Jon Fauer ASC www.fdtimes.com Spring 2020 Special Report

FILM AND DIGITAL TIMES

Cooke Tour 2020

Les Zellan, Chairman of Cooke Optics, in the master gauge library where thousands of original forms are stored. Cooke Optics has been making lenses since 1886.

The Ins and Outs of Cooke Optics

Outside view of newly expanded facilities of the Cooke Optics factory at Cooke Close, Thurmaston, Leicester UK.

Cooke Optics Factory Tour 2020

Les Zellan, Chairman of Cooke Optics

Les Zellan in the raw glass storeroom at Cooke Optics, Leicester.

Jon Fauer: How has Cooke Optics changed in the past few years?

Les Zellan: We've brought the factory a long way from when you saw it the first time in November 2006 and then again in 2009 and 2013. Over time and several steps, we have developed a very modern facility with state-of-the-art clean rooms and equipment. We work smarter, more efficient and are able to address some of our back-order issues. It will take time as we learn to adapt to the new surroundings, but in the long run it's necessary.

What did you do to improve and expand the factory?

The glass manufacturing area is cleaner and neater and there are many more CNC machines. The assembly area is now twice the size. We added a second floor. All the "dirty" work is done upstairs: the metal work, irises, assembling the outers and inners, cleaning it all, and then sending it downstairs to the clean area. The ground floor is basically one gigantic clean room. Everybody has to put on a bunny suit, hairnet, beard net or mustache net before going inside. Just to come into the factory, you need to get out of your dusty street shoes and wear indoor shoes. To go into the clean room, you change your factory shoes for clean room shoes. There's a strict regimen now to try to keep everything very clean.

What are "inners and outers?"

The "outer" of a Cooke lens is the metal work that you interact with: the outer barrel, the focus gear, the iris gear. The "inner" of the lens is where all the glass is. What we do is build the outer and the inner separately, and then when they are ready, the inner slides into the outer and we lock it all together.

Rhetorical question: why do you and other manufacturers now need a clean room for lens assembly when in the past you did not? Your clean room is on par with the best of the optical manufacturers worldwide.

To minimize dirt and dust that get into a lens. As often as you clean a lens and as hard as you try to keep a speck of dust from getting inside, it still finds a way to get in. Not just us, but everybody. In our case, we used to build lenses in a non-clean area. We'd adjust it (a very iterative process), put the lens together, look at it on the projector, see something that could be better, and then go back and make an adjustment. We'd keep doing this until the lens was acceptable. Then, after all that work, when the lens was good, we would go into a fairly small clean room, take the lens completely apart, degrease it, de-dust it, and then put it back together in a pressurized flow box in that small area.

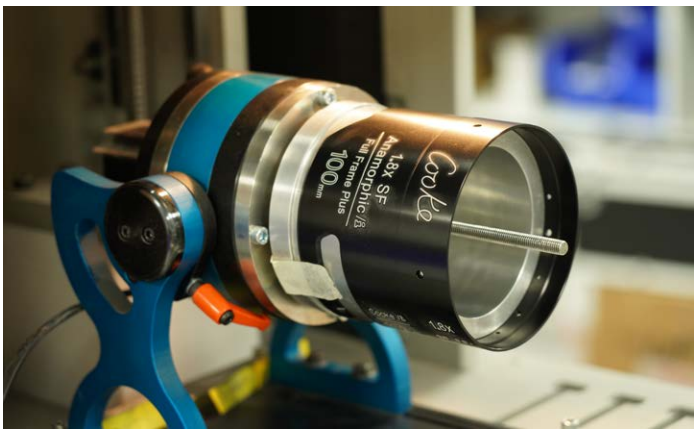
The theory now is to build the lens in a clean environment so when we get it right, we're done. We know that worked pretty well because while we were renovating and expanding the factory, we built a second facility a couple miles away that we used for three years using this new system. Now that we completed renovations, we have moved everybody back here, all under one roof.

On our new second floor, we have expanded the engineering area. As we have more designs and more lenses, we need more engineers and optical designers.

How has the business changed? I assume that's what drove you to do this expansion?

The business has changed ever since Jim Jannard announced the RED One camera in April 2006 and jump-started the new digital era in cinema. Up until then, all the companies—ARRI, Angénieux, Cooke, ZEISS—dealt with the same 200 or 300 main customers. It was very nice, very clubby: basically Denny Clairmont, Otto Nemenz, Joe Dunton, Movietech here in London and the major rental companies in the world. Everybody knew everybody. When the first RED One cameras came a year later, in April 2007, the market expanded exponentially, almost overnight.

"Inners" of a Cooke lens: the optical sub-assembly.



"Outers" of a Cooke Anamorphic/i 1.8x SF-FF+ 100mm barrel.

Cooke Panchro/i Classic S35 series

Cooke Anamorphic/i 2x S35 series

In the film days an ARRI camera package could cost $500,000—a half million dollars—and would not be replaced for more than a decade. Then, suddenly people thought they could make a movie for $20,000 with a RED One. I can't tell you how many people called and said, "I'm getting my RED One tomorrow and can I get a whole set of Cooke lenses tomorrow?"

It was aspirational and a paradigm change.

Jim had a dream. I remember that first announcement at NAB 2006. They were taking orders and you got a piece of metal with a serial number of the future camera on it. A year later, he had a big red tent that was about two-thirds of the way down in the South Hall and there was a quarter mile line of people all the way to the entrance of the RED booth. RED won best new product at the show without having a product yet. It was brilliant. That is when I realized this industry is about ready to be knocked on its ear because we all marketed like it was still 1950. Jim came in and marketed like it was today, and he really took it by storm. He started the digital revolution. And then, of course, everybody followed him. We went from a clubby little business of a few hundred customers to tens of thousands almost overnight.

If the digital revolution had never happened, we'd still be here — ARRI, Cooke, Panavision, Angenieux, ZEISS, Canon, Fujinon. But now, it's us along with what seems to be half your FDTimes sponsors. The lens and equipment business has expanded because the market has expanded and people see opportunities.

We all have benefitted from this rapid acceleration in the market. We've done very well with our Super35 and Full Frame anamorphics. People had asked me since I bought Cooke in 1998 to build anamorphic lenses, and I always resisted.

Until that fateful Cooke dinner in Munich around Cinec where every rental house guest kept topping up your glass of Scotch whisky until you agreed to make anamorphics.

Panavision had that market pretty well sewed up along with, and to a lesser extent, Hawk. If we were going to get into that space, we didn't want to compete with them we wanted to create our own space. Also, the economics of anamorphic at that time was steep: millions of dollars in glass before you even talked about modifying your film cameras and finders for anamorphic desqueeze.

When customers heard the costs, they walked away from the table. Then digital came in. It seemed clear to me from the beginning that digital was too sharp, too pristine as a storytelling format. We knew that because cinematographers were clamoring for vintage Cooke Speed Panchros and Baltars, diffusion filters and anything else they could get their hands on to take the sharp edge off the digital image. Meanwhile, the engineers were trying to put more sharpness in: 2K, 4K, more K.

It seemed to me that digital was crying out for things that would give it the character and personality that film intrinsically had.

Which included random grain, a degree of unsteadiness no matter how good your registration pin was, loss of sharpness through the many generations of processing and printing, not to mention all the different film stocks, labs, processes, and other variables—maybe even the water pumped into the lab.

Seeing the possibility of creating our own space in the digital market, we began work on anamorphic almost as soon as digital started to take a foothold.

And I think you kept that philosophy of more forgiving lenses with additional series.

The Cooke Look by definition is an interesting combination. I hate the word soft, because it's not. Smooth and gentle would be a good description.

The Cooke Look is sort of a magical thing, and it's been consistent with Cooke lenses since the Speed Panchro, going back to the 1920s. It's a warm and round look. I think Ed Lachman likes to call it a roundness to things. It has a nice falloff of focus. And it makes actors look good.

It's a consistent look. After we did the anamorphic lenses, we did the S7/i Full Frame Plus series. Dan Lopez at Otto Nemenz said he really liked the S7 primes because they looked like our S4/i series but were Full Frame instead of Super35. That was the idea.

As I mentioned above, we noticed how people were using vintage lenses for digital, and obviously old lenses are in limited and finite supply and various states of repair. So we introduced the Panchro Classics. They used the old designs of our vintage Speed Panchros. But, the last speed Panchros were built in 1965 and none of the glass types were made any longer. They used leaded glass, as did most lenses back then as well as the fact they had Thorium in them. None of those are allowed to be made anymore. We know what they're supposed to look like when the image gets on film, so using modern glass, we came up with the same end product.

One disadvantage nowadays with old Speed Panchros is you often need a different lookup table for each lens, because the colors can be all over the place. Coatings fade. Mixing sets of different vin-

Cooke S7/i Full Frame Plus

tages means that each lens may look slightly different. Our new Panchro Classics are consistent.

Panchro Classics have the same falloff, the same Cooke Look, the same characteristics as the Speed Panchros. They look like Speed Panchros would have looked when they were new. Also, you can get replacement front and rear elements. You can get spare parts. They're serviceable. They have modern mechanics and the cam focusing we have been famous for since the S4 primes. The new Panchro Classics have /i electronics, and a decent sized focus barrel for all the marks.

How has Full Frame changed things?

We introduced the S7/i spherical series and Full Frame anamorphics. Super35 orders have slowed. We thought they'd see a resurgence this year because ARRI was supposed to have a Super35 4K camera, which seems to have been delayed. Certainly, at the moment, our orders are shifting towards Full Frame, and some customers are using it on Super35 because they want to be "future-format proof."

If you're shooting Super35, why would you go back to a Super35 lens instead of a new future-proof Full Frame lens?

Part of the Cooke Look is the focus fall-off at the edges. Our lenses are not "flat" meaning that we do not try to make the corners and the center equally sharp.

If you draw a vertical line through the center axis and you spin that around and make a circle, that's what we call the picture height area. Obviously, that's a larger circle in Full Frame than it is in Super35. This area on a Cooke lens, the sweet spot, is where we pay a lot of attention. Outside that circle, we let the image fall off to the corners. The center is as sharp as can be, and as we move to the edges of frame, it gets slightly softer. We do that because most of the time you are filming people or things where the area of interest is towards the center, and the edge fall-off adds a pleasing dimensionality to the image and brings the viewer's attention toward the center.

Now, if you think about a Full Frame lens, keep in mind that the picture height circle is bigger. It is usually 24mm high instead of 18mm. So, if you put a Full Frame lens on a Super35 camera, the image is going to be cleaner because all that pleasing fall-off area is outside of frame.

I would guess that there are other things in heaven and earth that contribute to the Cooke Look in addition to fall-off?

The warmth of the Cooke Look comes mainly from the choices of glass that we use in the lens. We look at their color transmission. The designers are looking at their index of refraction. Every glass type, and there are several hundred, has different qualities for color transmission. Some do red better than green or blue and vice-versa, and we're always looking at different combinations. The choice of glass really helps define the Cooke Look.

What can you tell us about the Cooke special flare lenses?

When we designed the anamorphic lenses, we didn't want all flare all the time, so we designed them to be what I call a classic anamorphic normal, but funky, look.

The anamorphic look is funky. It has different bokeh. Distortion happens in weird ways. There are two different depths of field—one vertical and the other horizontal. All these things contribute to making anamorphic very interesting. To get a real anamorphic feel you should have front anamorphic cylinders, which we do. If you built a rear anamorphic lens, it's easier. We don't do that. They have teeny little cylinders behind the iris and you get the widescreen coverage, but you don't get the bokeh or the feel.

The challenge with front anamorphic is that some of the cylinders are 4 inches in diameter and they're huge.

But that's the trade off if you want a true anamorphic feeling. With the first series of anamorphics we introduced, you could get them to flare, but you had to work at it pretty hard. Then we had a lot of requests from the industry for something with more flare. We came out with the SF set, which really means Super Funky. But, as somebody pointed out, if producers were reading your equipment list and saw lenses called Super Funky, they'd say, "We're not renting those." So we changed the name in our literature and called them "Special Flair." I think an SF set is really the best of both worlds. You can get the flare pretty easily, and if you don't want it, you just have to light appropriately and you don't get it.

How are they built? Can you convert a normal funky anamorphic to super funky flarey anamorphic?

Unfortunately, you cannot just swap out a front element. The main differences between normal and SF sets are the coatings on the cylinders. The cylinder section is especially sensitive. So that's why you cannot convert back and forth between normal and SF sets. Many rental houses carry both types.

I'm sure you would be delighted to tell us about /i.

Oh, yes. That would make me happy. As you know, we've been working on metadata for almost 20 years, and I am pleased to say that it has evolved. All the camera and most lens manufacturers are supporting /i. It started off as just basic information about focus, iris and depth of field. Then we expanded it to the second generation, which was inertial data to help track the camera through space, and now we're expanding it with i3, which includes distortion and shading.

What lenses are coming next?

At BSC Expo, we announced the Full Frame anamorphic 85mm Macro. It is in the tradition of the Super35 65mm anamorphic Macro that we already have. The Full Frame 85mm has roughly the same angle of view as the 65mm Super 35 lens. It focuses to about 4:1 magnification, which is about six inches in front of the lens.

Cooke 85mm Macro Anamorphic/i 1.8x Full Frame Plus prime.

Cooke Anamorphic/i 1.8x Full Frame Plus SF primes.

At NAB, we were planning to announce and show the new 180mm Anamorphic/i Full Frame Plus lens, the 300mm S7/i lens as well as the new branch of the S7/i family, the 60mm, 90mm and 150mm 1:1 Full Frame Macro lenses.

Someone said that Cooke builds lenses to order. But it seems that some of your resellers order lenses and stock them, knowing that someone's going to need them right away.

We like resellers who are proactive because our delivery times are not stellar, to be candid. If a reseller has the financial wherewithal, they're much better off ordering lenses and putting them in inventory. If they call us and say, "I need two sets of lenses on Tuesday," they know the answer is going to be, "Are you kidding me?"

We try to encourage stocking because we just can't react quickly enough for what Jon Fry calls "Just in time." We have about a hundred products now and we're inefficient by design. We have all those CNC machines you saw, and all the skilled technicians who make us efficient. We have machines that could make thousands of the same lens, and yet we only make 10 or 20 of each, reconfigure the machine, and make 20 of something else. Every month we have to make a few of every focal length in every series because if a cinematographer is making a movie, they do not want to hear, "Oh I'm sorry, we're not doing long lenses until December, so you'll have to wait for your lens until December."

And you're still doing a lot of work by hand, which is part of the aura and the artisanal nature of Cooke.

Yes. Some of the glass types are better handled on traditional polishing machines. As good as CNC machines are, they're not as good as an experienced master polisher. If a lens requires really tight tolerances, we give it to one or our master polishers.

Paul Utting said he could get a five micron tolerance in the edging, whereas the CNC machine does about 10 microns. That's something.

They are true craftsmen and craftswomen.

Every lens we make is built from the ground up. We do not modify still lenses and put them in bigger barrels. Our lenses are designed and built specifically for motion picture use by the same team that did the fours (S4/i), the fives (5/i), the miniS4/i, the Panchro Classics, the S35 2x Anamorphics, the Full Frame 1.8x Anamorphics, the Full Frame S7/i and now the new S7/i Full Frame 1:1 Macros.

That's from the mechanical side as well as the optical side. We're really proud of that. That does mean it can take us longer to get to market because we're not saying, "Oh, look, we can take a mass-market still lens and stick it in here and nobody will know." So that's one of the reasons our delivery is not as good as people would wish, but the lenses are specifically designed to meet the needs of our customers.

It seems that in your newly-expanded factory, and with additional people onboard, your delivery times might get faster.

We certainly look forward to maintaining quality while increasing output.

How has manufacturing lenses changed since you acquired Cooke?

Since the days of Taylor Hobson, the workforce went through an apprentice program of four or five years. They emerged as highly skilled engineers. Today, few people want to apprentice. From 1998 to 2008, getting young people to work here was difficult because everybody thought they could go down to the City, London's equivalent of Wall Street, and make a million pounds overnight and retire. That was never true, but there was the perception. After the financial crash of 2008, hiring became easier. We have a lot of young, skilled people working here now.

We've done a lot of recruiting and we have a great crew. And we are all getting better. Tolerances on the metal parts are far tighter than they probably were 20 or 30 years ago. And in the old days, I have to say, there was a fair amount of trial and error and dark arts. We've tried to take that out as well, and replace it with smarter engineering.

One of our best builders was, in her previous career, a receptionist at a hair salon and she's been with us for over 10 years. We are constantly looking for people with intelligence and good hand-eye coordination.

That's one of the reasons they don't let me build anything because my hand-eye coordination is terrible. They won't let me near a screwdriver. I've owned the company for 22 years and I never lived here full-time. I'm here on average a week every month. The reason is that being on the road and talking to people all over the world is what I like best. It provides new perspectives and fresh ideas. Customers tell me, "Well, our business is starting to look a little like this." I read your Film and Digital Times magazine and look at the trends where the manufacturers are going. It's not brain surgery.

I am very grateful for the opportunity I've had here at Cooke. I am honored to have been working with such a great group of people here in Leicester and at Cooke Americas (formerly ZGC) for the past 40 years.

Robert Howard, CEO of Cooke Optics

Jon Fauer: Please tell us about recent developments at Cooke.

Robert Howard: The big developments have been in Full Frame. Initially, our S7/i Full Frame range, and then the anamorphic Full Frames, are proving to be very popular.

How have things changed in your business?

The major change is the work we've been doing here to create a mezzanine floor and get everybody back altogether in one factory, because we'd been running with two factories for the last couple of years. Getting the entire factory together helps a great deal and it also makes it easier to run the business. Multi-sites are more difficult to deal with. That was a nice start to the new year.

What can we expect to see coming next—that you can tell us about?

At the moment, we're gearing up to get more and more of the anamorphic Full Frames out into the marketplace. But they're not easy to do.

What's the current trend? Is it Full Frame spherical or anamorphic? Do you see a balance?

There's more to go, but we have quite a few of the Full Frame sphericals out in the market now. The anamorphics are driven by our customers who say, "We're desperate to have them because we want to get them on a certain project." It's usually the same with new things. There's that initial take up, and then people start to try them and figure out how best to use them and decide that they like the look, and then there's a further take up after that.

We're seeing the drive now on anamorphic. That doesn't mean to say we're not delivering the sphericals. We absolutely are and continue to do so. In fact, we can't deliver as many as our customers want, which is a constant problem, obviously.

It's like a pendulum swinging from anamorphic and back to spherical?

Yes. The other thing we are seeing, and it is a departure from our initial anamorphic set that we did in Super35, is there's a very strong initial demand for the SF, the Special Flair version. Whereas before, we sold quite a lot of the normal anamorphics and then introduced the Special Flares. By putting the two options together this time, the Special Flair is proving to be to be more popular. It depends on the regions, mind you.

Which regions?

America is definitely Special Flair. We've sold some of the normal ones into America, but probably deliveries have been about three-quarters SF and one-quarter normal anamorphics.

And how about the UK?

UK has a bit more of a balance, and in fact in Europe generally there may be a bit more of a balance between the normal and the Special Flares.

Some companies reported that orders for Super35 have plummeted. Do you see that as well?

Yes. I don't think that means Super35 is dead. It's a case of people having to be careful where they spend their money. They do not have unlimited budgets. And most rental houses already have a very large inventory of Super35 lenses on the shelf.

It has been said that the market may almost be saturated in Super35.

If you come out with something that's different, whether it's in the camera format or in the lens, then there will always be people who want to use it. But at this point in time, people are sitting there thinking, "Well, I've got Super35 cameras. I've got Super35 lenses. I don't have, or I don't have as many, Full Frame lenses. So I'm going to buy Full Frame."

And if you have Full Frame lenses, they are backwards compatible to Super35, right?

To an extent. But people need to be careful with that statement because at the end of the day, one of the things that we're known for at Cooke is the way our lenses fall off: a nice gradual fall off, et cetera, et cetera. If you get the same sort of fall off with a Full Frame lens on a Full Frame camera, but then try and put that Full Frame lens onto a Super35 camera, you've lose that fall out of frame. So yes, it's backwards compatible, but as I say, sort of.

Do you see that pendulum also swinging back and forth between Full Frame and Super35?

Super 16 basically started fading out as Super35 took over, except in certain very niche areas. So these are the questions. Is the same thing going to happen? Will Super35 be taken over by Full Frame? Is Super35 going to go the way of Super16?

As we keep getting bigger formats and faster lenses, the things we're doing with depth of field is interesting and can be creative, but also you can make a terrible mess with it.

In the great scheme of things, how do you allocate your resources as to how many Super35 lenses vs Full Frame lenses you're going to build?

We very much look at our order book to see what our customers are requesting. Essentially that's how we allocate the resources.

You don't have to build in advance to anticipate demand?

No. That would be a nice position to be in. But in another way it's not. Because we have such a high demand for our lenses, we're always in a position of knowing what we're going to be building. I could tell you what we are building next month quite easily. I could take a good stab at what we're going to be building in summer. We have good visibility from that point of view because we have all this pent-up demand. The main thing we have to predict is in R&D, obviously to look where the market's going, what's going to be new to the market and what people may want next.

How do you decide what's next?

We get all of our sales and marketing people together at an annual conference with Les and me. We brainstorm and ask, "What are people saying they want? Should we do that?"

Then Les and I will bring those ideas back here. We sit down with the R&D and manufacturing departments, and we hammer out the concept and specifications. Ultimately, all these specifications are somewhat of a compromise. How fast do you want the lens aperture? Well, super fast and weighing nothing and affordable.

But you cannot have all three?

Exactly. So you have to determine what people really are asking for. What are they willing to compromise? At the same time, we always have to be aware of our manufacturing ability. It's something that we try to have a very good eye on. Because we hand build. We are very much a craft industry.

That was very clear during the tour today. Some of the artisans have been here for 30 years.

Yes. And we don't want to change that. But on the other hand, there's no point in designing a lens that takes too long to build. Or that can't be built at all.

At the ever-popular annual Cooke dinners, your customers seem to grill you in a good-natured way about long deliveries. Is that getting any better?

Yes, deliveries are getting better. To be honest, with the new facility recently opened a couple of weeks now, it will take a little time. We just moved in, and we're moving some people around and training them in new areas. As we discussed, Super35 is not in as much demand as before. So, people in those departments are having to learn the new lenses and how to build them.

Is it a different skill set?

Very much with the anamorphic: moving from a spherical build to an anamorphic build. It's quite a change, even for people who've been building lenses for the last 20 years. You know as well as I do, when you project an anamorphic lens and compare it to a spherical lens, it's a completely different experience. One of the best ways to evaluate an anamorphic lens is to put it on a camera. But we still have to put it on a projector and that means we have to learn how to look at an anamorphic lens in a different way.

Thoughts on where the next trends will take us?

Everybody continues to try to come up with a new look, something that distinguishes their work from others. It's understandable. And we at Cooke Optics will try to be ready with lenses to take them there.

New Cooke 300mm S7/i Full Frame Plus (spherical).

New Cooke 180mm Anamorphic/i 1.8x FF+.

Alan Merrills, COO

Jon Fauer: What does the COO at Cooke do and how long have you been here?

Alan Merrills: I have been at Cooke for 12 years. The COO is the main progress chaser throughout the factory. Making sure everything's going through, making sure everything happens on time and that we get the output on time. Now that we are all under one roof, everybody gets one message and I think people work together better.

How many people work here now?

We're between 125 and 130. Yes. It's grown significantly over the years considering the fact that when we first moved into this building there were 36 of us.

We've grown. The business has grown, the turnover's grown, the product range has grown. We've moved on significantly. The number of products we have in the marketplace now is quite impressive and we have a big market penetration with all of our products.

Is turnaround time faster now?

It is, definitely. I think we've improved our production output. 12 years ago we were making about 35 lenses a month. We're now making around 200.

10, 15 years ago, design and development took 12 months for just one lens. We're now designing a whole series in that time. It is the result of computers, people, and different approaches.

How do you find skilled lens technicians?

With great difficulty. There are very few. We're one of the few companies in the UK that build cine lenses. So there aren't many skilled optical technicians out there. I tend to look for people with the right attitude and aptitude. If they've got that, I believe that we can give them the skills that they need to produce our lenses.

So there's no university in the UK that teaches these skills.

There is. Imperial College in London, which is where you'll find Jon Maxwell. They teach optical design. But when it comes to mechanical design and building and designing lens movements and mechanisms, there isn't anybody who teaches that. That comes from experience.

Allison Langley, Front of House

I'm Allison Langley—Front of House, Sales Support Administrator, answer the phone, deal with customers, suppliers, whoever comes through. I do all the quotations, invoices, order acknowledgements, shipping, export, and delivery notices.

I arrange the tours of the factory and training of lens technicians who come from all around the world.

I have been at Cooke for 12 years. When I first started I also used to do all the spare parts and arrange for service.

Recently I have seen a lot of new customers. It's not just the same ones that keep coming back. There are a lot of new ones going on. A lot more owner operators, individuals who want to buy their own lenses.

Chris Marriott, Next COO

My name is Chris Marriott. I recently joined Cooke to continue in the Chief Operating Officer position from Alan when he retires in July. My background is very similar. Previously, I was in the COO role at a company that was divested from Nikon. When I first came to visit as part of the interview process, the mix of technologies I saw here was astounding.

For me, the fundamental challenge will be continuing on from Alan. Obviously, the demand for Cooke lenses is growing and I've got to ensure that we can keep pace with that demand. We do not want to upset the balance of the iconic Cooke look or the Cooke characteristics.

The last thing you want to do with this iconic brand is to make them sterile and just another ordinary series of lens. You've got to be very careful about changes and make sure that they don't produce any adverse effects while increasing productivity.

I think the demand we're seeing now, that we're trying to build for, will continue to increase because the quality of the product remains the same, the characteristics remain the same, but the technologies and capabilities going into the lenses are driving new requirements. Anamorphic, /i data, and other technologies open up new opportunities for using the lenses in a different way and adding things in post-production.

In terms of new product development, we live in an age where the expectation is for things to be instantaneous. "I want it. I want it now." I heard how long it took for the S4s—nine years to get them off the drawing board into pre-production and then production. That is not possible anymore.

I think in most industries anything more than a year runs the risk of letting other technologies disrupt the product that you've planned. The time to market, the manufacturing to market lead time, is critical. Don't try and come up with a lens that is the next best thing but will take you 10 years to develop—because the market will have moved on by then.

You're actually better splitting the concept into two or three developments and iterating on your initial development to get the product to market.

One of the things that I've seen here at Cooke, which I was absolutely delighted with, is the NPI (New Product Introduction) process that is properly staffed. One of the things that a lot of companies either miss or disregard is the link between engineering, design and production.

In an ideal world, engineering designers would do their job, they would hand it over, and it would get produced. But that rarely happens. There are always issues that either are not apparent at the design stage. Or, changes are made after release of the lens and they improve the product, or the efficiency, or the process, or the cost.

So having an NPI team focuses on transitioning from engineering and design into the production environment. They're not bound by one or the other. They don't get wrapped up in the politics of pure design. They don't get pulled into the pressures of production. The NPI team is a task force to ensure that we have an effective transition. Any issues that are found during the process are resolved. It's an absolutely key role and it's one that is somewhat understated and not given, shall we say, the credit that it deserves.

New Optical Design and Mechanical Engineering Offices

The Lens design department is now in new offices upstairs at Cooke.

Also in new upstairs addition: outers department (irises, barrels, etc.)

John Monahan, Production Engineering Manager

I'm John Monahan, Production Engineering Manager.

The new mezzanine floor added 400 square meters of capacity to the assembly shop. We've upgraded the air-conditioning and all the air that comes into the building is filtered through F7 HEPA filters.

To determine the new layout, we had several meetings. I put my ideas down onto paper, did a rough layout of how we might want the rooms to be, and how we want to work. Then I discussed that with the assembly supervision and obviously with Alan Merrills, our COO. It was a process of elimination: "I like that bit. Don't like the other bit." Eventually we came up with how the room wants to be.

Keith, Jamie and Alan had many more ideas on how the assembly needed to work, so they had a great input to that. I then went back and did new layouts. And that's how we arrived here, at what we actually wanted and needed.

Steve Pope, Director of Engineering

I'm Steve Pope, Director of Engineering. My job involves optical, mechanical and a bit of electronic engineering as well as new product development. That includes R&D, prototype builds and getting products into production.

I have been at Cooke for eight years. In that time, some personnel have retired and and quite a few new people have come onboard. They brought new ideas with them and we've changed some of the ways we do things. For example, we do a lot more science and metrology in the build process than we used to. So, we're trying to do as much work before going on a lens test projector, and spending less time there as well.

We are putting more knowldege, more forethought and more educated guesses into the build process rather than just doing it in an iterative way. The other significant change is the way optical design capability has improved as computing power and the software has advanced. If you look at the past 30 years, the increase in the number of ray traces per second we can do is staggering. So now we can do many more optical design calculations in a much shorter period of time.

We tend to begin a standard optical design with calculations of aberrations and MTF performance. Since the introduction of SF series lenses, we have techniques in the ray tracing to set up and work out where we're going to take coatings off, put coatings on, change coatings and anticipate the effects that they will give. But that's very much a modeled image. We then have to try and simulate the effects by building the first lenses and shining a light down them, looking through and seeing what happens. You might almost call them prototypes. They're the ones you usually see at the trade shows. In general, we've modeled and reviewed everything in the design process to be where we want to be.

It's interesting. I go back 30 years ago to where we used to build lots of different prototype models before we got to production. I'd have to say what we now call a prototype here is usually the first set of three lenses. And then full series production follows from there.

We go over those first three lenses with a fine tooth comb to cover all the issues and to find out how things worked out. Next, they go over to the people who develop the tooling that we need for the production process of these new lenses.

We know from the optical design data that these optics are going to give us what we want. And we review our mechanical design to be sure we're in the bounds of what is manufacturable. We've done a lot of that hard work before we get to the build, to steer the design in the right way.

The Super35 Anamorphics were an interesting driver for us. We heard customers say, "Don't make them too pristine." The design became a place where science and art met.

It's definitely a team effort, and a great deal of the results come out of the optical design team. They've got the knowledge of what we're looking for in the final image.

We have a number of optical designers on site and off. We have seven mechanical designers. And I do a bit myself along with tooling design and development engineering.

Building Cooke Lenses

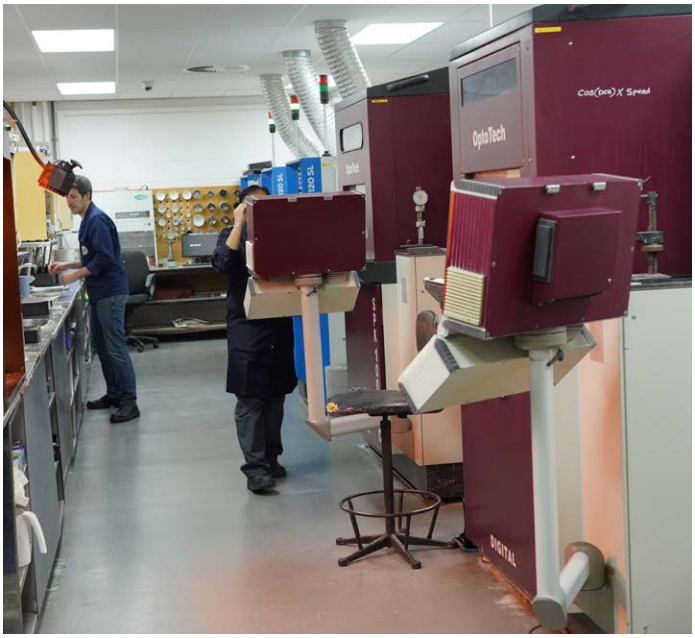
Lens manufacturing begins by sourcing the rough optical glass blanks.

Les Zellan and Chris Marriott among shelves of raw glass.

Paul Prendergast: "Although the glass is usually bought in molded forms, they may look round and parallel but actually are not."

"Supermarket" Supply Room for incoming parts.

Grinding and Polishing



OptoTech CNC lens grinding machines.

Satisloh CNC lens polishing machines.

Aspherical element polishing

High speed CNC polishing

Traditional polishing techniques are slower but can be even more precise

The polishing compound is an abrasive slurry of Cerium Oxide.

Chris Norton, Master Glass Polisher.

Paul Prendergast, Glass Production Manager

My name is Paul Prendergast and I manage the glass production, the flow of glass through the workshops and the team working on the grinding, polishing, edging, coating, blacking and finishing. I regard the assembly shop as my customer. I'm supplying my customer, which is the assembly shop, with the glass they require to build the lenses.

The first process that we do is pre-edging. Although the glass is usually bought in molded forms, they may look round and parallel but actually are not. They are made from molten glass, supplied mostly by Schott, a German company, and Ohara in Japan.

We do edging to ensure the glass diameters are perfectly round. Then they go onto the grinding machines to grind the surfaces prior to polishing.

I started at Cooke Optics a bit more than 30 years ago, back in the days when it was part of Taylor Hobson on Stoughton Street in Leicester city and then at New Star Road nearby. I can even remember the date I started. It was the 5th of November 1989. I started as an apprentice or trainee glass polisher. And I continued to do that for around 10 years. I became the cell leader—supervisor of the glass shop and then glass production manager, so it's worked out quite nicely.

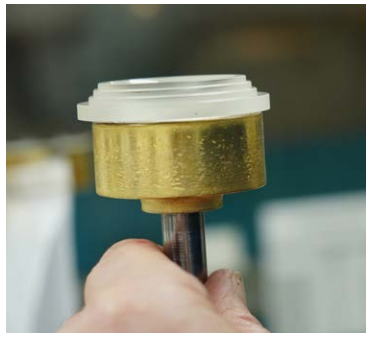
Since I started here, one of the main changes has been the CNC machinery. There was none of that 30 years ago, but now we rely on them heavily.

Of course, we're still using the old processes. The machines that I trained on in lens polishing are still in use every day of the week now, which is great. We use the old style machinery for some of the more difficult glass components. The CNC machinery is fantastic, and it is the way forward, but some of them have their limitations as to geometry. Therefore, we have the ability to make any lens shape we want.

Examples of when we use the conventional machines include polishing some of the steeper curves on the optical surfaces. As for edging, the conventional machines are generally used for some of the more difficult edge profiles and components with quite a few steps and chamfers.

One thing that the design team always has in mind is to reduce the weight of the lenses. Sometimes they put big chamfers on the optical elements. These look like big steps, just to reduce the weight of the glass. And sometimes that has another function as well: to fit into the metal work.

Aspherics are polished on Satisloh CNC machines and then measured on Taylor Hobson equipment.



Paul Utting, Supervisor of Edging and Blacking

I'm Paul Utting. As supervisor in the edging and blacking area, I do the day to day troubleshooting. Paul Prendergast and I liaise together to decide on what's actually needed throughout the process.

Here is a tour of the edging process.

First, we "pitch the lenses on." We are literally using pitch to attach the glass to a metal shaft. We warm up the brush chucks, finding the optical center through the collimator, which is a piece of equipment that's been within the business for many, many years. It was originally designed by Taylor, Taylor and Hobson. It's still in full production today. We stick the lens on using a gas flame to soften the pitch while looking at the optical image until it is absolutely perfectly centered.

It comes down to experience. To be honest, when anyone first learns this particular process, you hear a few obscenities, shall we say, because people might burn their fingers if not careful. But over a period of time, with practice and hand-and-eye coordination, you actually learn how to do that process, hopefully without burning your hands. If you've got any sense, you only burn yourself once.

The collimator shows a series of lines that you can see through the eyepiece. When we pitch the lens on, we optically true the lens using graticules that are graduated down to around five microns. It's a matter of centering the optical imaging until there's no deviation.

We have the 70 series machines within our department that date back to 1912-1914 and are still in full production today. They were working during World War I to produce lenses for binoculars.

The difference between what the old machines do and the CNC machines is as follows. The old 70 machines have a series of wheels. There's a very coarse wheel for when there's a lot of stock to remove rapidly. We also have a very fine wheel. And actually, we can use the CNC in conjunction with the older machines. When we want a very fine finish, the extremely slow, belt-driven rotation on the 70 gives you an absolutely superb, magnificent finish. This, I think, is one of the things that sets us apart from other companies. That probably helps with the Cooke Look because the way we do things is quite unique.

We maintain all the equipment ourselves. We do the chuck turning and we use a two micron clock to check the run out. The old machine is very is precise, to 5 micron accuracy, providing I actually pitch it on in the correct manner. Sometimes it can prove to be even more accurate than the CNC machines. But a lot depends on the lens. Different lenses react differently to what we're actually doing. We tend to do it through the experience of knowing the products. We know what works and what doesn't work, so we load the work accordingly.

I joined the company 20 years ago and worked in the edging department. Then I was moved into polishing for about five or six years. When my brother, who also worked in the edging department, retired, I moved back into the edging and became the edging supervisor.

It begins by heating and applying sticky pitch to a metal carrier.

Place the glass element on top. Careful not to burn your fingers.

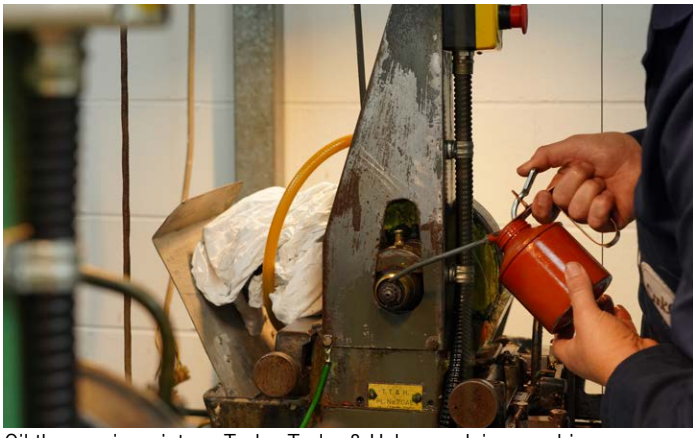
Looking through the collimator, center the element while pitch is hot.

Vintage machines in the hands of a master craftsman like Paul Utting can produce accurate results to tolerances of less than 5 microns.

Edging

Edging ensures the element fits into its mechanical supports within the barrel. Paul Utting demonstrates: once cool, the pitch is like glue.

Protect the top and bottom surfaces against scratches.



Oil the precise, vintage Taylor, Taylor & Hobson edging machine.

Begin edging.

Measure.

Example of complex stepped edge

Separate the element from the spindle by gently tapping shaft. Les Zellan demonstrates.

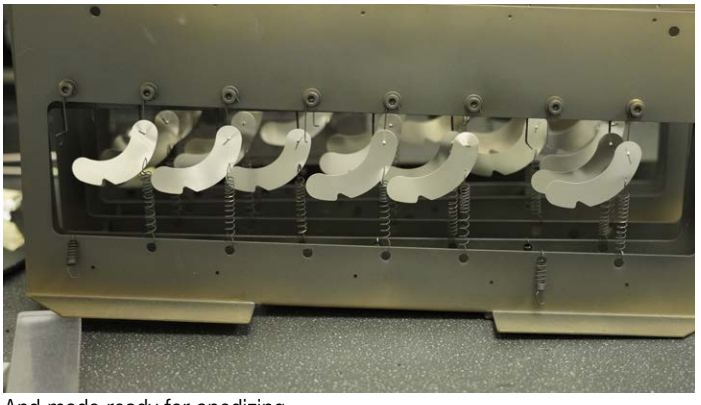
Of course, many lenses undergo high-speed CNC edging.

Blacking

Irises

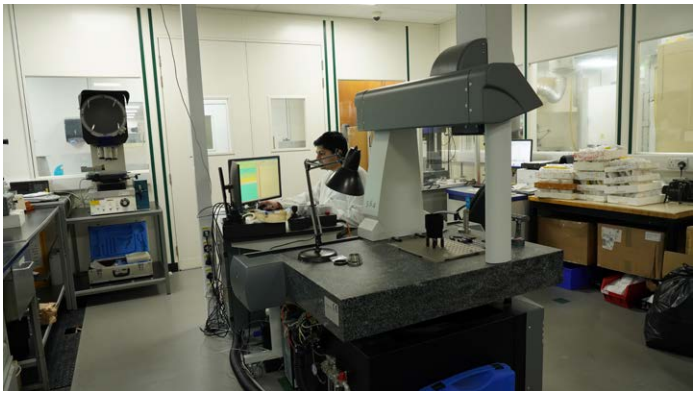
Iris leaf pins are welded into position.

Iris pins are measured.



And made ready for anodizing.

An essential ingredient of lens manufacturing is consistent, persistent and accurate measurements.



William and Thomas Smithies Taylor, founders of what is now Cooke Optics, knew “if you can’t measure it, you can’t make it.”

The Form Talysurf measures aspheric polishing inconsistencies. The original Talysurf 1 by Taylor & Hobson Talysurf was introduced in 1941 to accurately measure surface texture.

Ian Johnson, Coater for Cooke Optics

My name is Ian Johnson and I'm a coater. I have been with the company for 35 years. We work with several different types of machines: Bühler, Belzer and Leybold. Coating is a process of evaporating minerals at high heat in a vacuum to deposit a thin film onto the glass.

The Bühler plant uses a planetary motion in the top part. It doesn't just turn around on one axis, it turns round on several.

The Leybold Optics Box Coaters are older dome coating machines, some dating back to the early 1960s and are still actively in use today.

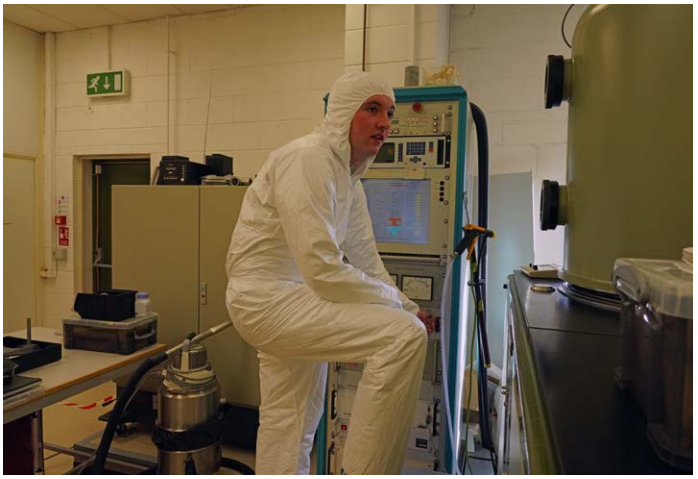
We essentially put down four different types of coatings on the glass depending on their various jobs.

The old Belzer machine is used for special coatings, like the ones that make up the SF — Special Flair (Super Funky) sets.

Clean the optical elements before coating.

Load the optical elements onto carrier.

Prepare the vacuum chamber. Add secret sauce. Close chamber. Heat.



Keith Wykes, Production Manager for Assembly

I'm Keith Wykes. Here at Cooke, we have increased capacity in our vast clean room with a lot more people working in assembly. This was necessary because the portfolio of lenses has expanded from S4/i, 5/i and Mini S4s to include to S3, S6 and S7 as well.

S3 and S6 were the code names during development. You know the S3 as Panchro Classics and S6 as Anamorphic/i (Super35). Some of the code names have stuck, like S4. That's because when we were ready with S4, nobody could come up with a better name.

We were about 46 people in assembly and struggling for space. An extension was built to accommodate the new lines of lenses that were coming out. We added a new projection room. We expanded the clean room, but it filled up very quickly. So, when it was decided to launch Panchro Classic, we needed somewhere to build them. A facility at Crest Rise, about 3 miles from the main factory at Cooke Close, was leased and all the assembly teams except for S4 and 5 moved there. We've only recently moved back. The S7s have only been back here about two weeks.

You asked earlier about our new preoccupation with clean rooms. In my opinion, you have two customers. You've got the customers whose money it is. If you've paid thousands of pounds or dollars for a lens, you might say, "Oh, I don't like this and I don't like that." It has nothing to do with how you would use the lens. Nothing at all.

The other customer is the one who uses the lens—the DP or Assistant. They are not as interested in the color of the paint on the outside of the lens. They're more interested in what the optics produce on the image sensor or film.

If it's your money, you wouldn't buy a new car with a mark on the paint job, would you? It's still going to drive. You're still going to go down the road. But if you're renting a car from Hertz or Avis, you don't worry about a blemish on the bonnet. And that is why we've got two customers.

The process of assembling a lens is as follows.

The majority of our lenses are divided into two essential parts: an inner and an outer. They are built separately. The inner contains the optics and the iris. The outer contains the barrels, the movement of the cam for focus and the iris movement. The inner clicks into place inside the outer and is driven off the cam followers.

With spherical lenses like an S4, 5/i, S7, one person will build the inner. Glass it all up. Look at it in projection. Put the mount on. Project it and tweak it again. Then present it to inspection to get tested. Next, somebody else will fit the inner into the outer, connect it all together and present it to inspection for focus and iris marks. And then off to engraving and the other final processes.

There are many skills involved. One of these, sometimes unappreciated, is to clean the piece of glass and then to be able to put it into the cell and keep it clean.

Anamorphics are a different story and really a team effort. There are five cells in an anamorphic. You've got the front, which everybody sees. You've got the focus, which is the internal focus. Then you've got the cylinder cell. Next you've got a middle cell that contains the iris and then the rear cell that everybody sees.

Next, we take those cells upstairs for fettling. Fettling is the term for making sure all the screw holes and all the metals are clean and there are no loose bits hanging off. Make sure it's all manufactured correctly and fits together correctly. It's cleaned upstairs again, and then brought downstairs.

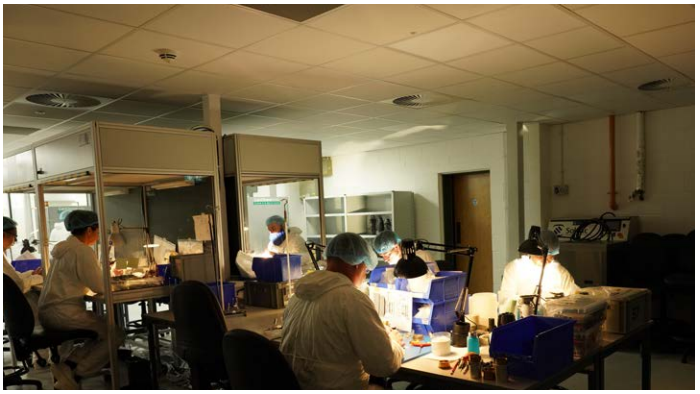
Once downstairs, they fit all the glass into the cells. They have a spreadsheet. They're putting in all the calculations to determine what spacers to use and which shims to add. And then what we have is what we call final inner builders who will put the cells together, put it in tooling, project it onto the wall, and tweak it.

It's not really an assembly line for the anamorphics, but more people are involved in building one lens. We do like to take ownership and say, "That's what I built." Not, "Well I put in them six screws and that sort of thing."

We have an apprenticeship program. People who come here are usually trained to use tools at college and to understand metals, but they don't get shown how to build lenses. So, when we take somebody on, it is like a buddy system and they are put alongside somebody with plenty of experience.

We've had lots of people here who had never built a lens before. The work is something completely different. One of the best people who joined recently came through a job placement scheme for 20 year olds. We've got a real good mix of people. The oldest person here is Keith Norton. He's mid seventies and has been with Cooke for over 50 years. He used to build zoom lenses. One of the youngest people is a supervisor. She's 22.

I've been here 37 years. I started in 1982 in the glass manufacturing department. I only came over to the assembly side when they started building the Minis. But, if you know glass, you'll be fine.



Flow booths and benches inside the clean room.

Jamie Cluer, Assembly Supervisor and Service Manager

Jon Fauer: Tell us about Cooke lens service please.

Jamie Cluer: After the lens has been out in the field for God knows how many years, and then returned to us for an overall overhaul, that would involve glass cleaning, a general check over of the mechanics to make sure that they're still okay, and cleaning the grease.

Do the cams have to be replaced?

Only if the lens has been dropped. Which happens more often than not. What you'll probably find is the internal pin will be bent in the cam and that means it will have to be replaced and the lens may have to be remarked.

How fast can you turn around a lens in service?

A new front element is pretty straightforward because it doesn't affect the optical unit as such. Changing a front element and checking it in projection would take about three hours. If you're replacing a cam, that's a whole different story because it means possibly having to rescale the focus of the lens. All our lenses are hand marked for focus. So you need a new focus ring.

Our turnaround time in general, whether it's from London or somewhere else, is normally three to four weeks. Many of the rental companies do their own service and we train them. Also, we now have Cooke service centers in Shanghai, Brazil, Los Angeles, New Jersey and, of course, the UK. That should make the turnaround much faster.

Take us through the assembly process from your point of view.

It's different now. We've gone from being a small company with just S4 and 5 lenses to bringing out the Minis, the Sixes, the Sevens. The company has grown a lot in the past 10 years. We have brought out more focal lengths and more series of lenses. The shop floor is now organized into various cells. The cells are for different series of lenses. It looks like rows of desks and booths with all the necessary tooling and equipment right there.

That's something that's changed from how we used to work. With Fours and Fives (S4/i, 5/i), each builder would do the whole lens from start to finish. The way we work now on some of the lenses is that we have sub assembly builders. Now their job is to do the first stage of the product, to take the glass measurements, work out the spacings between each glass and do the metal prep as well.

Once that stage is complete, they clean the glass and put that clean glass into clean metal work. Then it will go on to the final builder who will complete the job. Then it goes into projection tooling. where they make adjustments while seeing the adjustments' results on the screen. The old way of building was to take it apart, clean it, put it back together again, and so on. It was like building with your eyes shut.

It was a case of building the lens and you didn't know what you were going to see until you put it on the projector. And then, for example, if you saw a tilt, it'd be a case of taking that lens off the projector, going back to your desk, making an adjustment and hoping for the best. So you did not know until you weree back on the projector again. Now you can make adjustments in real time.

You have a lot more projectors than before.

That's basically to keep up with the amount of lenses we now have. And we need the projectors because that's where we now make our adjustments.

How are the lenses inspected once completed?

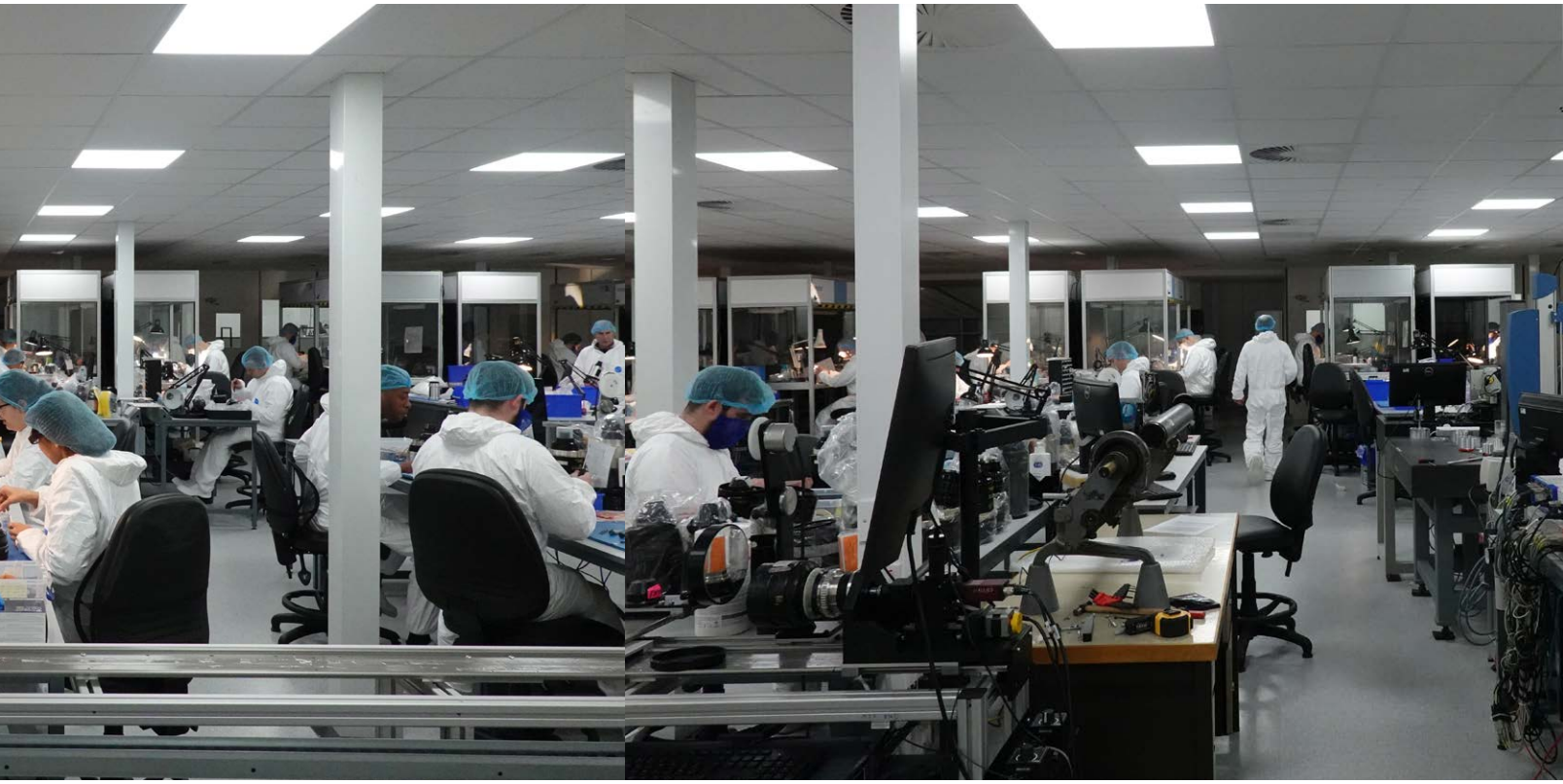
We have two inspection phases. In the initial QC, the lens is tested on the projector. It is inspected cosmetically: clean inside and out, no dust or scratches. If it passes that stage then we will continue to do the marking up of focus marks, the engraving, and fit the /i electronics. Then it will go to final inspection where we test it again for the final time.

The shop floor in the clean assembly room is organized into various cells.

“Glassing up the Inners”in the Clean Room — the assembly area where Inners meet Outers, below.

Above: the precise edging done earlier pays off as lenses mount inside barrels. Below: Inside a flow booth, the cams mate with cam followers.

Cooke Clean Room



Panorama of the new Cooke Clean Room, above.

Inners (sub assemblies) slide into outers.

Adjust the inners through the outers to correct specifications.

Securing the /i technology electronics into a Panchro/i Classic 40mm.

Preparing a Cooke S7/i 135mm for marking.

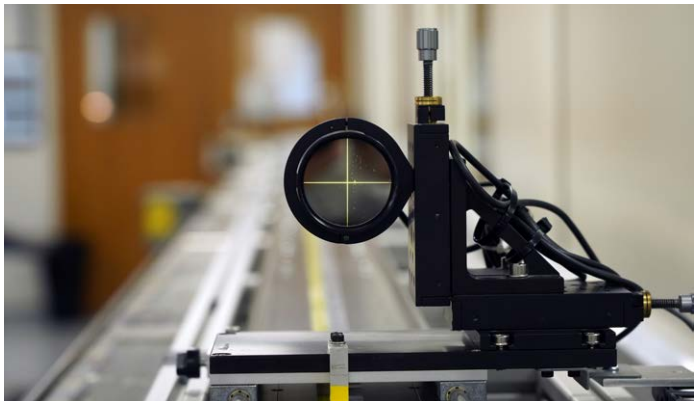
Marking the Focus Scale

Raj Mistry hand calibrates the focus scale of each lens. After this, the focus barrel is laser engraved.

Marking the Focus Scale

In the good old days (2014), Raj Mistry eye-focused the focus scales.

These days (2020) he now confirms accurate focus with an MTF display.

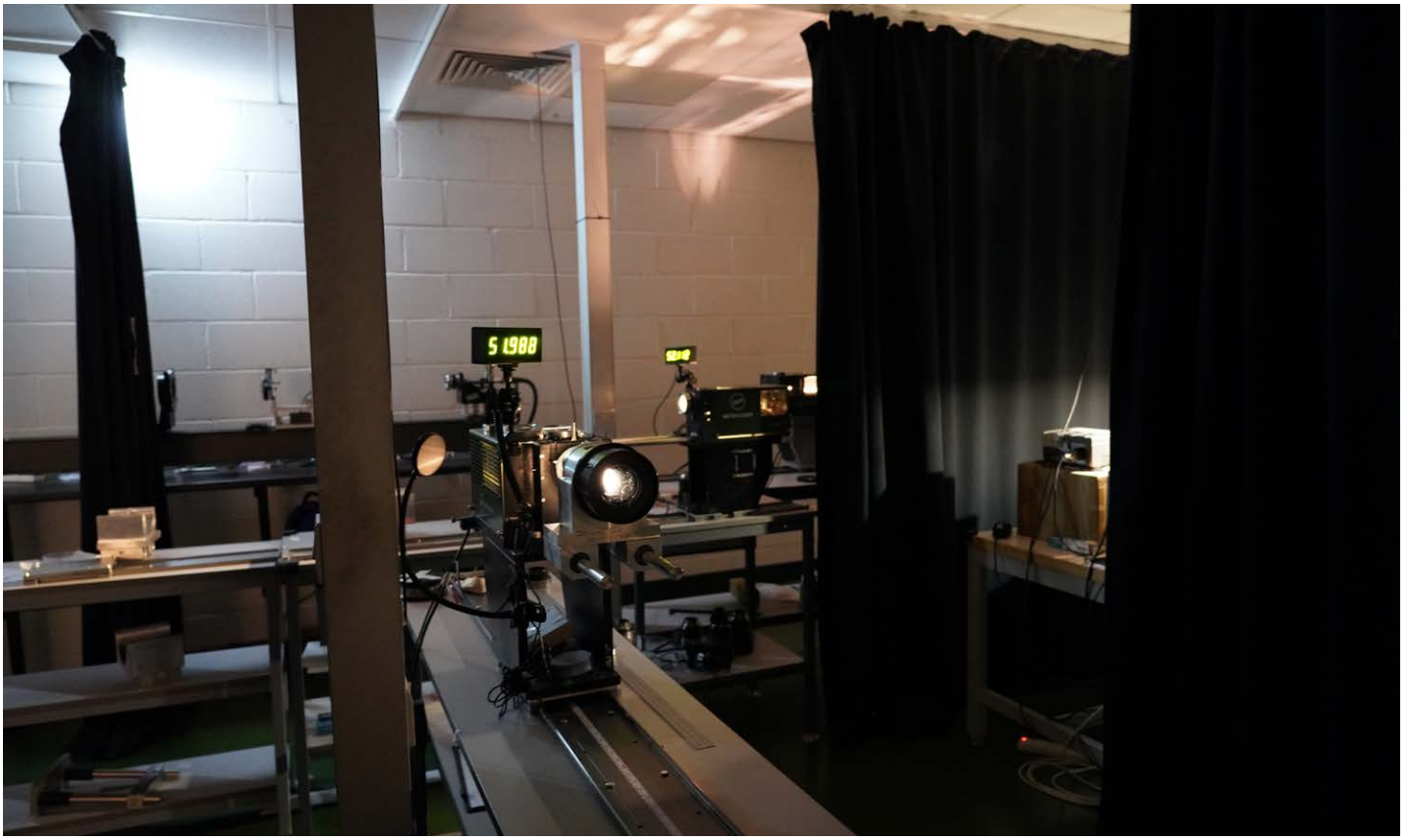


The focus target moves along a 60-foot long track.

Infinity is established with a supplemental mirror.

Each mark is lined and identified. The lens then goes to the engraving room. Laser engravers are seen above at left. CNC engravers are at right.

Lenses are checked, tweaked and rechecked in the newly expanded projection room that is part of the clean room. Gone are the days of building, testing, taking the lens apart again for adjustment, re-cleaning and re-assembling. It is now a seamless process within the one dust-free work space.



Cooke lenses flying off the shelves and into the shipping department.

Above and below: checking out the new 85mm Macro Cooke Anamorphic 1.8x FF+

New: Cooke S7/i Full Frame Macro 1:1 60mm, 90mm, 150mm Primes

"We are introducing a new branch of the S7/i family—the 60mm, 90mm and 150mm 1:1 Full Frame Macro lenses," Les Zellan said in our interview at the factory. He continued, "Most of our lenses have an MOD (Mininum Object Distance) of roughly 10 times the focal length. Over the years, we've been asked to do macro lenses and we've done it with the Panchro Classic 65mm and the Anamorphic 65mm and now the Full Frame Anamorphic 85m.

"The new 60, 90 and 150 mm S7/i Full Frame Macros include /i lens metadata, which we're very proud of."

By the way, 1:1 Magnification in a Macro means you can focus down to fill the frame with an object that is 36x24 mm or 40 x 20mm actual size.

60mm	
T-Stop Range	T2.5 - T22
Magnification	1:1
Close Focus from Lens Front	55 mm
Angular Rotation to MOD Endstop	270°
Max. Diagonal Angle of View for Super 35 Format	28°
Max. Diagonal Angle of View for 24 x 36mm Format	39°
Maximum Format Coverage	46.31mm
Front Diameter	110 mm
90mm	
T-Stop Range	T2.5 - T22
Magnification	1:1
Close Focus from Lens Front	114 mm
Angular Rotation to MOD Endstop	270°
Max. Diagonal Angle of View for Super 35 Format	19°
Max. Diagonal Angle of View for 24 x 36mm Format	22°
Maximum Format Coverage	46.31mm
Front Diameter	110 mm
150mm	
T-Stop Range	T2.5 - T22
Magnification	1:1
Close Focus from Lens Front	172 mm
Angular Rotation to MOD Endstop	270°
Max. Diagonal Angle of View for Super 35 Format	16.54°
Max. Diagonal Angle of View for 24 x 36mm Format	12.05°
Maximum Format Coverage	46.31mm
Front Diameter	110 mm

New: Cooke Anamorphic/i 1.8x Full Frame Plus 180mm SF & Regular

The newest members of the Cooke Anamorphic/i 1.8x Full Frame Plus family are the 180mm SF (Special Flair) and Standard Primes.

Cooke Anamoprhic/i Full Frame Plus	T-Stop Range	Min. Marked Object Distance (MOD)		Close Focus from Lens Front		Angular Rotation to MOD	Rotation of Iris Scale	Length: Lens Front to Mount	Maximum Front Diameter	Total Weight	Maximum Image Coverage
32 mm	T2.3-T22	900 mm	35"	630 mm	25"	270°	90°	206 mm	136 mm	4.2 kg	36x24 mm
40 mm	T2.3-T22	900 mm	35"	630 mm	25"	270°	90°	212 mm	136 mm	4.4 kg	36x24 mm
50 mm	T2.3-T22	850 mm	33"	600 mm	24"	270°	90°	204 mm	110 mm	4.0 kg	36x24 mm
75 mm	T2.3-T22	1000 mm	39"	750 mm	30"	270°	90°	206 mm	110 mm	3.5 kg	36x24 mm
85 mm Macro	T2.3-T22	500 mm	22"	181 mm	7"	270°	90°	272 mm	136 mm	5.2 kg	36x24 mm
100 mm	T2.3-T22	1200 mm	46"	925 mm	36"	270°	90°	228 mm	110mm	3.8 kg	36x24 mm
135mm	T2.3-T22	1500 mm	58"	1166 mm	46"	270°	90°	271 mm	110 mm	5.0 kg	36x24 mm
180mm	T2.3-T22	2000 mm	80"	1610 mm	63"	270°	90°	314 mm	110 mm	6.2 kg	36x24 mm

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