Roundness Technologies

RON-Centric

The most effective grinding technology for bearing industry

Bearing manufacturing problems and trends

Grinding is the core process in the bearing industry. It takes most of the time and production costs. Quality and productivity of grinding operations strongly influence the company's success.

The shoe-type centerless grinding (often referred to as 'Microcentric') is the most common technology for the production of bearing rings. It is so widespread because of three main advantages:

- Very fast workpiece loading and unloading.
- The ring is being ground in the unstrained state and its form is not changing after unloading from the machine.
- It is possible to achieve the workpiece roundness better than the workhead spindle's accuracy.

In the same time Microcentric technology has several important fundamental weaknesses:

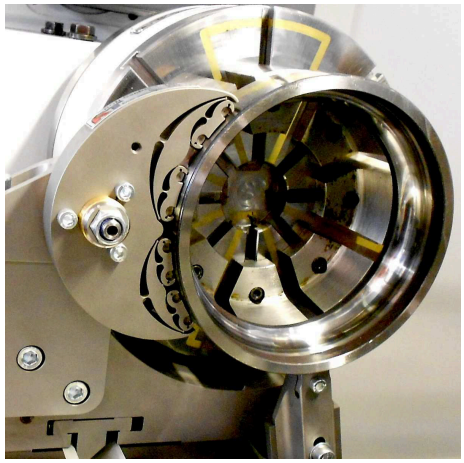
1. Low geometric and dynamic stability of the grinding process. The final ring roundness is very sensitive to the shoes optimal placement, the ring initial roundness, feed rate and other conditions. Various harmonics may increasingly regenerate due to above factors.
2. Considerable time wastes to change machine setup. Only highly skilled personnel can do this job. Operator must find the optimal shoes positions (alpha and beta angles between the shoes and the grinding point). This alpha-beta optimum is a hard compromise between productivity and accuracy. Several iterations are needed usually. Also this technology requires the regular accuracy monitoring and periodical adjustment.
3. Lack of stiffness of the workpiece-machine system. It becomes the huge problem for thin walled bearings.

Overcoming of the mentioned technology flaws is crucial today. The global bearing market is very competitive. It demands higher precision and more customized bearings under tightened prices.

Many bearings are being produced in small batches now. Technological flexibility is the key to making money in these conditions. Lack of skilled industrial labor hits all economies. Long and complicated machines setups turn into a real problem.

In addition the modern bearings become lighter and lighter because of new steels and advanced design. It means the rings become thinner and the problem of low stiffness grows up.

RON-Centric



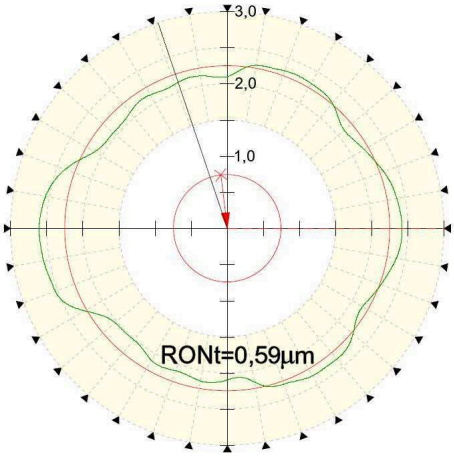
RON-Centric is the latest generation of the centerless shoe-type grinding technology. It keeps all advantages of traditional technology and eliminates its main drawbacks.

RON-Centric provides much better flexibility, accuracy and productivity in the same time.

RON-Centric is a tooling system replacing the traditional Microcentric shoes. This technology is based on the unique concept of multipoint centering. Design of the side shoe is mathematically optimized to correct roundness errors. The monolithic, precision shoe is made of the high strength titanium alloy and has six internal degrees of freedom, provided by the frictionless flexible hinges.

RON-Centric design guarantees suppressing of any roundness deviations for 2 through 500 lobes (harmonics)!

Because of the optimal internal structure, RON-Centric system does not need any optimization of the alpha-beta angles. The side shoe is always fixed on the level of spindle centers (180 degrees from the grinding point). Position of the bottom shoe is not very important and varies.



As a result RON-Centric provides many additional advantages, which are critically important for the higher total efficiency:

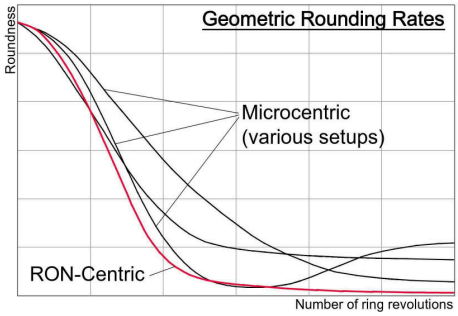
1. Very stable grinding process. High geometric stability is provided by the internal RON-Centric parameters and does not depend on alpha-beta optimization. Higher dynamic stability is provided by the optimal shoes positions and by the multipoint mechanical contact.
2. Final roundness <0.001mm can be achieved in one operation, regardless of a workpiece initial form. All lobes (harmonics) are being removed. The chart shows the typical roundness.
3. Very easy and fast setting up process. The shoes angles are fixed forever. RON-Centric shoes are changeable. Even a beginner can do this job in a few minutes with excellent results. No iterations are needed. Extra rings are not wasted to find the optimal machine setup.

4. Higher rounding rate (roundness improvement per revolution of the workpiece). The rounding rates are compared in the graph.

5. Increased stiffness of the workpiece-machine system.

6. The same RON-Centric setup is suitable for OD and ID grinding. (Microcentric needs different alpha-beta parameters for these operations). It allows to grind the ring completely in one set up. It is the most efficient technique for small-scale production of precision bearings. The four-step grinding cycle can be realized for the best accuracy: OD roughing- ID roughing – OD finishing – ID finishing.

7. Technology suitable for both modern and older grinding machines.

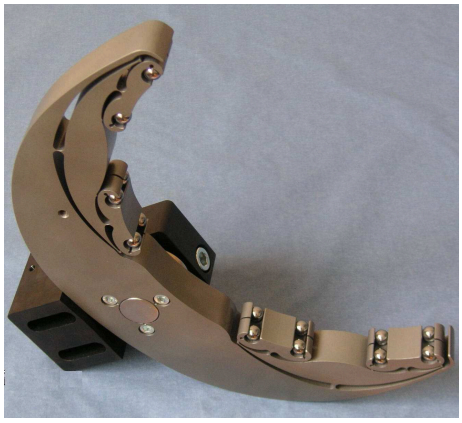


- **The sum of RON-Centric advantages increases drastically the total productivity and quality.**
- **Grinding operations become much more efficient and especially – for small-scaled premium products.**
- **Many market leaders and small companies have been successfully employing RON-Centric in the most troubled situations.**

RON-Centric-T

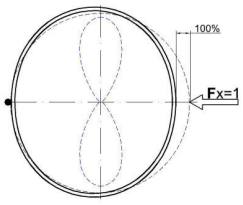
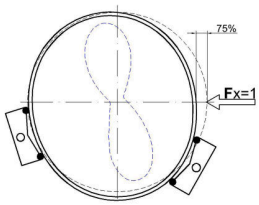
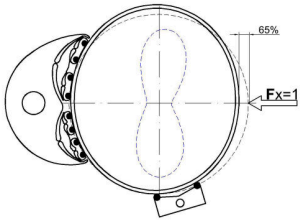
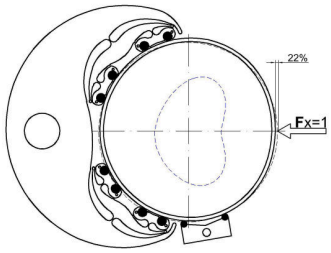
The ultra-light and special thin-section bearings are required in many growing industries – aerospace, robotics, high-speed machine tools, etcetera. Modern bearings can be much lighter than 30 years ago while able to keep the same load capacity and durability. It is possible due to the progress in steel industry and the latest computation methods. But production of such bearings meets lots of problems.

Most of all the troubles are associated with the thin walled rings. Such rings get much greater deformations after heat treatment than heavier ones. So their initial roundness before grinding is worse. In the same time it is very difficult to improve roundness by grinding because these rings have low stiffness. Manufacturers use long and multi-step grinding cycles to solve this problem. Some of thinnest rings are so flexible that it is impossible to grind them with Microcentric technology at all. They should be fixed on a mandrel to be ground. This technology has low productivity also. In addition rings change roundness after removing form the mandrel.



RON-Centric-T is a real revolution in this field. This shoe system is based on the same ideas and mathematical models as the basic RON-Centric version. It keeps all main RON-Centric advantages. But its parameters are optimized to increase total stiffness first of all. The RON-Centric-T shoe has much longer contact with the supported ring than a standard shoe. Because of this fact it suppresses roundness deviations for 2 through 150 lobes only. **But it increases the total stiffness 3 times!!!** The bottom table compares stiffness and deformation of the ring in various shoe systems under the equal force.

- **RON-Centric-T reduces processing cycles in several times, often – from hours to minutes.**
- **It provides the excellent roundness for very thin rings (unattainable by other technologies).**
- **The new types of ultra-thin rings can be ground easily on the RON-Centric-T shoes without any mandrels.**

Free ring	Microcentric	RON-Centric	RON-Centric-T
Stiffness=**100%**	Stiffness=**130%**	Stiffness=**150%**	Stiffness=**450%**
			

- **RON-Centric technology is suitable for diameters over 100mm, RON-Centric-T over 70mm.**
- **The shoes can be supplied separately or in a complete shoe system accommodated to a machine.**
- **The right choice depends on the specific stiffness of the ring per grinding width C/W: RON-Centric for C/W > 30N/mm^2, RON-Centric-T for C/W < 60N/mm^2, any of two in the range between.**

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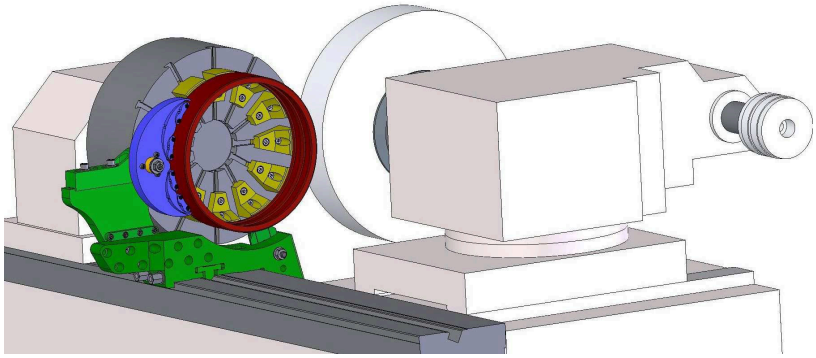
high grinding productivity logic



Higher total stiffness

Higher rounding rates

All lobes (harmonics) are surpressed (up to 500upr)

Fixed setup angle (in the level of centers)

The same setup for OD and ID grinding

Worse initial roundness is allowed (up to 0.5mm)

More stable grinding process

Easy setup for another ring type

Shorter grinding cycle (saved time 20% – 80%)

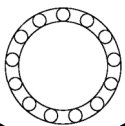
Grinding in 1 go (instead of 2 and more)

More rings are within tolerance (not rejected)

Shorter setup cycle (saved time 50% – 95%)

Two grinding operations in one setup

Increased productivity



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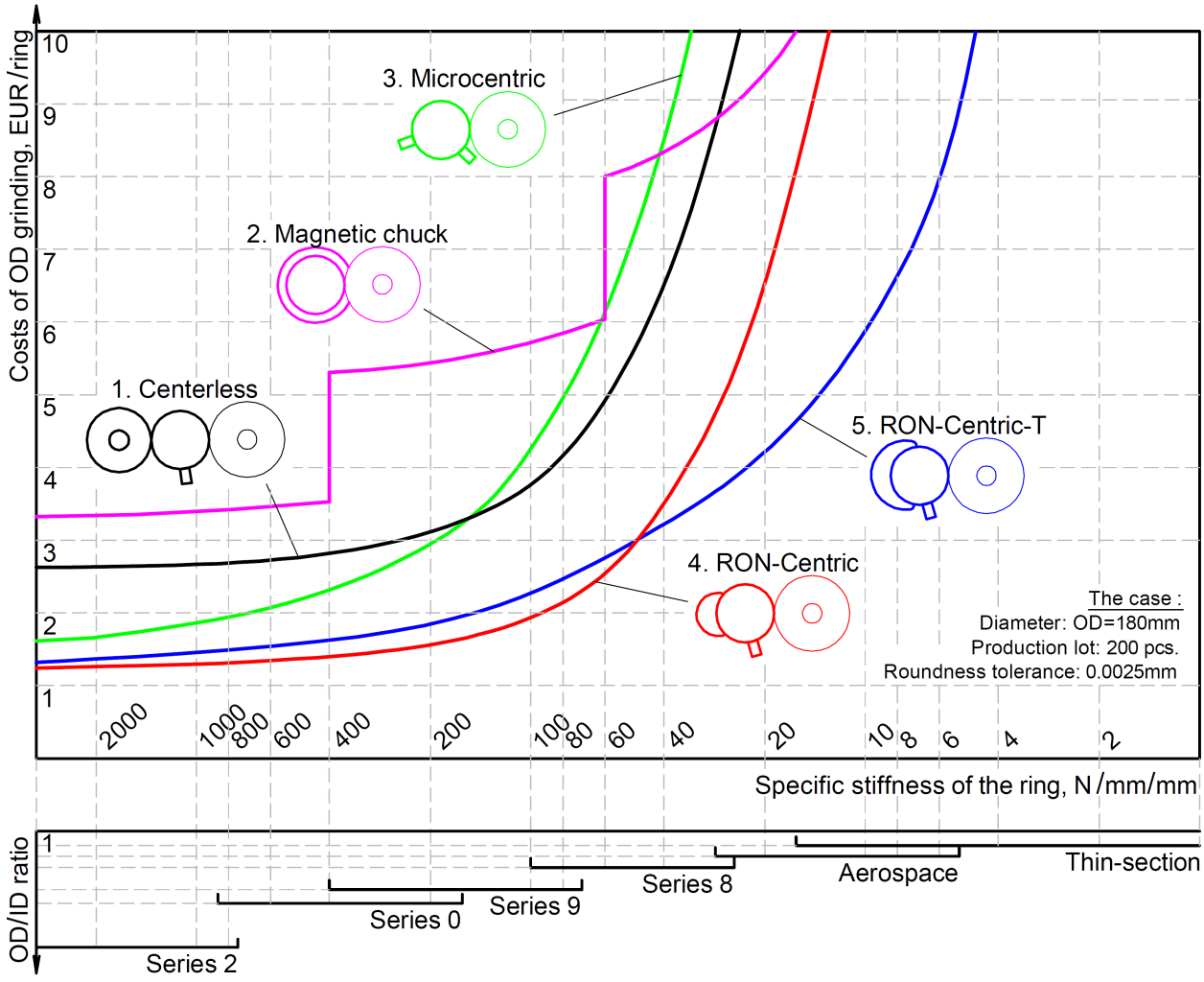
Cost analysis for precision OD grinding

Every manufacturer would prefer to choose the proper production technology on the clear cost-reduction basis. But often it can be difficult. In contrast to the well-known mass production, modern bearing manufacturing is very flexible and complicated for economical analysis. The manufacturing costs become very variable if hundreds of different precision parts are produced in small batches. And precision OD grinding of the rings is especially volatile part of the process. The grinding cycle time and machine setup time highly depend on the stiffness of the ring and roundness tolerance assigned. The other important factor is the portion of the rejected rings (including the ones used to prove machine setup). All these matters make the detailed cost analysis too labor-intensive and expensive itself.

To make the situation easier we offer to compare the OD grinding costs calculated for the typical case. The found ratios can be extended to other cases with the use of according scaling factors.

Costs of precision OD grinding depending on the technology and specific stiffness of the ring.



The above chart shows the costs per one ring for various OD grinding techniques depending on specific stiffness of the ring (stiffness per grinding width) and in correlation to the dimension series (OD/ID ratio). The cost analysis takes account of grinding cycle time, setup time, part loading/unloading time. The costs found for the following conditions: the production lot of 200 rings with the outer diameters 180mm and roundness tolerance 0.0025mm.

Of course, the absolute figures vary for different companies and countries. But the ratios remain practically the same for 100mm<OD<400mm. The wide analysis confirms the centerless grinder is effective for the large production lots (>1000pcs.), if the rings are stiff enough. Clamping on the magnetic chuck is acceptable for the small lots (<50pcs.). **RON-Centric (RON-Centric-T) is the most cost-effective solution for the production lots from 50 to 1000pcs.**

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