The earlier manufacturing is considered in the product design process the greater the benefit in terms of cost and quality. **Andre Eichhorn** explains how in the first in a series of articles covering design for manufacturing (DFM)

Good product design needs a structured approach

A product is conceived as an industrial design and then, in most manufacturing organisations, is handed over to a mechanical design team charged with responsibility for making the product work. At this stage in the product development process, designers are primarily focused on aspects such as industrial design, functionality and robustness of the final product. Sometimes aspects such as tooling, material selection, moulding process and post processes - all of which have a critical influence in determining the ultimate cost of the component or product - are overlooked.

It is almost always easier to incorporate essential changes to the product at this early stage because the design is not fixed. In a recent mould project taken on by AST Technology, optimisation of the component design made it possible to reduce material usage by 26%, while also achieving improvements in filling, cooling time and overall part quality. Cycle time was halved.

The investment in design optimisation in this case paid off in costs; the part price using the original design was calculated at €0.43 but the improved design was calculated to €0.24. The annual saving, based on a volume of 450,000 pieces / year, was calculated to €85,000. Had these changes been applied to the design after the tool was built then cores and cavities worth thousands of Euros might have had to be rebuilt.

There are a very wide range of production-related factors that influence product design and, as a conse-

Figure 1:
Typical savings resulting from a structured DFM approach

Potential cost savings	
Material savings	5% - 25%
Moulding cycle time reduction	5% - 45%
Reduction in mould costs through standardisation	10% - 55%
Yield improvement by eliminating part defects	5% - 25%

Leadtime reduction	
Component design development	10% - 35%
Tool design approval process	5% - 40%
Mould manufacturing time	10% - 65%
Mould de-bugging time at the toolmaker	20%-50%
Mould validation	10% - 30%

quence, it is highly unusual to find a mechanical designer who is highly skilled in every area of required expertise. In general, suppliers such as mouldmakers and moulders are relied upon to provide this kind of specific technical input. However, because the supplier's main focus is always going to be on their own business, their feedback may not be as independent or as comprehensive as is needed. For example, some tool makers may not be very interested in the moulder's problems during production once the tool has been approved by the customer and has gone out the door.

The bottom line is that somebody has to oversee and manage all feedback during the product development process to ensure the right decisions are made. This can either be done internally by one of the members of the product development process chain, or it can be outsourced to an external third party with the required in-house expertise to oversee all areas from DFM (Design for Manufacturing) and tooling manufacture through to processing.

Using a structured DFM approach will allow the component and product design to be developed in a positive way with regard to cost and reliability. In addition, it will enable the customer to meet desired timelines for product launch. Missing a product launch and having the product not sitting on the shelves at the appropriate time can cost an OEM millions of euros. Reputations can also be damaged if a competitive product does not make it into the shops on time.

For example, material selection will determine a whole raft of product and processing criteria, including physical properties, filling of the component and component design features along the flow path, as well as the costs at any specific production volume.

Analyzing component geometry is the next important step, ensuring that the part can be filled and demoulded according to specification. By using tools such as CAD for demoulding and thickness analysis, flow analysis applications, and FEM and combining that with hands-on moulding experience, it is possible to optimise the design to ensure optimal material (resin) usage, fast cycle times and to deliver the expected part quality with high yields in production. It has been shown in previous projects that cycle time savings of up to 65% can be achieved. Also, information gained at this stage can be used to perform a precise prediction of production cost, giving regard to cycle time, tool concept, number of cavities or tools, and moulding equipment.

At the end of the DFM phase, all this data is collected before the tool is designed so it is possible to estimate the direct impact on cost and quality if some significant design changes take place. Cost-wise, it is worth taking the time during the DFM process to investigate new tooling technologies that can be incorporated into the component design because they could ultimately simplify the tool build and aid in production. For instance, in several cases in the caps and closures industry it has been found that the use of collapsing cores rather than unscrewing mechanisms can allow the wall thickness to be reduced as the caps will not have to withstand torque force during demoulding. Looking at only a 1% material saving on a production volume of 200 million caps per year will result in huge cost savings.

Most production problems can be determined and eliminated just by looking at the product design and specifications. Unfortunately, only 25-30% of all projects will follow a structured DFM approach. Troubleshooting moulds that are already in production or are close to being ramped up is always an expensive exercise. Implementing a proper DFM analysis will reduce the risk of failure and keep the project and production costs low and controlled. Figure 1 shows the potential scope for cost and lead time savings through successful adoption of DFM.

So how does this translate into practice? Figure 2 shows a real example of a component - part of an overall assembly - where it was necessary to invest in new tooling for all components because the tools had reached the end of their serviceable life. All of the parts had similar issues, including relatively poor visual quality, long moulding cycle times and high component costs. DFM and process development was carried out to correct these issues.

Working with the customer, all of the moulded components and mating parts were redesigned to keep the same function and performance while making significant cost and efficiency improvements. The final result was an annual total cost saving of €147,000. This was achieved by cutting quality defects to less than 0.2%, saving on raw material usage, and reducing moulding cycle time. It was also possible to reduce the number of mould cavities needed to achieve the required product volumes through more efficient part and mould design. This gave a relative cost saving of 35% on the original tooling investment cost and yielded not only a capital saving but also a shortened the time required to qualify and approve the mould tools. Part-to-part variation in production was also reduced.

About the author

Andre Eichhorn is general manager of AST Technology, which is based in Germany. This is the opening instalment in a series of articles discussing the benefits of taking a design for manufacturing (DFM) approach to product development. Future instalments will discuss key elements of good DFM practice, providing practical examples of how the principles have been applied and what benefits have been achieved. Next month: Correct specification of materials.

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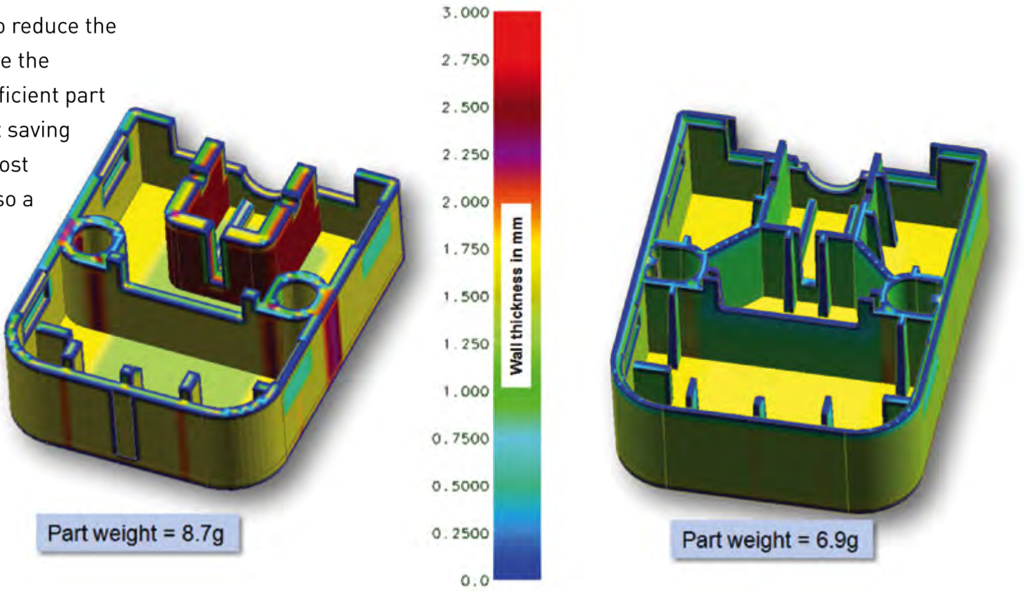

Figure 2: The use of DFM techniques resulted in a material saving of 21% in this part redesign, meeting all mechanical requirements while improving aesthetics and dimensional stability