emotional landscapes, an artist gets to express the deep, hidden parts of the soul that daily routines and social expectations keep locked away. Art lets us live many lifetimes, and many truths, in a single lifespan.

So, back to the teacher: who could really teach us anything? Yes, we go to teachers at school, or ask someone smarter than us for direction. But if we came from God, why can't he be our teacher? That is what the mystics believe. Sufi mystics say that even if we could see God, we would still be searching for him. A well-known Sufi story captures this. A seeker knocks on a teacher's door and asks to come in. "Who are you?" the teacher asks. "It's me," the seeker answers. "Then you can't come in," says the teacher. The seeker goes away to reflect, and returns. This time, when the teacher asks who he is, he replies, "I am nobody." "Now you may enter," says the teacher.

As long as you are "you," you cannot enter the room of spiritual knowledge. You can enter only when you have left your ego behind and realized that you are, in fact, nothing. Kirk Douglas is quoted as saying, "I've learned that you can't learn anything until you're humble." The human teacher we seek is always perishable. Teachers come and go, until we learn to stop looking for one. That is when all of creation becomes our intimate teacher.

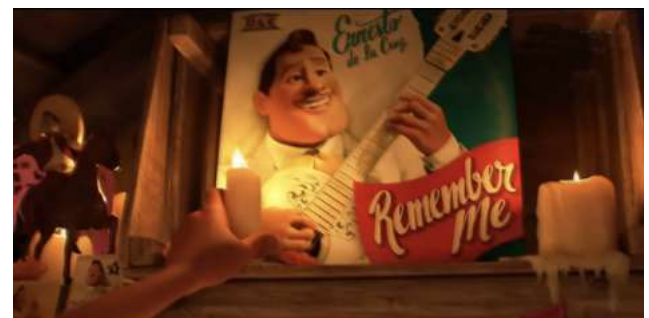
Think of "Candle in the Wind," in which Elton John compares the life of Marilyn Monroe to a candle burning in the wind, a song he later rewrote for Princess Diana. The light of that candle is made of your actions in this world, and it lights your path into the realm of nothingness. That is why you can't live



Miguel was so passionate about playing the guitar



His great great grandfather's picture had been always missing



His favorite song: "Remember me"



Miguel runs to catch up with De La Cruz



The authentic writer of that song wasn't Del La Cruz!

it all while you are here. You have to leave something behind to be remembered by, so that your light keeps burning in the hereafter.

The animated film *Coco* (Pixar, 2017) shows this vividly. In the film, the dead live on only as long as someone remembers them. Miguel is a young boy in a Mexican town whose family has banned music for generations. He idolizes Ernesto de la Cruz, a legendary singer and songwriter whose statue stands in the town square. On the Day of the Dead, Miguel ends up in the Land of the Dead and finally meets his hero, only to find out he is a fraud. De la Cruz stole his famous songs from his partner, Héctor, and poisoned him to do it. Héctor turns out to be Miguel's great-great-grandfather and the true artist. The film teaches children to think for themselves when choosing whom to look up to, instead of simply following the most famous and popular.



His own great great grandfather was the true artist



Siddhartha and Govinda wanting to see life's meaning



Siddhartha in meditation, seeking salvation

A ferryman, Vasudeva, carries him across a river for free and predicts that he will return. In the city, Siddhartha becomes the lover of the courtesan Kamala and a rich merchant. Over the years he sinks into greed, gambling and emptiness. He leaves in disgust and comes back to the river, wanting to die. There he hears the sacred word "Om" within himself and feels reborn. He stays with Vasudeva as a ferryman and learns to listen to the river, which teaches him that time is an illusion.



Siddhartha going to town (Samsara) to attain wealth

Years later, Kamala is bitten by a snake near the river and dies. Before she dies, she tells Siddhartha that the boy with her is his son. The boy resents his father and runs away. Vasudeva helps Siddhartha let him go, just as Siddhartha once left his own father. Listening to the river, Siddhartha finally hears all its voices blend into one, and he understands the unity of all things. Vasudeva, his work done, leaves for the forest.



Siddhartha outgrowing wealth, and bored with luxury life

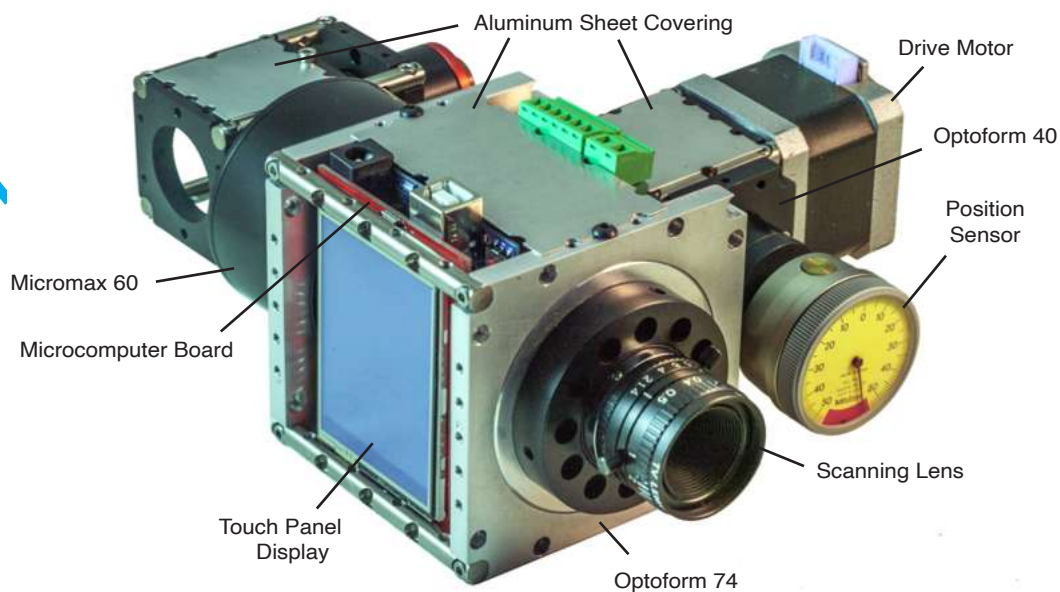
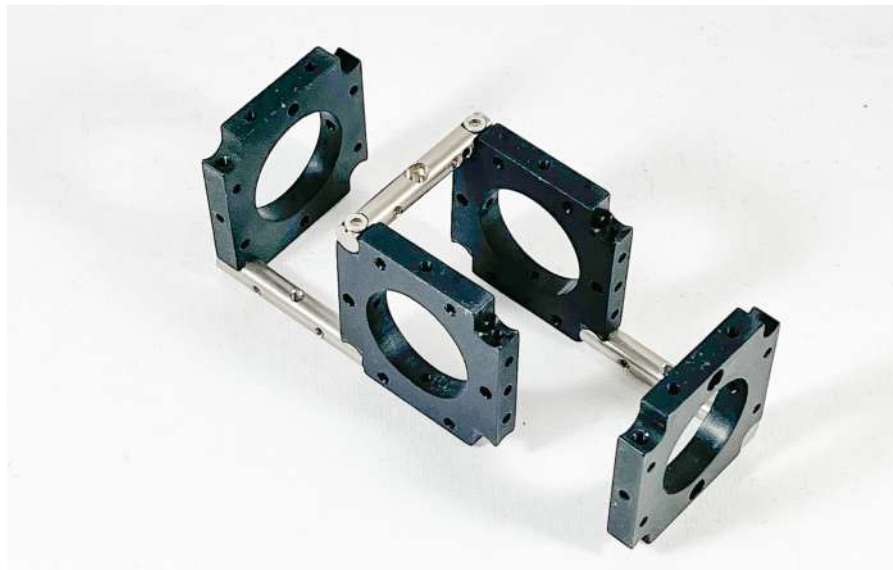
In the end, Govinda, now old and still searching, visits the ferryman. Siddhartha tells him that wisdom cannot be put into words, and asks Govinda to kiss his forehead. When he does, Govinda sees countless lives, deaths and rebirths flow through his friend's face, all united in a serene smile like the Buddha's. Deeply moved, he bows before him.

The friendship between Siddhartha and Govinda really takes place within you. The seeker in you is taught by your own inner self. In *The Power of Now*, Eckhart Tolle speaks of the observer: the awareness that watches all your life experiences flow by, like the river Siddhartha learned to watch. We should not forget that we are the observer, not Siddhartha or Govinda. The observer is God, and you cannot see him until you take on his attributes, just as a piece of iron pulled glowing from the furnace can say, "I am fire."

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