Precision Polishing



Knowledge Base for Toolmaking and Surface Engineering

„Es ist schon fast eine Kunst."

(In the words of one of my Austrian partners: "It is almost an art.")

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1. Fundamentals of Choosing a Toolmaker

What and why should you know before choosing a toolmaker?

If you, as a customer, now feel that you do not even want to spend this much time dealing with this subject, that is precisely why you should read this article:

It will help you ask the right questions.

A tool is not simply an object to be purchased, but a complex component of a complex system involving multiple parties.

As a customer, you do not need to know this system in detail. However, it is all the more important to be aware of some basic aspects so that you can choose the right partners and thereby receive a solution that meets your goals in the form of the tool you have ordered.

Just as a stable house can only be built on a solid foundation, stable production can only be built on solid foundations. With a tool, you will ultimately have a complex technical solution in which the tool itself is not the primary value, but rather the support provided by the partners, who know and understand your needs.

What is it worth knowing as a customer before choosing a toolmaker?

Let us first look at an everyday example.

We can probably agree that we do not need to know the intricacies of car manufacturing to choose a car. However, we do need to know what we are going to use it for, and which features are important for the vehicle to be suitable for our purpose.

Obviously, the same car will not be the best choice for commuting to work in the city as for business trips covering several thousand kilometres, or for transporting goods.

It may be less obvious, but the situation is surprisingly similar when choosing a toolmaker, so it is worth thinking about this in the same way.

Let us briefly look at the questions that arise from the manufacturer's perspective when making a tool, for orientation:

- What type of product will we manufacture with the tool, and what material will it be made of?
- What service life, production volume and durability should the tool be designed for?
- Should it be modular, upgradeable, or a "disposable" design?
- Is it intended for cyclical or continuous production?
- On which machine will it be used? - The tool must also be adapted to the parameters of the machine!
- Where can we use standardized (cost-effective) components, and according to which standard, and which parts require completely customized solutions?
- And, of course; which solutions are also cost-effective within the budget over the entire planned life cycle?

Who are the key participants in the network, and why is this of interest to you?

- Material manufacturers, heat treatment specialists, who provide the foundation in the required quality.
- Product developers, designers, and product and tool management, who assess the requirements, align the various aspects with each other, and design the product and the tool.
- Machine shops, which manufacture the components with the required precision.
- Toolmakers, polishers and coating specialists, who carry out the final finishing and assemble the tool.
- Testers, whose feedback enables the others to carry out the necessary optimizations before the tool is handed over to you as a proven, functional solution.

Some companies offer comprehensive solutions, while others – like me – specialize in one particular area, supporting the joint work with their high level of expertise and capacity.

As a customer, it is in your interest that, whether you choose a partner offering a comprehensive solution or coordinate the individual tasks yourself, the resulting network provides a complete solution to your problem, precisely tailored to your requirements, as described below:

(Similar to building our own house, where we can choose between a general contractor and organizing the work ourselves.)

What is it that you decide when choosing a supplier or toolmaker?

• How much do you have to personally deal with the project, and how many tasks does the selected professional partner take over to ensure that production of the product can start properly and on time?

• How long should the supply chain be, e.g. if spare parts or repairs are needed?

• What happens if a problem arises during production (e.g. with the product's fit on the production line) that could not have been foreseen and the tool needs to be adjusted so that the product is suitable?

• In such a case, who can you turn to, and how much time and cost are required to solve the problem that has arisen and requires an on-site assessment?

• Does this local partner know the tool's design, material and history, as well as the design considerations behind it, so that they can respond to the problem immediately?

• At what physical distance is the required expertise and capacity available?

• What happens if the product or the requirements change and the tool needs to be developed or modified?

• Who will maintain and repair the tool, do they know it and understand how it should be properly handled?

• What are the warranty conditions and options?

Summary

By choosing the toolmaker, you influence all of these consequences.

For this reason, it is worth carefully considering the options over the life cycle of the tool and the product,

because it can easily happen that a lower initial cost (a cheaper tool) ultimately results in higher overall expenditure,

and is also associated with additional effort and ties up many resources that you could otherwise devote to production.

In other words, a solution that is not chosen appropriately can cause losses in two ways!

Together with my partners, we are happy to help you find the solution that is truly most suitable for you in terms of value for money!

I can personally help you find a toolmaker who can be a suitable partner for your goals,

and I can also contribute to maintaining your production processes efficiently through my repair services.

Through my articles, I aim to provide both professionals and interested laypeople with further useful information to help them better understand the world of toolmaking and maintain cost-optimized, efficient cooperation on a win-win basis.

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2. The Foundation of Shared Success Is Mutual Trust That Is Given and Earned.

What does trust that is first given and then earned mean to you in your daily work?

This is not a philosophical article. Based on real industrial experience, its purpose is to help people in different professions and businesses, regardless of their size, make the most of the benefits of cooperation in their daily work—benefits that neither party should overlook.

What are these advantages?

Have you ever won a job because your customer knew that you had a reliable partner for a specialised part of the task?

In a partnership, the visibility of the partner can be beneficial to both parties in the long term. The presence of a suitable, well-known partner increases the customer's confidence and can create opportunities to win projects where the partner's specialised expertise assures the customer that the task will be carried out properly, even if the contracted company is not specialised in that field or does not have sufficient capacity on its own.

For the partner, this creates visibility and references that provide a basis for development and continued existence **— which is ultimately also in the interest of the partner who makes them visible and recommends them, as their partner can thus provide reliable support in the long term.**

A micro-business and a large company obviously do not share the same strengths and advantages.

The competitive advantages of a micro-business lie in tailor-made solutions, flexibility, and the ability to respond and adapt quickly. Especially in fields requiring highly specialised expertise, this can make a micro-business an exceptionally valuable partner for a large company, enabling it to undertake projects for which building and maintaining its own in-house capacity would not be economically justified. Furthermore, involving a micro-business can help resolve production interruptions or capacity shortages more quickly, reducing the resulting losses in high-volume manufacturing.

The strengths of a large company are clearly its financial stability, standardised processes and production capacity. These provide a reliable basis for long-term cooperation and help overcome liquidity-related challenges. Nevertheless, even large companies cannot completely avoid issues affecting production continuity. As described above and in the following sections, a micro-business can provide valuable support in reducing the impact of such situations.

The objective is shared, the benefits are mutual, and the way of working together should also be developed jointly so that the strengths of both parties can be fully utilised.

Working with smaller business partners is not necessarily a competitive advantage because they provide the same services as a large company on a smaller scale. Rather, it is because they can offer advantages that, by their very nature, large companies cannot provide in the same way.

For this reason, the terms of cooperation do not need to be identical for every partner. In fact, applying the same approach to everyone may even prevent both parties from fully benefiting from the partnership.

Many of the obstacles that stand in the way of successful cooperation can be overcome with just a few simple steps.

Large companies and their employees (regardless of their position) should not adopt these practices in order to "accommodate the needs of a micro-business". They should do so because it enables them to benefit from the advantages that a micro-business can offer.

What Matters to Each Party – and Why?

For a large company, one of the highest priorities is to deliver its products to customers with the required quality and on schedule, as higher production volumes also mean that potential losses can be significantly greater.

It places its trust in a micro-business by entrusting not only valuable tools, but also part of its production process — or the rapid restoration of that process—to its partner.

The micro-business earns that trust by fulfilling its commitments completely and reliably.

For a micro-business, on the other hand, liquidity and the financial reliability of its customers are among the most important factors because of its more limited financial resources.

It places its trust in its customer by accepting responsibility for the assigned work and, until the invoice is paid, effectively financing the value of its own work on the customer's behalf.

A larger partner earns that trust by establishing internal processes that allow shorter administrative lead times for smaller suppliers, ensuring direct and meaningful communication, and paying invoices within the agreed payment terms.

A micro-business applies shorter payment terms simply because its administrative and financial flexibility is more limited.

As it usually manages fewer projects at the same time, they cannot offset each other's financing to the same extent as they can within a larger company.

As a result, even a single late payment has a proportionally much greater impact on both its day-to-day operation and its liquidity.

These two needs, however, are not in conflict with each other!

These are naturally different operating models that can only create value together if they also take each other's needs into account.

How Can It Work Successfully?

Clearly, a small business must also take the necessary steps to ensure smooth cooperation. However, its possibilities are naturally more limited.

It can

- be more flexible,
- provide the required expertise,
- deliver on time,
- work in a documented and traceable manner,
- take responsibility for its work,
- and complete the assigned tasks with precision.

What it cannot do is

- financially bridge longer periods without payment,
- or carry out additional administrative work that could have been avoided, as this would reduce the capacity available for the production-related work itself.

A small business—and especially a micro-business—is able to respond quickly and flexibly because its decision-making process is shorter, its communication is more direct, and its internal processes are simpler.

A large company can easily benefit from these advantages because it has the ability to

- appoint a dedicated contact person who takes responsibility for communication and forwards questions to the appropriate colleagues,
- agree in advance with its small business partner on how the cooperation will work and under what conditions, ensuring that neither party faces unpleasant surprises,
- establish internal processes that allow it to benefit from the strengths of a small business partner without disrupting its own operations.
- Examples include simplified invoice processing below a defined value threshold or appointing a dedicated financial contact for small suppliers.

In return, it gains:

- specialist expertise that is available quickly whenever needed,
- a loyal business partner,
- additional production capacity,
- valuable professional contacts,
- and broader experience and perspective.

If a company applies exactly the same cooperation processes to a micro-business as it does to a multinational supplier, it may lose precisely the advantage for which it chose the micro-business in the first place.

Trust is a two-way process. Both parties must first extend it and then earn it in order to build a long-term partnership that is mutually beneficial. However, both extending and earning trust have different meanings in the operation of a large company and that of a micro-business.

Cooperation works best when the parties do not expect the same things from each other or contribute in the same way, but instead each makes the most of its own strengths and opportunities to achieve shared success.

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3. From First Impressions to Cycle Time...

Among the many processes involved in toolmaking, there is one essential step that is rarely discussed. Its cost and the time it requires are clearly visible, yet its real value is usually reflected only indirectly through indicators such as:

- cycle time,
- costs over the entire service life of the tool,
- part release,
- productivity and downtime,
- long-term reliability,
- maintenance requirements,
- product quality,
- manufacturing time and costs,
- customer satisfaction as a result of all these factors,
- and ultimately the marketability and competitive advantage of the finished product.

Why is this the case, and how can we turn a process that is often treated as little more than a necessary evil into a genuine business advantage?

Perhaps the reason is that, during tool manufacturing, only the cost and time required for this process appear directly in reports, while its real impact does not.

However, as the above list clearly shows, this is in fact a relatively small long-term investment with considerable indirect profit potential.

This process is surface finishing, and the result of a **well-finished surface is far more than just an attractive appearance**!

Modern machining centres provide an excellent foundation, significantly reducing the amount of manual work required, including surface preparation. However, in many applications they cannot replace manual finishing, or it would simply not be practical to look for a fully machined solution.

If cycle time, part release, maintenance requirements, downtime and product quality are all considered important performance indicators, why is surface finishing and polishing so often regarded merely as a cost rather than as one of the factors influencing them — one of the potential tools for achieving success — when that is exactly what it is?

Creating the required surface finish by hand is typically a one-time investment, whereas the consequences of an inadequate surface finish may recur throughout the entire production life of the tool.

Inadequate Surface Finish

- ✖ parts sticking in the mould
- ✖ manual intervention
- ✖ longer cycle times
- ✖ increased deposits
- ✖ higher release agent consumption
- ✖ ongoing costs and losses
- ✖ constant frustration and extra work
- ✖ delayed deliveries
- ✖ reduced product marketability
- ✖ customer complaints

Proper Surface Finish

- ✔ easy part release
- ✔ stable automated production
- ✔ shorter cycle times
- ✔ reduced maintenance requirements
- ✔ less downtime and lower material consumption
- ✔ one-time investment
- ✔ continuous production
- ✔ predictable production schedule
- ✔ higher perceived quality and a better first impression
- ✔ more satisfied customers

Yes, surface finishing also has an influence on all of these factors, alongside other important parameters such as geometry, dimensional accuracy, cooling and many others!

In reality, everyone measures the results of surface finishing, yet the process itself is not always recognised as a factor that influences overall performance.

By giving proper attention to surface finishing, you can achieve:

1. Manufacturing Benefits
- improved part release
- shorter cycle times
- reduced downtime
- lower maintenance requirements

2. Economic Benefits
- lower long-term operating costs
- reduced losses
- less scrap
- more stable production

3. Market Benefits
- a better first impression
- higher perceived quality
- greater customer confidence
- fewer customer complaints

If you had to choose between these three sample products;



which one would make the best first impression on you?

The right surface finish influences not only manufacturing efficiency, but also what the customer thinks about the product in their hands <u>and the company that produced it.</u>

Interestingly, when discussing toolmaking, virtually every major process is mentioned—from design to CNC machining—yet surface finishing is often omitted, even though its results are measured every single day.

For this reason, the effects of surface finishing should not be overlooked from either a technical or a business perspective, whether the application requires high-gloss polished, textured, brushed or functional technical surfaces.

Since cycle time, part release, downtime, maintenance requirements and product quality are all important performance indicators, surface finishing should be regarded not merely as an aesthetic process, but also as one of the factors influencing these results. Its importance—and the professional expertise behind it—should also be communicated to customers and business partners.

Whether carried out in-house or with the support of an experienced specialist, proper surface finishing is not merely a cost, but a long-term investment in manufacturing efficiency, the manufacturer's reputation and customer satisfaction alike.

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4. Cheap Polishing?

Almost every profession has misconceptions that seem perfectly logical to outsiders.

The following article outlines a few of them without attempting to provide a complete list.

Polishing paste is only a small tool—no more than a single key on a keyboard. If I only had one key, or even just a keyboard, you would not be reading this article now...

Polishing is a time-consuming process whose costs can be significantly reduced when approached correctly, but can also increase substantially if mistakes are made.

What Does Surface Finishing Actually Involve?

1. What Happens Before the Polishing Paste?

• defining the required final result by balancing technical possibilities, budget and customer requirements;

• assessing the initial condition and, wherever possible, planning ahead, as described in detail in my article "Planning Polishing";

• determining the amount of material that needs to be removed (also discussed in the second section of the above article);

• evaluating geometric risks and the material's expected behaviour;

• planning the entire process;

• developing the appropriate polishing technology;

• manufacturing the required tools;

• preparing the surface.

Only after all of this does the polishing paste come into play. Even then, certain steps are repeated throughout the process, such as producing custom-made tools suited to the specific geometry, material and polishing objective.

2. Why Can't Manual Polishing Be Compared with CNC Machining?

• CNC machining is based on fast, accurate and repeatable processes that can be planned and quantified in advance.

• Manual surface finishing, by contrast, has no program and no measurable sequence of operations. It relies on what the trained eye can recognise and what experienced hands can achieve.

Material must be removed step by step in relation to the visible machining marks or defects, while continuously keeping the entire geometry and the complete, carefully planned process in mind. Every stage must support the next one and ultimately contribute to achieving the desired final result.

In manual surface finishing, defects created during the coarse stages cannot be eliminated simply by refining the final finish.

Repeatability is not inherent in the process itself. It can only be achieved if it has already been taken into account during the planning of the entire workflow described above.

3. The Impact of Surface Preparation.

I often receive tools on which surface work has already been carried out, but not in the appropriate way.

In such cases, the work cannot simply be continued. It is first necessary to return the surface to a condition from which the desired result can be achieved safely, resulting in additional work and extra cost.

• Whether the preparation is carried out by machine or by hand, it largely determines the final result.

• I discuss machine surface preparation in more detail in the next article, which is linked above.

• With manual preparation, an operation carried out incorrectly or with unsuitable tools results not only in additional time and therefore higher costs, but also

• depending on the geometry, excessively deep scratches, grinding marks or damaged edges may even make it necessary to manufacture a new insert.

• If the surface has been prepared incorrectly, these defects must first be removed before the required finish can be achieved. In many cases, this requires more work than starting from a properly machined surface.

Defects introduced during surface preparation cannot be removed with finer tools or the final finishing stages. On the contrary, the finer the finished surface becomes, the more visible those defects will be.

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• In my experience, this is related to a common misconception: many people believe that the final finishing or "bringing out the shine" requires the greatest skill and attention. In reality, surface preparation is no less demanding, and if it is not carried out correctly, the final polishing will never produce the desired result.

To achieve the desired final result, the effect of every preceding step must be understood in advance and the entire process must be built accordingly. In this respect, it is similar to writing a CNC program—if the roughing operation removes too much material, the finishing pass cannot correct the mistake. The difference is that manual surface finishing is carried out without numbers or software, relying entirely on experience, the trained eye and skilled hands.

4. The Tools Required.

Another common misconception is that polishing requires little more than a few polishing compounds, a machine and some spare time.

Let me briefly outline what is actually required for professional polishing—without claiming to cover every aspect.

• Although the catalogues of polishing tool manufacturers and suppliers are "only" a few hundred pages long,
• every tool is different, making it impossible to manufacture suitable tools in advance for every individual task.

In addition to the expertise already described, professional polishing also requires, for example:

• Stands, V-blocks and precision vices
• Machinery suitable for machining cylindrical and rotational components
• Rotary, linear and ultrasonic polishing systems, including electric and/or pneumatic equipment selected for the specific application
• Tool holders capable of working at different angles
• Proper lighting with suitable light intensity and colour temperature
• Magnifiers, microscopes and other surface inspection equipment
• A dedicated working environment (for example, a single metal particle from deburring can ruin an almost finished surface)
• Abrasive stones, abrasive cloths and abrasive papers in a wide range of sizes, materials and hardness grades
• Hand-held and machine accessories designed to hold these abrasives for the specific geometry
• Diamond abrasive tools (hand and machine files, diamond films)
• Flap wheels and other rotary abrasive tools
• Lubricants, cleaning agents and cleaning equipment

Only after all of this do we arrive at the actual polishing materials, such as:

• Diamond compounds (for different applications and materials, typically in at least six grades)
• Other polishing compounds
• Emulsions
• Polishing sticks made from wood, plastics, composites and metals, available in various hardnesses, sizes and shapes—from tools for gaps of only a few tenths of a millimetre to those suitable for surfaces spanning several hand widths
• Felt, microfibre materials, papers and cotton polishing media, likewise available in various sizes, shapes and hardnesses
• Hand-held and machine accessories for applying these materials
• Custom-made polishing tools and abrasive heads manufactured individually for every unique geometry

And finally, the expertise and experience required to combine and apply all of these tools in the right sequence and in the right way.

Today, polishing compounds can be purchased with just a few clicks. However, the knowledge, experience and complete set of tools required to achieve the right surface finish are far more complex.

I am pleased to assist you in creating cost-optimised surface finishes tailored to your specific requirements, whether for new tools or repair work,

so that surface finishing does not generate avoidable costs,

making it genuinely cost-effective within reasonable limits.

5. Professional Guidance for Planning Surface Finishing

I often encounter situations where rapidly changing market conditions and new manufacturing technologies create unexpected challenges for production processes that have worked successfully for years. In other cases, a company enters the market for products or tools requiring polished surfaces for the first time, facing challenges it had never previously encountered.

Surface finishing also needs careful planning. This article is intended to help you with that process.

What Should Be Taken into Consideration?

1. Selecting the Right Material

Naturally, the primary consideration is always that the insert material meets the required mechanical and chemical properties. Within these requirements, however, there are usually several suitable material options.

From a polishing perspective, a material that polishes well is not necessarily one that polishes quickly. For high-quality surfaces (typically finer than approximately 10 microns), the price of the material—although certainly not insignificant—should no longer be the primary deciding factor.

It is always advisable to consult the material manufacturer rather than selecting a grade solely by its designation. Material standards define permissible tolerances, meaning that a particular producer may not recommend one of its own materials for a specific surface finish requirement. This can lead to unpleasant surprises, especially where fine, high-gloss surfaces are required.

It also makes a difference whether a manufacturer specialises in materials intended for high-quality polished surfaces or primarily serves other industrial sectors while producing the same material grades — or perhaps both.

2. The Machining Process

The first step is selecting the appropriate manufacturing process itself, such as turning, milling, grinding or EDM (Electrical Discharge Machining). Within each of these processes, however, choosing the correct machining parameters is equally important.

General but Important Considerations:

• To obtain a surface free from machining marks, material must be removed from the entire surface down to the bottom of the deepest machining mark. It is therefore easy to see that if the deepest mark is, for example, 0.1 mm deep, then 0.1 mm of material must be removed from the entire surface using tools that are much finer—and therefore considerably slower—than those used for machining. Moreover, the greater the amount of material to be removed, the coarser the tools that are generally required. The marks left by these tools must then be removed with progressively finer ones, adding further processing time and additional finishing stages.

• Furthermore, the more material that has to be removed and the larger the surface area, the more difficult it becomes to remove exactly the same amount of material everywhere using hand tools. As a result, maintaining the intended shape, geometry and dimensional accuracy becomes increasingly challenging.

• For these reasons, it is usually worthwhile paying greater attention to the quality of the machined surface, as this can reduce the manual polishing effort by as much as 30–50%.

About Individual Machining Processes:

• Turning

In turning, even the choice of insert grade should not be underestimated. A higher-quality insert may produce a sufficiently better surface finish for its additional cost to be recovered during the polishing process. For example, it is often worthwhile to perform the final finishing pass with a dedicated insert used exclusively for that purpose, avoiding unnecessary wear during rougher machining operations. The same applies to feed rate selection: the additional machine time is almost certain to pay for itself during manual polishing, for the reasons explained above.

• Milling

For non-rotational components, milling is clearly the preferred choice wherever it is technically feasible. Modern machining centres and high-precision cutters are capable of producing surfaces that can often be polished almost immediately, eliminating one, two or even more abrasive finishing stages and saving a considerable amount of time. Furthermore, milling generally produces machining marks of relatively uniform depth that are easy to identify, making it the machining process that offers the best conditions for maintaining the intended geometry during subsequent manual finishing.

• Grinding

In most cases, grinding is not the most effective solution. Although it appears to produce a very uniform surface, achieving a sufficiently fine base would require an excessively fine grinding wheel, making the process uneconomical in terms of both time and cost. By its very nature, grinding creates millions of tiny scratches with an elongated triangular profile, while detached abrasive grains and metal particles inevitably become embedded in the surface. Because these marks vary in depth and are relatively deep, removing them can be surprisingly difficult. For this reason, the general principles discussed above apply even more strongly in the case of grinding.

• EDM (Electrical Discharge Machining)

EDM is often an unavoidable manufacturing process and, in many situations, the best available choice. At the same time, however, it can make subsequent polishing considerably more difficult.

Where a surface can be machined by milling, using EDM is generally not worthwhile from a polishing perspective.

This is partly because producing a sufficiently fine EDM surface is time-consuming, and partly because EDM hardens the surface layer. Another fundamental characteristic of the process is that it creates countless tiny craters of varying depth. A perfectly polished surface can only be achieved once even the last of these microscopic craters has been removed. Unfortunately, some of them become visible only when the surface is already close to its final finish, making it necessary to rework the surface several times. The rougher the EDM process, the deeper these craters will be.

For high-quality polished surfaces, the machined surface should ideally be no rougher than VDI 16, and in any case not rougher than VDI 20.

Another potential disadvantage is the risk of arcing in areas where flushing is insufficient. This may create deep craters that can render a component unusable because too much material has to be removed, resulting in dimensional deviation.

It is also important

that whenever a sink EDM surface is intended for polishing, a copper electrode should preferably be used, and its working surface should itself be finished by hand (essentially polished). Milling marks left on the electrode are reproduced on the steel surface, where removing them takes considerably longer than removing them from the electrode itself. This effect is multiplied if the same electrode is used to produce several workpieces.

With wire EDM, it is also almost unavoidable that a witness line or a slight step will remain at the point where the cut begins and ends. This can be particularly problematic on rotational parts and in bores, because either material must again be removed from the entire surface down to the depth of that line, or removing it locally will result in ovality.

3. Accessibility of the Surfaces

• Wherever possible, polished surfaces should be designed to provide at least a 45° viewing angle, and ideally a direct 90° line of sight.

• This is not simply a question of whether a polishing tool can physically reach the surface.

• Since visual inspection is the primary means of controlling the polishing process, it is equally important whether the surface can be observed directly or whether, for example, reflections from a textured surface interfere with its inspection. In such cases, evaluating the quality of the finished surface may only be possible after moulding the plastic part, making additional polishing work potentially necessary.

• It is also important to consider which tools can reach the surface and from what angle. This directly influences the pressure that can be applied during polishing and therefore affects both processing time and cost.

• For rotational geometries, it is generally advisable to design the insert itself as a rotational component that can be clamped in a lathe chuck.

• For partly rotational geometries, a well-designed parting line or the addition of an extra insert (where mechanical requirements allow) can reduce polishing costs by as much as 50%, for the same reasons discussed earlier under the general considerations.

4. Timing

When product prototypes are being developed, it is not always possible to take polishing requirements into account. However, once the mould is being designed and the product model is available, it is always worthwhile considering surface accessibility from the very beginning.

Accurate quotation of polishing work is only possible once the mould models and drawings are available, precisely because all of the factors discussed above have a direct influence on the machining time.

It should also be considered whether, for example, unpolished sample parts need to be produced first, or whether polishing should be carried out in two stages. This allows the trial parts to be evaluated while avoiding the need to repeat the entire polishing process if design modifications become necessary.

Overall, polishing is always one of the final stages of tool manufacturing, where delays from previous operations have often accumulated. At the same time, rushing the polishing process is rarely beneficial, as correcting mistakes at this stage is usually time-consuming and may even require inserts to be manufactured again. For this reason, errors caused by unnecessary haste can have the greatest consequences.

The beauty of toolmaking lies in the fact that every tool is different and presents new challenges. Achieving the best possible result therefore requires close cooperation, combining knowledge, experience and an understanding of each stage of the manufacturing process.

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6. Surface Quality – Standards – "Mirror Polish"...

Although it may seem straightforward, selecting and specifying the appropriate surface quality is far from simple. This article is intended to help you make the right choice.

First of all, I would like to mention the frequently used term "mirror polish". On its own, it is not suitable for specifying a surface finish, because even within the range of finishes that may be described as "mirror polished", the cost can differ by as much as 60–80%, depending on the application.

The quality of polished surfaces can differ by orders of magnitude between industries (such as automotive, packaging or electronics), and even within the same industry. For example, an average household appliance and a premium product may require completely different types of surface finish, even if the components perform exactly the same function. For this reason, the primary consideration is always understanding the customer's requirements, which in most cases are strongly influenced by the available budget.

If the required surface finish has not been clearly specified by the customer, or if the requested finish does not appear to be the most suitable choice for the intended application, please feel free to contact me. For the surfaces I produce, I am always happy to assist in selecting the surface quality best suited to the product.

Free sample cards are also available, allowing different surface finishes to be viewed, handled and compared in person.

Standards

are not always straightforward either, partly because several different standards are in use, and partly because their interpretation is not always entirely consistent.

Personally, I prefer specifying surface finishes either by the abrasive grain size (diamond compounds, polishing stones, abrasive papers, etc.) or by the Ra/Rz roughness parameters, as these can be defined and measured relatively unambiguously.

Even within these categories, the requirements often need to be further refined according to the specific characteristics of the product. In addition, surface quality affects not only the appearance but also, for example, part release, cycle time and maintenance requirements (see my article "Surface Quality and Cycle Time").

A single diamond compound grade is capable of producing more than one type of surface finish. For example, a product may need to appear bright and glossy without requiring a scratch-free surface under magnification. In other cases, a perfectly uniform and precisely specified surface roughness may be required, where gloss is of secondary importance. Quite often, both characteristics are equally important.

For these reasons, it is always worthwhile discussing the available options individually. The range of possible solutions is virtually unlimited, and this is the best way to achieve the optimum balance between performance and cost.

7. What You Should Know About Rust.

"It's only a little surface rust..."

Unfortunately, when it comes to polished surfaces, the expression "surface rust" is misleading. The term may be appropriate, for example, when sheet metal (such as a car body panel) has corroded only superficially and has not rusted completely through.

Rust never forms on the surface — it forms from the surface itself.

Rust is simply the corrosion of the material itself—the transformation of the non-stainless steel particles at the surface of the tool under the combined effect of moisture and oxygen. During this process, the material becomes porous and expands in volume. The corroded areas therefore protrude above the surrounding surface, giving the impression that the rust is merely sitting on top of it. In reality, however, material has already been lost beneath those areas.

A rust spot consists of thousands — or even millions — of tiny rust "spots", which are in fact microscopic pits whose depth is generally of the same order of magnitude as their diameter.

This is why

although the rust itself can easily be removed or wiped away because of its loose, porous structure, the damage left behind between the unaffected areas of the surface remains.

To eliminate these defects, material must be removed from the entire surface down to the bottom of the deepest corrosion pit. Only then can the surface be polished again.

The appropriate repair method for a rust-damaged surface must always be determined individually, taking into account the size of the affected area, the depth of the corrosion pits, the geometry of the surface and its dimensional tolerances.

Depending on the depth of the damage and the geometry of the surface, restoring the original shape and surface quality may require remachining, provided that the dimensional tolerances still permit it.

If the required dimensions can no longer be maintained within tolerance, the only possible solutions are complete removal of the corrosion, rebuilding the surface by welding followed by remachining, or replacing the component.

8. Polishing? Metal finishing? What's the Difference?

Everyone knows the satisfying feeling of peeling the familiar blue protective film from a long-awaited new product and seeing its flawless, glossy plastic or metal surfaces for the first time.

When most people hear the word polishing, they imagine a cloth, a polishing compound, or perhaps the chrome parts of a motorcycle. But what does it actually take to make a stainless-steel component, a brass door handle or a chrome-plated part shine brilliantly? Or to give a plastic component—such as a car headlamp lens or the back cover of a mobile phone—a flawless, mirror-like finish?

While polishing a motorcycle component or a brass door handle belongs to the field of decorative metal finishing (which, until not so long ago, was recognised as a separate trade), precision polishing is much more closely associated with the toolmaking profession.

In decorative metal finishing

the polished metal component itself is the finished product.

Every single part must therefore be polished individually, which explains why such products generally belong to a higher price category. Likewise, chrome-plated components are polished before the plating process itself. In other words, polishing is also an essential part of decorative metal finishing.

The confusion simply arises because the name of this traditional trade has gradually disappeared from everyday use.

In plastic injection moulding, however, these methods simply would not be suitable.

The plastic, however, perfectly reproduces the surface of the mould during the injection moulding process. It follows the mould so precisely that even the tiniest scratches on the steel surface—far too small to be seen with the naked eye—will be reproduced on the plastic part. In other words, the plastic surface will faithfully replicate the surface of the mould in which it was formed.

Have you ever examined a chrome-plated component under magnification?

In precision polishing, we often work under a microscope. In many respects, our work begins where decorative metal polishing ends: carefully refining surfaces that already appear perfectly mirror-like to the naked eye.

This illustrates that polishing is actually a collective term covering several highly specialised disciplines. Depending on the industry, these disciplines differ considerably in their techniques, equipment and the level of expertise they require.

The tools used in precision polishing are, in many respects, comparable to those found in a dentist's practice, and even large surfaces are finished through meticulous, highly controlled manual work. **This is the field in which I can assist you.**

Decorative metal polishing, on the other hand, focuses primarily on improving the appearance of finished products and relies on larger, fundamentally different types of equipment that I do not use.

9. Questions and Answers.

On this page of my website you will find my answers to the questions you have asked.

1. Asking a question:

✔You can ask your question by e-mail (cskpolir@gmail.com).

✔For professional questions of general interest and questions related to my services,

✔I will answer them here, so that the answers may benefit us all.

✖Personal questions,

✖or questions involving confidentiality, will of course not be answered here.

Ask your question too!

10. About the author

After gaining 10 years of experience as a toolmaker, I founded my own business, CSKpolir, in 2016.

My aim is to provide high-quality precision hand polishing and surface finishing services for plastic injection moulds and other tools, with the primary focus always being on quality. I operate my business in such a way that its one-person structure guarantees the consistent quality provided by the same pair of hands. At the same time, despite its small size, my business is able to meet the expectations of large industrial companies thanks to its consistent and systematic way of working.



Further information and my contact details can be found on my website:
www.cskpolir.hu

Yours sincerely,

Csobánczy Krisztián
Sole Trader