WHITEPAPER

SECURING THE START OF PRODUCTION

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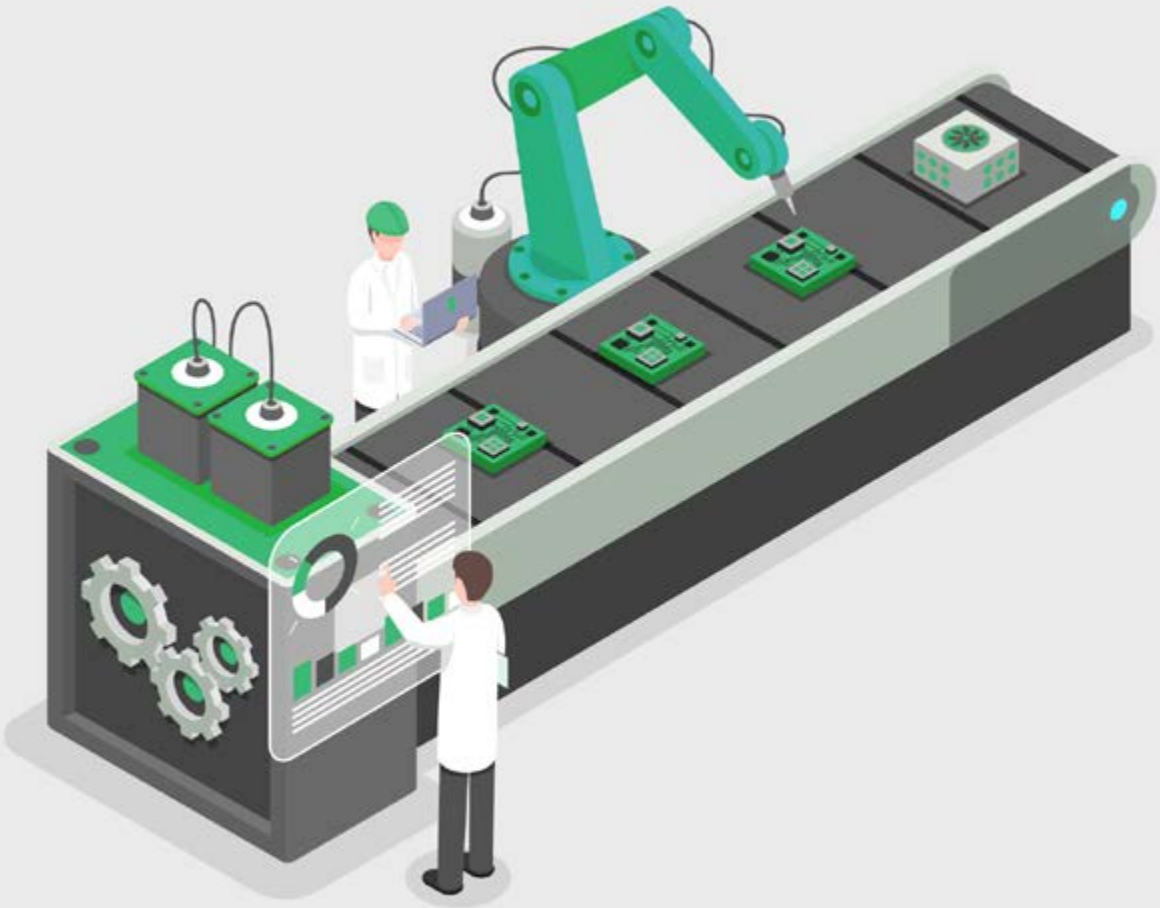

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SECURING THE START OF PRODUCTION

How to reduce development times for rubber and plastic components, cut costs and optimize products

Industrial companies that want to survive in international competition need to produce their products faster, more efficiently and at lower cost. This goal can be achieved in several ways. One path that development teams still tread too rarely concerns the handling of rubber and plastic components.

In this white paper, we describe measures your company can take to reduce development times, cut costs and optimize products. Among other things, you will learn:

1. Why supposedly simple rubber and plastic components can delay the Start of Production (SOP).
2. How careful project management helps keep development budgets and schedules on track.
3. Why it pays off to discuss mold concepts with material experts at an early stage in order to keep costs, resource consumption and the carbon footprint of the components as low as possible.
4. What advantages result from intelligent material selection.
5. What you should consider with regard to testing and validation measures.
6. How to increase your supply security when procuring raw materials.

1 RUBBER AND PLASTIC ARE NOT GAP-FILLERS

Rubber and plastic parts are rarely among the core components of a machine. As a result, they are usually neglected in the design process. If, for example, companies need a seal between two housing parts, many development teams believe that "all that is needed is some rubber". There is then just as little discussion about the specific design of the component as there is about improvement potential that can be tapped through factors such as intelligent material selection or modern tooling concepts. This attitude can lead to problems in practice.

Design drawings are too often focused on metal

In many cases, the development of components made of rubber and plastic is complex and time-consuming. Despite this, corresponding components are often considered at a late stage in the product engineering process (PEP), sometimes even after the surrounding metal components have already been designed. This provokes errors, for example, if the available installation space for elastomers is not optimally designed or suppliers cannot design the part in the intended shape. The result: additional development loops that delay the planned start of production of the assembly or machine.

Rubber and plastics are integral components of machines

Even if a component can be industrially manufactured as planned, careless handling of rubber and plastic is risky. For example, if companies invest too little time in the design of a seal, this can have a negative impact on its reliability and service life. In the worst case, the seal will fail after a short period of time in use and shuts down the entire plant or machine. The consequences are production downtime, high follow-up costs or even loss of reputation.

Companies that want to improve their development processes must correctly classify the value of the functions of rubber and plastic. They are not gap-fillers, but integral components of a machine. They must be considered in the product development process just as thoroughly as more expensive metal or electronic components. In this way, companies can safeguard ambitious development plans at an early stage.

Tip: Weigh up material costs

In some cases, companies deliberately opt for rubber or plastic components with a low price and short service life, which are replaced regularly if necessary. This may initially seem sensible from a financial point of view, but it affects the reliability of the material as well as the service life of the machine or system. In addition, this can result in high repair costs or even production downtime, for example, if foreign substances leak or penetrate at the wrong place and thus endanger functionality.

During the selection process, development teams should therefore always seek an exchange with material experts. In combination with an energy-efficient and resource-saving tool design, this can simplify the geometric complexity of the components, reduce tooling costs and ultimately lower part prices.

2 CONSIDER RUBBER AND PLASTIC PARTS IN PROJECT MANAGEMENT

When components made of rubber or plastic cause problems in the product development process, it is often due to errors that occur in the early stages of development. Many design teams have little experience with rubber and plastic; they tend to view the materials as a means to an end and focus on other priorities in their planning. Potential that could be leveraged through the intelligent use of materials therefore often remains untapped. In addition, there is a risk that material properties are not given sufficient attention and already designed components have to be adapted at a later stage.

Careful project management is essential when dealing with materials such as rubber. Companies achieve the best results when they define clear specifications with a view to the entire development process - from the functional requirements of the product and tooling concepts to manufacturing and testing procedures. To do this, all requirements for the planned component must be elicited at the beginning of development.

Design teams must ask the right questions

To design a rubber or plastic part in such a way that the specific properties of the materials are optimally exploited, companies must first ask the right questions:

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What is the intended use of the component?

The design of the component depends on its intended use. For example, is it a statically or dynamically stressed seal? Do the parts move due to the effect of pressure or tension? This information is important because it determines the essential requirements for the component (geometric design, material properties, number of sealing surfaces, etc.).

What physical and chemical conditions prevail in use?

Components made of rubber and plastic must be designed in such a way that their function is maintained even if they come into regular contact with other media. Accordingly, it is important to analyze the general conditions before selecting the material. The primary area of application is crucial - a seal must be resistant to fuels in a vehicle engine, for example. Furthermore the context of use is important. If a machine is operated outdoors, components made of rubber or plastic must also function in prolonged exposure to sunlight, for example.

What is the target price of the component?

The function that rubber and plastic can perform in the component and which material is suitable for this purpose often depend on the target price that a company wants to pay. The challenge is to develop the best possible functionality with a view to monetary targets.

In what quantity is the component to be produced?

The number of manufacturing processes in the rubber and plastics sector is high. Depending on the number of pieces, different tooling and material costs, among other things, arise as a result. Good preparation is also a key success factor here. Anyone who wants to cover the series production of several hundred 'machines with a single-caliber prototype mold for reasons of time and cost is ill-advised.

What is the environmental footprint of the component?

Vulcanization of rubber/elastomers requires temperatures of more than 160 degrees as well as high pressure for vulcanization. Plastic granules/thermoplastics, on the other hand, must be melted before they are injected into the mold, where they solidify again into complex geometries.

Both processes are fundamentally energy-intensive and, depending on the complexity of the mold, also generate a process-related proportion of waste. Vulcanization is an irreversible crosslinking process that gives rubber its specific elastic properties. Thermoplastics can be re-melted and re-molded.

In principle, however, the postulate of lowest material and energy consumption applies to both material groups in order to minimize the carbon footprint.

What needs to be considered during transport?

Rubber or plastic parts with sensitive lip geometries sometimes require special delivery conditions and intelligent packaging, which in turn affects transport costs. Material and process specialists must pay attention to this when designing the material (pressure stability, ductility, brittleness, etc.).

Materials expertise is the be-all and end-all

Further questions concern, among other things, the test procedures during production, test gauges, test and validation procedures, and the targeted service life of the product. Answers to these questions require a great deal of materials expertise, especially in the case of flexible rubber parts. It therefore makes sense for companies to call in expertise from outside. It has proven useful to discuss the topics listed here with a development partner (e.g. specialized supplier) right at the beginning of product development. The earlier specialists receive the requirements in the form of specifications, the more positively the development process can be influenced.

Cooperation with suppliers enables companies to close knowledge gaps and make the development of new products more efficient and cost-effective. Good partners provide fresh impetus through their process- and material-neutral view and question standards as well as design specifications if necessary - always with a view to the best possible material and process. This has a positive effect on the quality of the products developed, especially with regard to criteria such as sustainability and reliability.

Get development partners on board early

The degree of cooperation with partners varies from project to project. It has proven effective to integrate the suppliers into the development team from the beginning in order to design the components correctly from the start.

In addition, some companies rely on outsourcing entire development activities in the area of rubber or plastics to their partners. This partner is then not only responsible for the development and function of the component (material selection, testing and validation, etc.), but also manages all sub-suppliers and stakeholders involved.

Tip: Discuss specifications with the supplier

The specification sheet is the basis for manufacturers of rubber and plastic products to align a component with its intended use. The document contains all essential information the supplier needs for the development, from the target price to test criteria and packaging requirements. Experience has shown that if companies discuss the specifications with the supplier at the beginning of development, the supplier can produce the best results for its customers.

3 USE INTELLIGENT MOLD CONCEPTS

Mold production is often underestimated in injection molding manufacturing projects (whether rubber or plastic). Injection molds are not standard components. They are precision molds whose geometry must exactly match the design specifications, because even the smallest deviations can jeopardize the performance of the molded parts.

Molds have to be manufactured from scratch in every project, including suitable concepts for design, production and transport. It is obvious that this process involves numerous risks of error.

In mold making, four influencing factors are decisive

Mold making is often a project within a project, involving all the process steps commonly used in production. Companies can neither shorten nor accelerate this complex process. Accordingly, it is important that they consider the construction of the tools in their planning. In particular, they should focus on four influencing factors that can stand in the way of on-time delivery of the tool (and thus the start of production):

Avoiding errors

Companies can positively influence these factors by bringing experienced material experts on board as early as possible. Particularly in toolmaking, customers benefit from discussing project specifications with their supplier at the start of development. This makes it easier to carry out reliable scheduling and rule out errors as early as possible. Together with the development partner, they develop a tool concept that is suitable for the material and takes all project specifications into account. In order to do this, they discuss the specifications of the product in detail. Diligence is also the top priority at this point.

Design

In many cases rubber and plastic parts are designed, dimensioned and toleranced similarly to components made of metallic materials. As a result, rubber and plastic components are often not designed to suit the material and production process, and subsequently require iterative, time-consuming and costly adjustments.

Manufacturing

Companies under high cost pressure often rely on manufacturing partners from low-wage countries for tooling. Although the quality of these partners is comparable to that of German products, the coordination costs for the customer are very high. Different time zones and language barriers can make agreements extremely difficult and cause delays.

Transportation

Cooperation with low-cost suppliers from abroad can also lead to delays in transport (e.g. due to weather events or blocked seaports), especially in times of crisis. For critical components, working with locally based partners is usually the more predictable option.

Release

Even the smallest mold deviations from the design specifications can make the molded parts produced unsuitable. Therefore, companies must allow sufficient time for testing and validation measures.

Practical example: Making tooling concepts more sustainable

If companies take a closer look at existing tool concepts, astonishing results can be achieved. This is illustrated by a project we have developed with a manufacturer of commercial kitchens. The customer needed a rubber seal for its project, which was to be developed in close cooperation with our product and process development team. In particular, the company wanted support in developing the mold concept and selecting suitable materials.

The challenge

The customer's original mold concept corresponded to the classic transfer molding (TM) process. In this method, the rubber compound is poured into the upper part of a vulcanizing mold and injected by a press through channels into mold cavities.

The process is particularly suitable for complex parts with tight tolerances and for small and medium series. Vulcanization times can be greatly reduced, but there is increased material waste because a significant portion of the rubber compound vulcanizes in the distribution channels and overflow grooves as the press moves together. The ratio between part weight and waste weight is not ideal (up to 70% process-related material waste for small, filigree components).

The solution

Our customer wanted to reduce the process-related waste in the form of vulcanized elastomer with a special interest in reducing costs and achieving its own sustainability goals. Instead of developing a completely new mold concept, we decided to make selective improvements to the classic transfer process. This was essentially done by reducing the number of injection points. With the aid of pistons welded to the upper plate of the mold and inserted by the press into four cavities, the film gate in this case can be done from the inside, outside the sealing surface.

The result

Ultimately, this change enabled a more resource-efficient production with considerable material savings:

- Process-related expulsion was reduced by 83 percent.
- The weight of the compound required for production was reduced by 51 percent.
- The insert weight was more than halved from 833 to 405 grams.
- Overall, this resulted in a cost saving of 27 percent for the seal.

By using the optimized mold concept, our customer was able to achieve their project goals by making relatively simple adjustments to the existing machinery. Due to the lower output, the amount of rework required has fallen; in addition, the reduced compound consumption leads to a reduction in part costs and a process that conserves resources (even at low volumes). From now on the blanks have to be cut to size and weighed more accurately according to the new process. However, this is done outside the heating times and therefore does not determine the process-cycle. In other words: the advantages clearly outweigh the disadvantages here.

4 CLOSELY INTERLINK COMPOUND DEVELOPMENT, COMPOUND PRODUCTION AND LABORATORY TESTS

The selection of materials has a major influence on the properties of rubber and plastic products. Intelligent material selection can help reduce product costs (e.g., through weight reductions or reduced material usage) and improve the company's carbon footprint (e.g., in the form of reduced process-related waste). Wrong decisions, on the other hand, can worsen the functionality and reliability of the component (and thus also of the machine or plant).

The components of a rubber compound

Material selection is one of the most complex tasks in the development of rubber and plastic parts. Rubber compounds consist of a large number of raw materials and additives that influence both the processing and the properties of the final product. In addition to rubber, these include, for example, fillers, plasticizers, processing aids, crosslinking systems and various additives.

Development teams have to select a mixture of materials that fits the intended use of the product. This requires a great deal of know-how and experience. Especially since the components also interact with each other. So optimizing one factor can create undesirable effects in other areas.

Material selection requires sufficient lead time

Companies that have little experience with rubber or plastics should integrate material experts into the development team right from the start. Their expertise facilitates the targeted selection of the rubber or plastic compound and enables close integration of compound development, compound production and subsequent laboratory analysis of the physical properties. This linkage is the basis for target-oriented results.

The selection of materials is one of the first steps in the development of a new molded part. Especially in the case of compounds created specifically for the product, development teams must calculate a corresponding lead time for this; after all, the compound must first be tested in the laboratory with regard to its properties.

Companies can speed up the selection process enormously by working with specialists who can assess the requirements of different applications. Especially since rubber and plastics producers not only create new composition, but also have standard compounds that can be flexibly adapted to the specific requirements of the project.

Advantages of various materials

- Resistance against mechanical stress, good compression set and high tear strength
- Resistance against UV light or ozone (do not become porous under their influence)
- Resistance against high temperatures (retain their properties even in extreme heat or cold)
- Insensitivity to substances or media with which they come into contact (i.e. grease, mineral oil, gasoline, solvents, acids or bases)
- Insulating or conducting of electric voltage

Practical example : Reducing production costs through intelligent material selection

Sometimes companies approach suppliers with specific material ideas. This is not necessarily the best solution for the planned product. In our experience, it makes sense to question and, if necessary, adapt existing ideas regarding material composition and manufacturing processes. This is time-consuming, but has many advantages in the long run.

The potential that can be tapped in this way is shown by a project that Jäger Gummi und Kunststoff carried out with a manufacturer of agricultural machinery. We had already been producing rubber spring elements for the customer for some time, which the company uses to optimize the suspension of disc harrows on its agricultural machinery. The spring elements decouple the attachment from the tractor and give the machine more flexibility, which is particularly beneficial when working on uneven, stony ground. The customer can thus significantly increase the machine´s lifetime.

The challenge

Large-volume components, such as those involved in this project, require high energy consumption and carbon emissions during production. This is due to the long heating times required to vulcanize the rubber compound. In order to reduce energy costs in its production, the agricultural machinery manufacturer wanted to adapt the composition of the compound on which the rubber spring elements are based. The properties of the original formulation were to be retained.

The solution

Our first approach was to adapt the compound to reduce heating times and optimize the filler composition in terms of cost. We achieved this by adjusting the crosslinking system, which in turn increased the crosslinking speed. We were able to maintain the dynamic properties of the compound; in addition, the adjustments led to an increase in rebound, as requested by the customer. In addition, we made selective adjustments to the filler system, which also had a positive effect on costs without negatively affecting the properties of the compound.

The second approach was to reduce the heating time in the hot press by sensible annealing. This allowed us to reduce the press load without changing the crosslink density. The molded part is first produced in the heating press and then removed earlier than originally planned so that it can be reheated in a hot-air oven. The desired vulcanization effect and sufficient crosslink density can also be achieved in this way, while the dwell time in the press is significantly reduced.

The result

Both solutions helped the customer to significantly reduce its energy and time consumption in the production of the component. The reduction in heating times alone was between 15 and 35 percent across various products we produced in this category. The customer was able to improve its carbon footprint, optimize its machine utilization - and thus reduce its production costs.

5 EXTENSIVE TESTING OF CRITICAL MOLDED PARTS MADE OF RUBBER AND PLASTIC

Components made of rubber and plastic do not usually enjoy high priority in product testing and validation. As a result, defects in components such as seals or damping (e.g. leaks or undesirable vibrations) often come to light very late in the product engineering process (PEP), which increases the number of development cycles and can result in follow-up costs. In the worst case, the components fail to perform in practice, so that the manufacturer's reputation is permanently damaged (e.g. in agriculture with its tight harvesting and sowing times).

Check component and compound

To avoid such problems, companies must extensively test and validate critical rubber or plastic components. Realistic (long-term) testing helps to identify and eliminate weaknesses long before the start of production. When dealing with rubber and plastic parts, two areas are important in this regard:

a) Functional tests on the finished component (e.g., a gasket).

b) The control of the material compound in the laboratory (tensile strength, compression set test, elongation at break, abrasion resistance, etc.).

Testing activities can be very time-consuming and costly in the rubber and plastics sector, especially if the development teams have no experience with these materials. Companies that want to ensure the quality of their products also benefit from working with specialized development partners. Their expertise makes it easier to integrate testing and prototyping into the PEP in a meaningful way and to reduce the number of development cycles. Experience shows that this opens up competitive advantages, as the end product is developed faster and more reliably.

Testing and validation measures

In order to provide their customers with the best possible support, suppliers need all test-relevant information about the product (test criteria, etc.) and - if possible - (prototype) parts. Specialized suppliers usually have the necessary tools and can design suitable fixtures if required. Computer-aided load configurations, for example, allow different geometries to be compared and component life to be estimated.

It is also common to design test fixtures that replicate the use of the component and test its functionality in interaction with surrounding components. Testing that takes place directly in the customer's plant or machine in turn reveals optimization potential and bottlenecks in production.

It is important that companies investigate the physical and chemical properties of the material of the components. Here in particular, suppliers make an important contribution with their own laboratory tests. Decoupled from pure design, they not only define the ideal composition of the rubber or plastic, but also test it using test specimens in selected media and temperature profiles, among other things. These simulations usually reduce the overall effort up to the field test enormously.

Unfortunately, it is not possible to make a blanket statement about which testing and validation measures are necessary for rubber or plastic parts. This always depends on the requirements of the product. It is important to note that testing is not always justified in terms of its cost. Therefore, companies should coordinate with their development partner as early as possible which tests and validation activities actually make sense in their project.

Tip: Use ready-to-install assemblies

If an assembly combines components from different manufacturers, it can happen that the individual parts do not fit together, even though they have passed the quality tests of the respective suppliers. The reason for this is the smallest deviations from the design dimensions, which are so small that they fall below the manufacturer's tolerance values. Particularly in the case of filigree parts, it therefore makes sense to purchase assemblies from a production partner. This makes it easier to precisely match individual parts and avoid delays in assembly. The customer receives a field-tested, production-ready "plug-n-play" part that they can easily integrate into the overall system.

6 INCREASE SUPPLY SECURITY IN RAW MATERIAL PROCUREMENT

Crises such as the Corona pandemic can have a major impact on the demand for raw materials and supplies. This does not only affect their prices, but also their availability. When demand is high, certain raw materials are not always available on the desired date, which can lead to delays in production. In some cases, the available quotas are also so severely limited that companies can only obtain them in small quantities.

In the rubber and plastics sector in particular, manufacturers very quickly become dependent on certain raw material suppliers. For example, there are raw materials that can only be obtained from a small number of suppliers. These monopolistic or oligopolistic structures cannot always be avoided in procurement. However, we can at least cushion their effects.

Alternative materials and blending increase flexibility

It is advisable to consider alternative materials and compounds for components made of rubber or plastic, which can replace each other if necessary. The desired functionalities can often be realized with different compounds, so companies can significantly increase their flexibility with a little effort. This does lead to higher costs, as both solutions have to be sampled, among other things. At the same time, however, there is the opportunity to increase their own supply security and reduce dependencies.

Overlooking issues such as raw material shortages and sustainability, it also makes sense to take a fresh look at existing products. If a certain raw material is currently difficult to obtain or too expensive, it may be worthwhile to look for an alternative material. The resulting costs are offset by advantages in form of increased supply security (and possibly more efficient products that can be produced even cheaper).

Re-evaluate supply chains

In the course of raw material procurement, companies should also rethink the structure of their supply chain, if necessary. Complex supply chains that include raw materials, materials and components from all regions of the world sometimes harbor high risks. Political events, but also natural disasters, can lead to raw materials being temporarily unavailable very quickly. Taking countermeasures at short notice in such scenarios is difficult and cost-intensive. In this case, cooperation with local suppliers is the safer option, which also makes it easier to meet statutory climate targets due to the transport conditions.

CONCLUSION

The influence that components made of rubber and plastic can have on the product development process is underestimated in many projects. Their development is sometimes highly complex and time-consuming, especially when it comes to selecting the right compound for the application, developing mold concepts, and planning and implementing testing and validation measures. Numerous sources of error accure at this stage, which can delay projects, make them more expensive or even cause them to fail.

The most effective way for companies to avoid these errors is to work with a specialized, experienced supplier. Proactivity is crucial here. Experience has shown that if the customer and supplier join forces at the beginning of the project, the best results will be achieved in the form of more reliable products and optimized production and energy costs. This process starts with the specifications and includes all processes that are significant for the production of rubber and plastic components.

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Locations in Germany

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