Blockless lens surfacing technologies

Opportunities and challenges

In the ophthalmic industry, the process of lens surfacing has been largely dominated by alloy blocking, a technique that has stood as the industrial standard for decades. Approximately a decade ago, Satisloh introduced ART (Alloy Replacement Technology), providing the first viable, alloy-free and environmentally friendly blocking alternative, which has since been widely adopted and used in hundreds of lines around the world. Despite the advances that ART has made, the industry now faces a significant question: to what extent will the future of lens surfacing be blockless, and when will this transformation happen?. *By Dr. Michael Kreis*

Before exploring a possible blockless future, it is important to understand why lens blocking is so important in lens processing. Both Alloy and ART block-pieces play a crucial role in ensuring precise positioning, stability, and protection of the lens throughout the production process.

Why is a blockpiece needed?

Here's a breakdown of why it is needed and what functions it serves:

Ensure positional accuracy: Blocking ensures accurate positioning in all six degrees of freedom for the lens, including three rotational and three linear movements. This precision is critical to accommodate various lens geometries, such as front side progressive, bifocal, and trifocal lenses, as well as lenses with features like tints, gradients, or polarization.

Keep the lens in position during cutting: The block-piece stays as a reference during all cutting operations. Therefore, the blocking technique needs to provide mechanical strength and rigidity.

Support of the lens during surfacing: Especially in the fine cutting stage with a diamond turning tool the block provides mechanical stability, preventing the lens from flexing or deforming due to cutting forces. Choosing a block-piece that provides maximum support, reduces

the risk of deformation and increases the quality of the cut, resulting in high-quality finished lenses which maintain their intended curvature and thickness through each production stage. This support is particularly important for thin lenses or lenses made of softer materials like polycarbonate. Choosing the right surface coverage allows processing lenses with thin edges.

Transportation: Once blocked, lenses can be safely transported in a job-tray through various stages of production, including cribbing, milling, turning, polishing, and in some cases AR coating, without losing positional alignment while having protection because the lens is not touching the tray.

In a blockless process all these functionalities must be redesigned to produce lenses with the same quality and consistency.

A new approach to blockless surfacing

Blockless surfacing aims to streamline and simplify the process steps by reducing the need for separate machines for each stage. However, blockless technology also presents new challenges (Fig. 1).

Satisloh is actively working on a blockless surfacing solution utilizing their well established and proven technologies and processes. The goal is to create a reliable, blockless line that integrates processes from other Satisloh machines, holding, aligning, and positioning lenses without a traditional block.

The new generator is based on the well-known VFT-orbit-2i . Modifications like a pre-cribbing feature, lens positioning technologies derived from the ART Blocker-A and a specific vacuum lens reception are enabling it to function as a fully blockless generator.

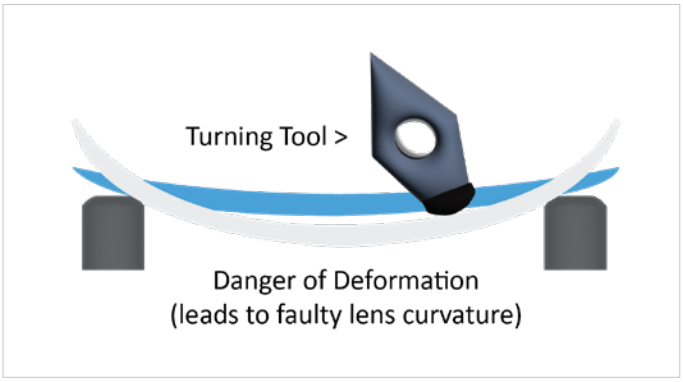

Fig.1: *Example for lens deformation. Picture: Satisloh*

Fig.2: *Future blockless technology: generating, engraving & polishing. Picture: Satisloh*

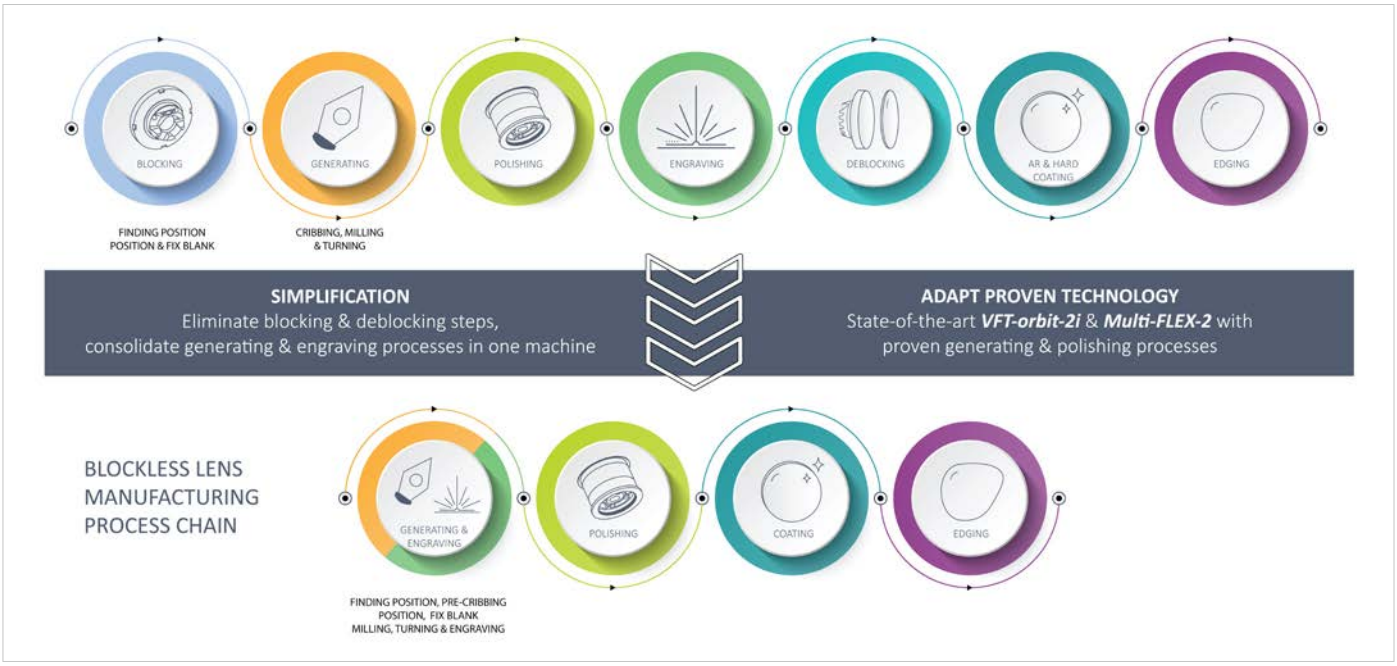

Fig.3: *Now and future chain process. Picture: Satisloh*

Meanwhile, polishing will be performed in a redesigned Multi-FLEX-2 machine including new features that process lenses of various types without a block-piece (Fig.2).

Multitasking machines vs modular systems

One critical consideration for labs interested in blockless is the choice between multitasking machines and modular loop or line setups with separate machines. Lens production requires multiple stages, each with varying demands depending on lens material.

For instance, polycarbonate lenses are faster to process in the turning stage, but polishing can take much longer than other materials like CR39 or high-index lenses. The ophthalmic industry is unique, requiring a high capital investment while having high numbers of individual work pieces produced in a "one piece flow".

Having lines running 24/7 with the highest possible utilization and output is key to competitiveness. Due to this very specific way of manufacturing, many decisions revolve around trade-offs in efficiency, flexibility, and downtime management.

Multitasking machines integrate multiple processes into one unit, which simplifies workflows but suffers from lower overall efficiency due to compounded downtime; if one module fails, the entire system halts.

In contrast, modular loop or line systems decouple process steps by using separate machines for each task, such as multiple blockers, generators, and polishers. If one machine goes down, others in the loop can still operate, maintaining production flow.

Besides reducing the impact of individual machine failures, this approach allows for superior load balancing with different materials and improves overall system efficiency. Due to the generally higher output separate machines can also be competitive in terms of lens per hour per square foot and investment per lens per hour.

There are different opinions on which option is fundamentally better, and it depends on the requirements and needs. But from Satisloh's perspective the loop or line configuration remains the preferred option. Its modularity enables better line balancing, easier maintenance, and a reduced risk of system-wide stoppages.

This preference is reinforced by evidence from other production industries, where separate, multi-functional machines have demonstrated greater efficiency than all-in-one solutions.

Opportunities and benefits of blockless technology

The shift to blockless technology offers numerous potential advantages, especially in terms of production simplicity and efficiency:

- Fewer production steps: Eliminating two stages, blocking and deblocking, shortens processing time.
- Reduced set-up times: Simplifying the process reduces set-up times, allowing faster transitions from one stage to another.
- Lowered material costs: Eliminating block pieces and blocking consumables reduces operational expenses.

Challenges of initial approaches to blockless surfacing

From Satisloh´s perspective the initial approaches to blockless technology that have been recently introduced to the market have shown technical and operational limitations that need to be addressed before the technology can become a viable industry standard.

On the one hand this is a reduced working range: The front and back lens curve are significantly limited, as well as the diameter range, the lens material choices and non-rotationally symmetric surfaces like front side progressives cannot be processed.

Another challenge is reduced throughput: Due to additional machine functionalities required for blockless processing, throughput of current

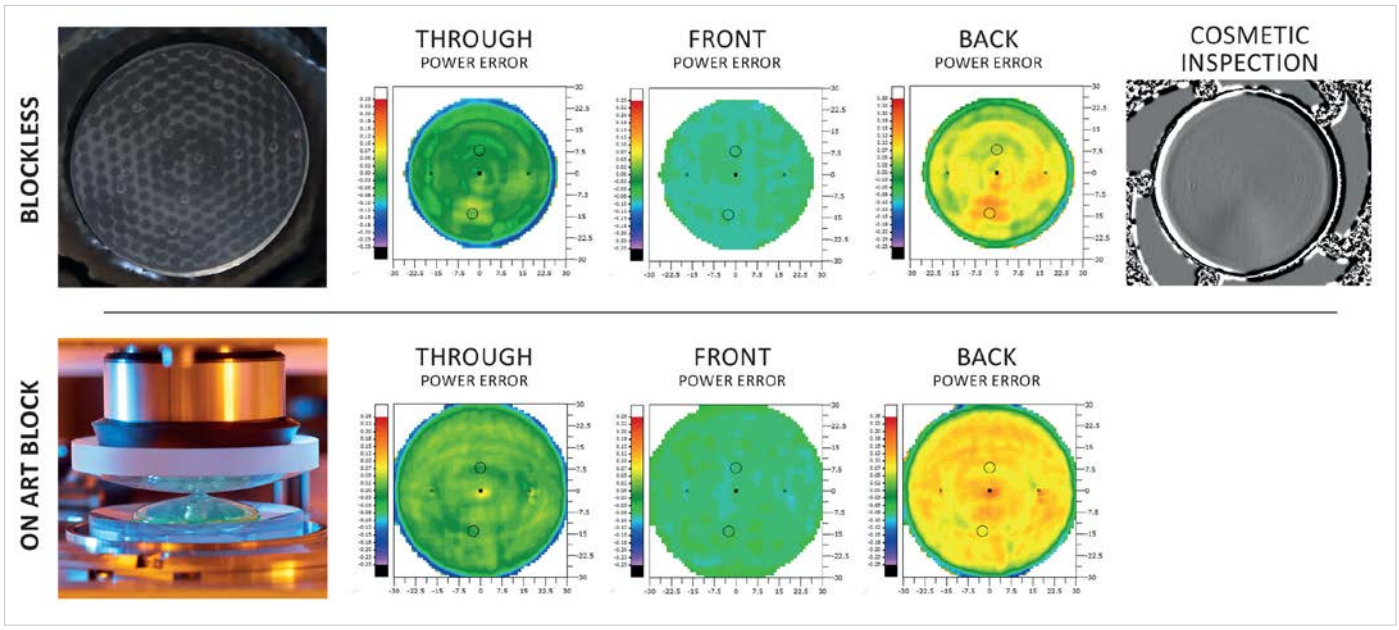

Fig.4: *Test job results with: CR 39 | FC 2.5 | BC-2.00/-4.00 | Add 2.00 | ø 60mm. Picture: Satisloh*

approaches is lower than traditional blocked processes. This limitation is critical for high-volume labs where maximizing production capacity is a top priority. And finally line balancing and machine downtime is a challenge: With traditional blocking, multiple machines handle specific stages of production. If one machine experiences downtime, the rest of the line can often continue. This often does not apply to multitasking machines that handle multiple steps, and where any machine downtime impacts the entire process. This limitation underscores the importance of line balance and redundancy in high-volume production settings.

Overcoming blockless technology limitations

The new approach aims at overcoming these limitations by introducing several solutions:

Patented pin vacuum reception: Satisloh's pin vacuum reception functions similarly to a pin-point impression mat, combined with a protective tech membrane and vacuum-based grip, providing the support needed to hold the full lens diameter securely without a traditional block. Tests have shown that this technology holds the lens as firmly as the ART blocking process.

Integrated smart cribbing technology: Integrated into the blockless generator, smart pre-cribbing technology eliminates knife-edge lenses, preventing damage to the pin vacuum reception, while processing lenses of a wide range of diameters and almost unlimited prescription range.

Throughput: Based on Satisloh´s proven technology, and processes we expect the same quality results with only a slightly lower throughput reaching 80 lenses per hour.

Line balance: By ensuring compatibility with current line or loop configurations, Satisloh's blockless machines will work alongside traditional systems, offering flexibility and reducing potential disruptions as labs transition to blockless surfacing.

Initial results

Satisloh's initial tests with the company's blockless system have shown promising results. For example, a CR39 progressive lens with a base curve of 2.50, back curves of -2.00, and -4.00 in the two major meridians, and an addition of 2.00 was processed on the blockless system. The quality and cosmetic results were comparable to lenses processed with ART blocking technology in both cosmetic and optical quality. Furthermore, preliminary testing across various materials, prescriptions, and diameters has shown that almost the entire range of materials and geometries can be processed with only small limitations. ◆

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Dr. Michael Kreis joined Satisloh and the optical industry in 2016. He is VP Global R&D for Satisloh, a leading manufacturer of surfacing, coating and finishing equipment. Kreis holds a Dr.-Ing. degree in Production Engineering from the Technical University Darmstadt. Besides his research activities on machine tool vibration behavior, his previous experience includes R&D management for high speed milling machines at Datron (Mühltal, Germany) and for steel beam processing installations at Kaltenbach in Lörrach, Germany.